ABSTRACTS
American Society of Animal Science

* Author Presenting Paper

GROWTH AND DEVELOPMENT AND DAIRY COMMITTEE SYMPOSIUM
Conjugated Linoleic Acid: Effects on Metabolism and Health

1   Biosynthesis of CLA and its incorporation into meat and milk of ruminants. D. Bauman*[1] and J. M. Griinari[2], [1] *Cornell University, Ithaca, NY USA,* [2] *Valio Ltd., Helsinki, Finland.*

Food products from ruminants are the major dietary source of CLA for humans. The uniqueness of CLA in ruminant fats relates to the biohydrogenation of unsaturated fatty acids by rumen bacteria. CLA is an intermediate in the biohydrogenation, and a portion escapes the rumen and is incorporated into fat. In addition, the animal itself synthesizes CLA from trans-11 octadecenoic acid, another intermediate in ruminal biohydrogenation which is absorbed. This involves delta [9]-desaturase which is present in mammary tissue (lactation) and adipose tissue (growth). Investigations to alter CLA content have typically involved lactating cows (milk fat) with less data from growing cattle (meat fat). Dietary factors which alter CLA content through effects on the rumen biohydrogenation processes include unsaturated fatty acid substrates (e.g. type and amount of plant lipids) and altered rumen environment (e.g. fiber level, ionophores). The cis-9, trans-11 CLA isomer is the major isomer found in ruminant fat and typically represents 90% or more of the CLA isomers in milk fat but its proportion in beef fat is only 60 to 85%. Thus, dietary factors also alter the direction of the biohydrogenation pathways in the rumen. CLA possesses anticarcinogenic effects and our recent work has shown this relates to the 9, 11 isomer as evident from results with the rat mammary tumor model. CLA also alters lipid accretion and nutrient partitioning in several species, effects frequently referred to as antiobesity. Our recent work demonstrates this relates to the 10, 12 and the 8, 10 CLA isomers as evident by milk fat depression in lactating cows.

Key Words: conjugated linoleic acid, CLA, fat

2   Identification of the CLA isomer responsible for milk fat depression. L. Baumgard*[1], B. Corl[1], D. Dwyer[1], A. Saebo[2], and D. E. Bauman[1], [1] *Cornell University,* [2] *Natural Lipids Ltd.*

Conjugated linoleic acid (CLA), an octadecadienoic fatty acid, is a derivative of linoleic acid with conjugated double bonds which occurs naturally in meat and milk from ruminants. CLA has been shown to be anticarcinogenic, antiatherogenic, antidiabetic and an immune stimulant. In addition, it has profound effects on lipid metabolism. We previously reported abomasal infusion of CLA caused a 50% reduction in milk fat synthesis. Our objective was to evaluate effects of specific CLA isomers on milk fat synthesis. Three multiparous Holstein cows (111 ± 12 DIM) were utilized in a 3x3 Latin square design to determine effects of 2 specific CLA isomers on milk yield and composition. Treatments consisted of 4-d abomasal infusion of 1) control, 4 L of skim milk/d (adjuvant), 2) 9,11 CLA, 10 g/d of cis-9, trans-11 CLA isomer and 3) 10,12 CLA, 10 g/d of trans-10, cis-12 CLA isomer. CLA isomers represented .05% of DMI. Data represent the means from days 3 and 4 of infusion and were considered significant at P<.05. Treatments had no effect on DMI, milk yield, protein yield, or SCC. Relative to control and 9,11 CLA, infusion of 10,12 CLA caused a reduction in milk fat percent (3.04^a, 2.94^a, 1.92^b) and milk fat yield (1068^a, 1086^a, 696^b g/d). Infusion of 9,11 CLA increased the milk fat content of cis-9, trans-11 CLA to 8.0 vs 4.9 mg/g in control. Infusion of 10,12 CLA increased milk fat content of trans-10, cis-12 to 3.9 vs <0.1 mg/g in control. Compared to control and 9,11 CLA, infusion of 10,12 CLA reduced *de novo* synthesized fatty acids by 44% (265^a, 275^a, 152^b g/d) and preformed fatty acids by 24% (471^a, 500^a, 370^b g/d). There were no treatment effects on the ratio of C16:0/C16:1 but infusion of 10,12 CLA increased C14:0/C14:1 (10^a, 11.9^a, 17.8^b) and C18:0/C18:1 (0.40^a, 0.51^a, 0.71^b). Treatment had minimal effects on plasma concentrations of glucose, NEFA, insulin or IGF-I. Results clearly demonstrate trans-10, cis-12 is the CLA isomer responsible for inhibition of milk fat synthesis. By analogy, 10,12 CLA would be responsible for the antiobesity effects in growing animals.

Key Words: CLA

3   Variation of milk fat concentration of conjugated linoleic acid and milk fat percentage is associated with a change in ruminal biohydrogenation. J. M. Griinari*[1], K. Nurmela[1], D. A. Dwyer[2], D. M. Barbano[2], and D. E. Bauman[2], [1] *Valio Ltd., Helsinki, Finland,* [2] *Cornell University, Ithaca, NY.*

Conjugated linoleic acids (CLA) have demonstrated a number of health benefits in animal models. Our previous work with lactating dairy cows has shown that a wide range of milk fat CLA concentrations can be produced (Kelly et al. 1998. J. Nutr.128:881). This study was conducted to produce milk fat with high CLA content. Cows (n=23) were fed a total mixed diet with 30% forage supplemented with sunflower oil

at 5.3% of dietary dry matter. Data presented here are based on milk samples (n=23) obtained on day 11 after the feeding of the sunflower oil supplemented diet was started. A subset of these cows which had the highest milk fat content of CLA (n=10) were sampled again on day 18. Concentration of cis-11 CLA in milk fat on day 11 averaged 2.5% of total fatty acids and the individual cows ranged from 0.7 to 4.9%. Unexpectedly, over the next seven days in the high CLA subset, milk fat content of cis-9, trans-11 CLA decreased from an average of 3.49 to 1.95%. Decrease in milk fat cis-9, trans-11 CLA was associated with a decrease in milk fat content of trans-11 C18:1 and with an increase in trans-10 C18:1 suggesting a change in ruminal biohydrogenation. Variation in milk fat concentration of cis-9, trans-11 CLA in the entire data set was closely predicted by concentrations of trans-11 C18:1 in milk fat ($y = 0.40x + 0.46$; $R^2 = 0.8$). Similarly, variation in milk fat concentration of another CLA-isomer, tentatively identified as trans-10, cis-12 CLA, was predicted by concentrations of trans-10 C18:1 in milk fat ($y = 0.013x + 0.011$; $R^2 = 0.7$). Furthermore, variation in milk fat percentage was predicted by concentrations of trans-10, cis-12 CLA in milk fat ($y = -9.1x + 3.47$; $R^2 = 0.5$). These data support the role of trans-11 C18:1 as a precursor of milk fat cis-9, trans-11 CLA over a wide range of trans-11 C18:1 supply. Data also provide additional support for our previous work (Griinari et al. 1998. JDS. 81:1251) indicating an involvement of trans-10 C18:1 and trans-10, cis-12 CLA in milk fat depression.

Key Words: CLA, Milk fat depression, Biohydrogenation

4   Examination of the importance of Δ^9-desaturase and endogenous synthesis of CLA in lactating dairy cows. B. A. Corl*[1], S. H. Lacy[1], L. H. Baumgard[1], D. A. Dwyer[1], J. M. Griinari[2], B. S. Phillips[3], and D. E. Bauman[1], [1]*Cornell University, Ithaca, NY,* [2]*Valio Ltd., Helsinki, Finland,* [3]*New Crops Research Unit at the National Center for Agricultural Utilization Research, ARS, USDA.*

Conjugated linoleic acids (CLA) are geometric and positional isomers of linoleic acid which have been shown to have a number of positive health benefits in animal models. CLA is an intermediate in the biohydrogenation of linoleic acid by rumen bacteria and it was thought this was the sole source of CLA in ruminants. However, we challenged this idea and our recent studies demonstrated that endogenous synthesis of CLA occurs from trans-11 C18:1, another intermediate in rumen biohydrogenation, via the enzyme Δ^9-desaturase (Corl et. al., J. Dairy Sci. 81 (Suppl. 1):233). Our objective in this study was to examine the importance of Δ^9-desaturase and the extent of endogenous synthesis of CLA. To do this, we used sterculic acid, a nineteen carbon fatty acid with a cyclopropene ring structure located between carbons 9 and 10, which specifically inhibits Δ^9-desaturase. Sterculic acid was isolated from the seeds of *Sterculia foetida*. We found the seeds contained 23% oil by mass, and sterculic acid comprised 55% of the fatty acids in the oil. The sterculia oil was prepared as an emulsion in skim milk which was abomasally infused into high producing dairy cows. In the preliminary study, 3 cows (140 ± 53 DIM) were abomasally infused for 4 d with the emulsion (10 g/d sterculia oil). Infusion had no effect on dry matter intake or the yield of milk and milk fat. However, milk fat composition was altered. Consistent with an inhibition of Δ^9-desaturase, the ratio of stearate to oleate was increased by 181%. Furthermore, the infusion of sterculia oil reduced CLA by 40%. This represents a minimum estimate of the contribution of endogenous synthesis of CLA and studies are in progress to refine this estimate. Nevertheless, it is clear that endogenous synthesis of CLA is a major source of CLA in milk fat.

Key Words: CLA, desaturase

5   Interactive effects between fat source and modified tall oil on growth performance and carcass characteristics of finishing pigs. J. C. Woodworth*, R. D. Goodband, J. A. Unruh, J. L. Nelssen, M. D. Tokach, A. T. Waylan, and P. R. O'Quinn, *Kansas State University, Manhattan.*

One hundred, forty-four pigs (initially 41 kg BW) were used to determine the interactive effects between fat source and modified tall oil (MTO) on growth performance and carcass characteristics. Pigs were blocked by ancestry and initial weight and randomly allotted to one of the twelve treatments arranged in a 2 X 2 X 3 factorial with main effects of sex (barrows (B) or gilts (G)), MTO (0 or .5% of the diet), and fat source (no added fat (NF), 6% choice white grease (CWG), or 6% poultry fat (PF)). Corn-soybean meal diets were fed from 41 to 66 (1.1% lysine) and

66 to 113 (.75% lysine) kg. Overall, B had greater (P < .0001) ADG and ADFI compared to G. Modified tall oil had no effect (P < .16) on ADG, ADFI, or G/F. Pigs fed diets containing PF had decreased (P < .01) ADFI and increased G/F compared to pigs fed diets containing NF or CWG with pigs fed CWG having intermediate response. A fat source X sex interaction was observed for G/F, with G fed NF having lower (P < .05) G/F than B; however, G fed PF had higher G/F than B. When pigs reached 113 kg, one pig per pen was slaughtered to measure carcass characteristics. Gilts were leaner, had increased LMA, lean %, and pH and had firmer bellies compared to B (P < .04). Belly firmness was improved (P < .06) by MTO. Pigs fed PF had increased (P < .002) average backfat thickness compared to pigs fed NF. Pigs fed CWG had firmer (P < .008) loins compared to pigs fed PF, and decreased (P < .04) longissimus drip loss compared to pigs fed NF or PF. Pigs fed NF or CWG had firmer bellies than those fed PF (P < .05). Instrumental color of the longissimus muscle and fat was not affected by MTO or fat source (P < .40). In conclusion, regardless of fat source, MTO improved belly firmness. Added fat decreased ADFI and increased G/F. Pigs fed PF had the highest G/F, but the fattest carcasses and softest loins and bellies.

Key Words: Pigs, Fat, Modified Tall Oil

6   Conjugated linoleic acid (CLA): A ruminant fatty acid with beneficial effects on human health. M. A. McGuire*[1] and M. K. McGuire[2], [1]*University of Idaho, Moscow,* [2]*Washington State University, Pullman.*

Diet has a significant impact on human health. Although the human diet contains components which may promote cancer, it also contains components with a potential to prevent cancer. Research shows that ruminant fat contains an anticarcinogenic compound called rumenic acid (RA). This fatty acid is produced when dietary linoleic acid is isomerized by rumen bacteria during biohydrogenation and is one form of a family of fatty acids collectively called CLA. Although commercial sources of CLA contain other forms of CLA, ruminant fat contains primarily RA. Classic models of tumorigenesis in rodents have demonstrated that CLAs inhibit the growth of a variety of tumors. All studies demonstrate that CLA can be an effective inhibitor of tumor growth at concentrations in the diet less than 1%. The feeding of CLA during only the period of rapid mammary gland development, offers protection for life from mammary cancer. Further, protection from mammary cancer by CLA is independent of the amount or type (saturated or unsaturated) of fat in the diet. Moreover, RA and milk fat rich in RA can act to inhibit mammary tumor growth similar to results when commercial sources of CLA are fed, suggesting that RA is the anticarcinogenic CLA. Humans appear to produce little CLA in their bodies and thus, diet is probably the primary source. We have shown that CLA intake influences CLA content of blood and breast milk. This may be significant, since diets rich in dairy products and beef could supply humans with the level of CLA necessary for protection from cancer. Other evidence suggests that CLA can influence atherosclerosis, growth, immune function and diabetes; reinforcing the important role of ruminant fat in establishing optimal human health. Together, these relatively recent findings concerning the health benefits of CLA (and specifically RA) suggest that ruminant fats remain a significant part of the human diet. One way to accomplish this without increasing energy intake is the use of butter, instead of margarine or other non-dairy substitutes.

Key Words: Conjugated Linoleic Acid, Rumenic Acid, Health

7   Effects of modified tall oil on body composition and serum and tissue levels of α-tocopherol, cholesterol, and phospholipids in ovariectomized rats. P. R. O'Quinn*, S. I. Koo, S. K. Noh, J. L. Nelssen, R. D. Goodband, and M. D. Tokach, *Kansas State University, Manhattan.*

Adult ovariectomized rats (a model for post-menopausal women) were assigned (n = 13/group) by BW (initially 256.8 g) to either a standard AIN-93G diet containing 8% α-tocopherol (αTP)-stripped soybean oil or the same diet containing 1% modified tall oil (MTO) at the expense of soybean oil. Diets were matched in fatty acid profile except for the isomers of conjugated linoleic acid found in MTO. Rats were pair fed (90% of *ad-libitum* intake) twice daily for the duration of the 6 wk trial. By 3 wk, rats fed MTO had reduced (P < .05) BW; this trend continued for the duration of the trial. Rats fed MTO had higher (P = .05) non-protein respiratory quotient (RQ) and lower (P = .05) heat production

(KJ/hr/BW(kg)) when measured over a 44-hr fast, indicating more efficient utilization of glucose substrates by rats fed MTO. Rats fed MTO also had lower total body fat (P < .001) and more lean tissue (P < .05) measured via dual energy X-ray absorptiometry (DEXA). Serum total cholesterol and phospholipids (PL) did not differ between groups (P > .05), but rats fed MTO had lower αTP levels (P < .005) at 4 and 6 wk. Total cholesterol, PL, and αTP levels in the heart and brain were not affected by diet; rats fed MTO had higher (P < .05) total cholesterol in the liver, kidneys, and abdominal and retroperitoneal fat. Rats fed MTO also had higher (P < .05) liver PL, lower gastrocnemius αTP, and higher abdominal fat lipid content. Rats fed MTO had enhanced (P $\leq$ .005) abdominal and retroperitoneal fat αTP over control rats (134.11 vs 81.66 nmol/g and 128.51 vs 92.87 nmol/g for rats fed MTO and the soybean oil control diets, respectively). These results suggest that, unlike growing pigs, adult ovariectomized rats fed MTO grow slower due to a decreased efficiency of gain, were leaner, had less total body fat, used glucose substrates more efficiently for fuel during fasting, and preferentially deposited αTP in fat tissues when compared to rats fed a control diet.

Key Words: Modified tall oil, Body composition, α-tocopherol

8   Anti-diabetic effects of dietary conjugated linoleic acid (CLA): Isomer-specific effects on glucose tolerance and skeletal muscle glucose transport. J. Ryder[1], D. Bauman[2], C. Portocarrero[3], X. Song[1], M. Yu[1], D. Barbano[2], J. Zierath[1], and K. Houseknecht*[3], [1]*Karolinska Institute,* [2]*Cornell University,* [3]*Purdue University.*

CLA are geometric and positional isomers of linoleic acid. Although the role of specific isomers has not been established, CLA have anti-cancer, anti-atherogenic and anti-obesity properties. We have reported that CLA improves glucose tolerance in ZDF rats and activates PPARγ response elements in vitro. It is not known which CLA isoforms are responsible for the anti-diabetic effects. Here, our aim was to elucidate the mechanism(s) by which CLA (2 different isomer mixtures) improves glucose tolerance. Male normoglycemic, prediabetic ZDF rats were fed either control diet (C), CLA oil supplemented diet (1.5% CLA; 50% c9, t11, 50% c10, t12 isomers; COIL), high CLA butter supplemented diet (1.5% CLA; 90% c9, t11 isomer; BUTTER) or were pair-fed (P) the C diet to match the intake of COIL rats. Following 11 d of treatment, glucose tolerance tests were performed. After 14 d of treatment, 3-O-methylglucose transport into soleus and EDL muscles was assessed. Insulin (IN)-stimulated PI3-kinase activity was determined in soleus and EDL muscles. COIL rats ate fewer g of food and grew more slowly than C fatty rats (P<0.05). BUTTER rats weighed more than all other treatments (P<0.05). Although food intake was identical, final body weights were lower for COIL vs. P rats (P<0.05). Epididymal fat pad weight was reduced by both COIL and P (P<0.01) compared to BUTTER or C. There was no effect of treatment on glycogen in liver or muscle of fed rats. Plasma trigylcerides were lower in COIL and BUTTER vs P or C (P<0.03). Fed blood glucose and IN were reduced in COIL and P rats compared to C or BUTTER (P<0.05). Glucose tolerance was improved by COIL but not BUTTER compared to C (P<0.01). Pair-feeding had an intermediate effect on glucose tolerance compared to COIL. Glucose transport into EDL muscle was not improved by any treatment. COIL but not BUTTER or P, increased IN-stimulated glucose transport into soleus muscle compared to C (P<0.01). PI3-kinase activity in EDL and soleus was not affected by treatment. Thus the anti-diabetic effects of CLA appear to be specific for the c10,t12 isomer. Furthermore, the improved glucose tolerance in COIL rats is due, at least in part, to increased IN-stimulated glucose transport into soleus muscle, and cannot be explained simply by reduced food intake.

Key Words: Fatty acid, Insulin, CLA

9   Feeding conjugated linoleic acids (CLA) decreases lipogenesis and alters insulin responsiveness in porcine adipose tissue explants. M. L. Heckart*, J. M. Eggert, A. P. Schinckel, S. E. Mills, and S. S. Donkin, *Purdue University, West Lafayette, IN.*

Dietary conjugated linoleic acids (CLA) have profound effects on body composition and glucose homeostasis in several species. The addition of CLA to diets for swine may be a strategy to alter glucose utilization for lipogenesis in favor of energy partitioning towards lean growth. Thirty pigs from each of two genetic populations characterized by high or average carcass lean percentage (54 vs 52% fat-free lean) were fed a corn and soybean meal diet with the addition of 0 or 0.6% conjugated linoleic acids (CLA) in a 2 $\times$ 2 factorial arrangement of treatments. Pigs were serially slaughtered at 23, 46, 68, 91, 114 and 136 kg body weight to obtain subcutaneous adipose tissue. The effect of insulin (0, 100 nM) on lipogenesis (nmol glucose incorporated into total lipids $\cdot$ h-1 $\cdot$ mg tissue -1) from 5.5 mM U-[14C]glucose was determined during a 2 h incubation period. Basal lipogenesis was not different between the two genotypes (8.6 vs 9.1; high lean vs low lean). There were no interaction effects (P > .05) for CLA $\times$ genotype $\times$ body weight $\times$ insulin, or CLA $\times$ insulin $\times$ body weight, or genotype $\times$ CLA, or body weight $\times$ CLA. There was a genotype $\times$ insulin effect (P < .05) which indicated insulin was more effective in low lean pigs. There was no CLA $\times$ genotype $\times$ body weight effect (P > .05). Basal lipogenesis was decreased (P < .05) in adipose tissue from pigs fed CLA (6.3 vs 11.3; CLA vs. control) as was lipogenesis in the presence of 100 nM insulin (15.1 vs 24.3; CLA vs. control) characterized by a CLA $\times$ insulin effect (P < .05). The basal rate of lipogenesis was depressed by 54% and the direct effects of insulin to stimulate lipogenesis were dampened with the addition of CLA to diets of growing pigs. These data support weight- and genotype-independent effects of CLA to reduce lipogenesis in growing pigs.

Key Words: Lipogenesis, CLA, insulin

10   Dietary conjugated linoleic acid (CLA) increases CD8 T lymphocyte subpopulation in weanling pigs. J. Bassaganya*, R. Hontecillas, K. Bregendahl, M. Wannemuehler, and D. R. Zimmerman, *Iowa State University, Ames.*

Cytotoxic T cells constitute the main subset of T lymphocytes expressing, along with suppressor T lymphocytes, CD8 co-receptors on their membrane. CLA, a mixture of positional and geometric isomers of linoleic acid, induces changes in the proportions of recirculating T lymphocytes in early-weaned pigs. To further understand the effects of CLA on cell-mediated immune response, T lymphocyte subsets were measured by flow cytometry. A factorial (2x4) arrangement within a split-plot design with four pigs from the same litter as the experimental unit for the environment, pig as the experimental unit for the CLA treatment, and day 0 as a covariate were used in data analysis. Management schemes were used to create two (dirty and clean) microbiological environments. A total of 32 (5.3 $\pm$ .3 kg) pigs were individually penned in each environment. Experimental diets were formulated to contain increasing amounts of CLA-60 (0, .67, 1.33 or 2%). Diets were formulated to exceed NRC (1988) nutrient recommendations for swine and were self-fed for 7 wk in three phases. Within phases, diets were isocaloric and isonitrogenous. Pigs were bled on d 0, 14, 28 and 42. On d 14, as dietary CLA increased, CD4 T lymphocytes increased linearly (24.9, 26.8, 33.1 and 34.1%; P<.0001), CD8 T lymphocytes were linearly reduced (31.2, 27.5, 18.3 and 16.7%; P<.0001), and a CLA x E interaction (P<.08) was described in CD4CD8 double positive T lymphocytes. On day 42, dietary CLA produced both a linear increase of CD8 T lymphocytes (21.7, 22.3, 28.0 and 32.7%; P<.001) with a concomitant linear decrease of CD4 T lymphocytes (27.3, 26.0, 26.0 and 22.7%; P<.02). We demonstrated that cytotoxic T lymphocytes increase following a phase of helper T lymphocytes (CD4) predominance in response to CLA. Therefore, our data are consistent with the anticarcinogenic properties of CLA and its reported immunomodulating effects. Furthermore, we identified changes in the populations of CD4CD8 double positive T lymphocytes indicating possible effects of CLA on the process of differentiation of T lymphocytes.

Key Words: Conjugated linoleic acid, T lymphocytes, pig

MEAT SCIENCE AND MUSCLE BIOLOGY SYMPOSIUM
Roles of the Calpain/Calpastatin System in Muscle Growth and Meat Quality

11   The calpain system: its proteins, properties, and secrets. D. E. Goll*, V. F. Thompson, and J. Cong, *University of Arizona*.

The first protein of a group of proteins now identified as belonging to the calpain system was purified in 1976. The calpain system presently is known to be constituted of three well-characterized proteins; several lesser studied proteins that have been isolated from invertebrates; and 10 mRNAs that encode polypeptides, which based on sequence homology, belong to the calpain family. The three well-characterized proteins include two calcium-dependent proteolytic enzymes, μ-calpain and m-calpain, and a protein, calpastatin, that has no known activity other than to inhibit the two calpains. A substantial amount of experimental evidence accumulated during the past 25 years has shown that the calpain system has an important role both in rate of skeletal muscle growth and in extent of postmortem tenderization. Calpastatin seems to be the most variable component of the calpain system, and skeletal muscle calpastatin activity is highly related to rate of muscle protein turnover and rate of postmortem tenderization. The current paradigm is that high calpastatin activity:1)decreases rate of muscle protein turnover and hence is associated with increased rate of skeletal muscle growth; and 2)decreases calpain activity in postmortem muscle and hence is associated with a lower rate of tenderization. The properties of the calpain system will be reviewed and regulation of its activity in living and postmortem muscle will be discussed.

Key Words: Calpain, Calpastatin, Muscle-specific calpain

12   Molecular features of striated muscle calpastatin. S. Lonergan*, *Iowa State University, Ames, IA*.

Calpains are ubiquitously distributed intracellular calcium - dependent cysteine proteinases that are thought to contribute to diverse processes such as myoblast differentiation/fusion and myofibrillar protein turnover. Calpastatin, the endogenous proteinaceous inhibitor of the calpain enzymes, has been found in all the tissues that contain calpains and is hypothesized to play a major role in the regulation of calpain proteolytic activity. Calpastatin binds to calpain domains IV and VI (the calcium binding domains) in the presence of calcium and inhibits calpain activity. The interaction of calpastatin with the calpains is reversible with both molecules retaining activity following dissociation of the calpain/calpastatin complex. Striated muscle calpastatin from mammalian and avian species examined to date exhibits a structure of four repeats of mutually homologous sequences at an interval of about 140 amino acids. An alkaline N-terminal region is referred to as domain L, and the repetitive acidic domains are known as domains 1, 2, 3, and 4. Three highly conserved regions within domains 1, 2, 3, and 4 are apparently responsible for calpain inhibition. A previously undefined N-terminal region containing 68 amino acids ("XL" region) has recently been characterized as a potential site for phosphorylation of newly synthesized calpastatin by cAMP-dependent protein kinase. The bovine calpastatin promoter appears to be up - regulated by dibutyryl cAMP. Consequently, the calpastatin promoter and protein appear to be at least partially regulated by cAMP-dependent protein kinase pathways. A broad range of molecular weights has been reported for purified tissue calpastatins (from 24-172 kDa). Alternative splicing, different translation initiation sites, and proteolytic processing may explain a portion of this variation. Intuitively, variation in calpastatin structure or phosphorylation may influence cellular localization or binding and inhibition of calpains. However, the physiological significance of these documented variations in calpastatin is not clear. Definition of molecular structure, function and diversity of calpastatin will aid in developing an understanding of regulation of calpain mediated processes in striated muscle.

Key Words: Calpastatin, Striated Muscle, Proteinase Inhibitors

13   Possible role of the calpain proteolytic system in muscle growth and development: A review. M. Koohmaraie*, D. J. Nonneman, and G. H. Geesink, *USDA-ARS, U.S. Meat Animal Research Center*.

The objective of this presentation is to review the potential roles of the calpain proteolytic system in prenatal and postnatal muscle growth and development. The involvement of the calcium-dependent proteases,

the calpains, and their specific inhibitor, calpastatin, in muscle growth and differentiation is well documented. The expression of calpains and calpastatin during prenatal muscle growth and development is well described, as well as the requirement of m-calpain for myoblast fusion. The involvement of skeletal muscle-specific calpain (skm-calpain) in muscle physiology, however, is poorly characterized. An important role in muscle growth and development is anticipated, since it is expressed primarily in skeletal muscle at an early stage of development and throughout adulthood. The expression of skm-calpain in myoblasts mirrors that of m-calpain during fusion and differentiation. Skm-calpain is more stable in muscle than previously thought; its autolysis proceeds more slowly in situ than it does in vitro which may allow us to elucidate its regulation in situ. Also, mutations in the skm-calpain gene in humans leads to a limb-girdle muscular dystrophy (type 2A), and skm-calpain antisense treatment of myotubes results in myofibrillar disorganization. Mutations of other calpains or calpastatin have not yet been described, suggesting that these would be lethal. In postnatal muscle, the calpain system serves as a major regulator of protein turnover. The nature of this regulation has been described experimentally through beta-agonist or glucocorticoid administration, and a genetic model, the callipyge lamb. Finally, calpains are also actively involved in muscle (and other tissues) atrophy in concert with caspases; however, it is not clear if their role is permissive, consequential, or active in this process.

Key Words: Muscle, calpain, Calpastatin

14   Possible role and regulation of the calpain/calpastatin system in meat quality. E. Huff-Lonergan*, *Iowa State University, Ames, IA*.

Postmortem processes that govern meat quality are highly complex. This is due, in part, to the myriad of changes occurring in the tissue as living muscle is converted to meat. Additionally, factors inherent in muscle may vary between individual animals at the time of slaughter and also contribute to variations in meat quality. One important quality attribute that can differ widely is tenderness. As meat is held for a period of time postmortem it becomes more tender. This tenderization is associated with the degradation of myofibrillar/cytoskeletal proteins. The protease mu-calpain is implicated as a major causative agent of myofibrillar/cytoskeletal protein degradation. Calpastatin has been hypothesized to regulate the postmortem degradation of myofibrillar/cytoskeletal proteins by calpain. The precise factors regulating the interaction between calpain and its inhibitor, calpastatin or between calpain and its substrates have not been definitively identified. Mu-calpain is a member of a family of calcium-dependent cysteine proteases that depend on reducing conditions to be active. Therefore, one factor that may dramatically impact postmortem calpain activity and postmortem protein degradation is the sub-cellular environment. For example, the ability of postmortem tissue to maintain reducing conditions is compromised. Since mu-calpain is sensitive to oxidizing conditions, the redox capacity of the tissue may impact myofibrillar/cytoskeletal protein proteolysis by mu-calpain. In addition, as muscle is converted into meat, the environment changes within the tissue to create conditions of low pH and relatively high ionic strength. These conditions may alter protein conformation and protein interactions. Information regarding the effect of postmortem conditions on the activity of mu-calpain, the interaction between mu-calpain, its inhibitor and its substrates can yield important clues regarding the regulation of postmortem meat tenderization and the development of meat quality attributes.

Key Words: calpain, calpastatin, meat tenderness

PASTURES & FORAGES SYMPOSIUM
Point-Counter-Point What is the Appropriate Experimental Unit in Grazing Research?

15 A liberal interpretation of the term experimental unit. C. P. Bagley*, *Mississippi State University*.

The term experimental unit(EU)is defined as the unit to which one application of a treatment is applied, and the effects of that treatment are measured on the sampling unit. Frequently, the sampling unit is defined as the pasture containing animals, not animals,resulting in a conservative definition of EU. Statistical evaluations of experiments are made to determine the reliability of biological results, and the associated levels of confidence for inferences regarding the extension of that information to populations under study.Due to financial and logistical constraints, the number of animals and paddocks are generally limited in grazing experiments. Generally, the biological impact of treatments on cattle are of major interests due to financial considerations. Estimates are that pasture variation has a CV of about 5%, compared to 10-30% for animals.The importance of the effects of treatments causing variances in animals creates a compelling reason to utilize animals as the EU in studies where possible. Because animals vary (higher CV)more than pastures, using animals as the EU may result in more difficulty in reporting treatment differences. Combining animals and paddocks as the error term when possible, after sequential tests for both, can give a conservative and appropriate test for significance. Several studies have shown large variances with group treatments,so animal as EU may be appropiate.Studies have shown problems associated with group feeding and/or the impact of varying levels of individual animal intake within a group on performance; reasons to be aware of group dynamics in treatment effects.The group dynamics are best measured, in many cases, where the EU is the animal.

Key Words: Experimental unit, Statistical methods

16 A conservative definition of the term experimental unit. D. S. Fisher*, *USDA-ARS, Watkinsville, GA*.

The definition of the term experimental unit has been established since the foundation of agricultural statistics and cannot be logically altered. The experimental unit is the unit of experimental material to which a treatment is applied. This definition provides the foundation of the definition of experimental error, which is the variation among observations of experimental units treated alike. Randomization is an implied characteristic of distributing treatments among experimental units. At times, sampling within an experimental unit is confused with replication. Logistical concerns and a desire for increased efficiency and productivity in research may produce a strong desire to redefine the experimental unit. This can result in the use of an inappropriate statistical model that infers an experimental design that was not really applied to the research in question. Regression analysis has been used to provide an alternative to traditional replication but also results in risks that some scientific communities and journals may find unacceptable for publication. For example, this issue has resulted in differences of opinion in the analysis and publication of unreplicated stocking rate studies. In addition, some studies are conducted on experimental units that are so large or unique that no replication occurs within the study but rather, in essence, a single replication is published as a case study (with no estimate of experimental error) for comparison with other similar case studies. Each scientific community interacts to establish standards for experimental design and analysis. What is accepted in one community or field of science as common practice may be unacceptable in another. In part, standards vary because of the logistics of conducting research in a particular field of science and based on what is considered to be an acceptable level of risk in the reliability of the results. The risk is associated with reduced accuracy in the determination of the experimental error and consequently the reduced confidence in the accuracy of the estimates of the parameters.

Key Words: Experimental Error, Experimental Design, Statistics

PHARMACOLOGY AND TOXICOLOGY SYMPOSIUM
Phytochemicals as Nutriceuticals

17 Medicines from plant poisons: biomedical applications. L. F. James*[1], W. Gaffield[2], K. E. Panter[1], B. L. Stegelmeier[1], R. J. Molyneux[2], and D. R. Gardner[1], [1]*USDA-ARS-Poisonous Plant Research Laboratory, Logan, Utah, USA*, [2]*USDA-ARS=Western Regional Research Center, Albany, California, USA*.

Certain plants biosynthesize and accumulate chemical compounds that have adverse effects on various biological systems of the body when consumed by animals. It is therefore not unreasonable to suppose that by changing the dose expected outcome maybe altered and that these bioactive constituents could be manipulated to yield more positive results. Moreover the information gained from research on poisoning of livestock by plants has yielded valuable information in relation to veterinary medicine and human health and disease. One such example is the cyclopian-type malformation occurring in lambs born from ewes that graze *Veratrum californicum* on the 14th day of gestation. The causative agent, cyclopamine, has been shown to regulate genes involved in development and this information is now being used to study facial birth defects and other health problems in man. Another example arises from certain lupines (*Lupinus* species), poison hemlock (*Conium mac-*

ulatum) and other plants that produce structurally related alkaloids. When cows graze these plants on days 40-70 of gestation skeletal malformations and cleft palates are produced in the calves. These results have been extended to goats fed the alkaloids during gestation and the prenatal kids with cleft palates thus produced are currently being used as a model to study the etiology of cleft palates and their surgical repair *in utero*. Some species of *Astragalus* and *Oxytropis*, known as locoweeds, when grazed by livestock induce abnormal behavior in the animal, wasting, habituation and skeletal birth defects, as well as congestive heart failure when grazed at high elevations. The toxin, an indolizidine alkaloid named swainsonine, inhibits certain enzymes, (mannosidases), essential for the correct processing of glycoproteins which are involved in structural and metabolic processes of mammalian cells. The study of this problem has led to the identification of many other glycosidase inhibitors in plants and a better understanding of the way in which glycoproteins influence the proper functioning of cells and cellular recognition. This information has stimulated research on the control of metastasis in the management of cancer.

Key Words: Poisonous plants, Biomedical applications, Livestock

PHYSIOLOGY AND ENDOCRINOLOGY SYMPOSIUM
Follicular Physiology

18 Factors regulating apoptosis during folliculogenesis in pigs. H. D. Guthrie*[1] and W. M. Garrett[1], [1]*Germplasm and Gamete Physiology Laboratory, ARS, USDA, Beltsville, MD*.

Apoptosis is recognized as the mechanism of death among female germ cells through all stages of folliculogenesis. The incidence of apoptosis is low (5 %) among oogonia and preantral follicles. However, we found that with antrum formation apoptosis increases among granulosa cells

so that as the proportion of apoptotic granulosa cells reaches 10 %, an average of 50 % of follicles are classified atretic. The exception to this is on days 3 and 5 of the cycle when 95 % of antral follicles are healthy, not atretic. However, on day 7 the proportion of atretic follicles is increased to about 50 % and the production of estradiol and inhibin subunit peptides and transcripts, and steroidogenic enzymes is decreased. During the earliest stages of atresia, estradiol and inhibin production decrease

as the proportion of apoptotic granulosa cells increases. In contrast, theca function was maintained in atretic follicles with progesterone production and expression of thecal 3beta-hydroxysteroid dehydrogenase positively correlated with apoptosis. During the mid-luteal phase of the estrous cycle the incidence of atresia averaged 50%; the incidence of atretic follicles among gilts ranged from 12 to 73%. The level of atresia was not correlated with plasma FSH concentrations during the last 42 hr before slaughter. This is in contrast to the massive loss of non-ovulatory follicles that is accompanied by decreased plasma FSH during the follicular phase of the cycle. Exogenous FSH also increased follicle number in prepuberal and altrenogest-treated gilts, but did not cause growth of large follicles or induce aromatase activity. To investigate FSH and other factors that regulate follicle growth and apoptosis, granulosa cells were incubated for 24 hr in their presence. Either FSH or IGF-I attenuated spontaneous apoptosis by 50%. Their effects were not additive, supporting a mediating role for IGF-I. No evidence was found to support the hypothesis that androstenedione alone or in the presence of FSH was atretogenic in pigs. Protease inhibitors attenuated apoptosis showing that members of the interleukin-1 beta-converting enzyme family were active during apoptosis in cultured porcine granulosa cells.

Key Words: Follicle atresia, Granulosa cell apoptosis, Swine

19   Nutritional regulation of ovarian function in beef cattle. R. P. Wettemann*, I. Bossis, M. L. Looper, F. J. White, N. H. Ciccioli, and T. D. Ridgway, *Oklahoma Agricultural Experiment Station, Stillwater*.

Nutrient intake and body energy reserves are major regulators of reproductive performance of beef cows. Reduced body weight causes cessation of estrous cycles, and inadequate body energy stores at parturition lengthens the postpartum anestrous interval. The objective of this presentation is to evaluate the ovarian response to restricted nutrient intake. Nutritionally induced reduction in follicular growth is a result of decreased secretion of GnRH and LH. Potential metabolic signals controlling gonadotropin secretion are IGF-I and NEFA. During anestrus, ovarian follicular waves are recurrent but inadequate estradiol is secreted by the dominant follicle to cause estrus and ovulation. Realimentation of nutritionally induced anovulatory cows results in ovulation when adequate body energy stores are achieved, and the first ovulation is followed by an interovulatory interval of $10.5 \pm .9$ d. Increased follicular growth rate is associated with increased concentrations of LH, estradiol and IGF-I in plasma. When nutritionally induced anovulatory cows are realimentated, a transient increase in plasma progesterone occurs, usually without estrus, before the first normal estrous cycle. The number of times an estrous cow is mounted before the first normal luteal phase after anestrus is less ($P < .05$) then before the second luteal phase. We conclude that prolonged restriction of nutrient intake reduces secretion of LH, less estradiol is produced by the dominant follicle, and ovulation ceases. Realimentation of anestrous animals alters metabolic signals resulting in pulsatile LH secretion, increased size of the dominant follicle, and ovulation.

Key Words: Nutrition, Ovulation, Beef Cow

20   Changes in gene expression associated with ovarian follicular development: A review. H. A. Garverick*, *University of Missouri, Columbia*.

Ovarian follicles in most domestic species can grow to the antral stage with little or no gonadotropic support. From this stage, a cohort of follicles of n size is recruited to grow towards ovulation by a transient rise in circulating FSH. From the recruited follicles, one or some (species dependent) are selected for continued growth and become dominant. A few follicles achieve ovulation; the fate of the others is atresia. Changes in mRNA expression of the gonadotropin receptors (FSHr and LHr), key steroidogenic enzymes [cytochrome P450 side chain cleavage (P450scc), cytochrome P450 17α-hydroxylase (P450c17), cytochrome P450 aromatase (P450arom) and 3β-hydroxysteroid dehydrogenase (3β-HSD)], steroid acute regulatory protein (StAR), growth factors (IGF-I and IGF-II) and their binding proteins (IGFBP) have been associated with growth, development and atresia of bovine ovarian follicles. Recruitment has been associated with initiation of mRNA expression of P450scc and P450arom in granulosa cells. Selection has been associated with initiation of expression of mRNA for LHr and 3β-HSD in

granulosa cells. In general, changes in mRNA expression of the gonadotropin receptors (FSHr in granulosa and LHr in theca and granulosa), steroidogenic enzymes (P450scc in theca and granulosa, P450c17 in theca, P450arom in granulosa, 3β-HSD in theca and granulosa), and StAR in theca increase with follicular development. Expression of the above mentioned mRNAs in follicles decreases prior to morphological signs of atresia at any stage of development. Expression of mRNAs for gonadotropin receptors, steroidogenic enzymes, StAR and growth factors is usually non-detectable in late stages of atresia.

Key Words: Ovary, Follicle, Gene Expression

21   Endocrinology of increased ovarian folliculogenesis in cattle selected for twin births. S. E. Echternkamp*, *USDA, ARS, RLH, Clay Center, NE*.

Three generations of genetic selection in cattle using an index of ovulation and twinning rate (Twinner) has increased the frequency of twin births to >50% and enhanced ovarian follicular development beginning at the secondary preantral stage. Ovaries of Twinner females contain a twofold greater number of secondary preantral follicles, exhibit 50% more small ($\leq$5 mm) and medium (6-12 mm) antral follicles, and have a >70% frequency of twin or multiple dominant (ovulatory) follicles within a follicular wave compared to unselected (Control) females; numbers of primordial and primary follicles do not differ between populations. Evaluation of circulating FSH and LH concentrations during proestrus and estrus and after GnRH treatment or follicle ablation revealed no difference in FSH secretion between populations but LH release to GnRH was increased in twinners, which was likely related to the higher systemic estradiol concentrations. Ablation of all follicles >5 mm in Twinner and Control cyclic cows on d 7 or 8 (estrus=d 0) initiated a transient increase in FSH (but not LH) followed by enhanced recruitment of growing follicles and subsequent selection of multiple dominant follicles in Twinners vs Controls, without population differences in FSH or LH. Circulating concentrations of insulin and cholesterol also do not differ between populations. Conversely, circulating IGF I concentrations are elevated 50-100% in Twinner cows. Graafian follicles of Twinners also have higher follicular fluid IGF-I concentrations than Controls, but follicular fluid estradiol and progesterone concentrations do not differ between populations. Results suggest that the increased follicular recruitment and selection in Twinner cows are not related to level of gonadotropin secretion, but the enhanced preantral and antral follicular development is likely associated with increased intraovarian and(or) systemic IGF-I production. Preliminary results are suggestive of a QTL for ovulation rate on chromosomes 5 and 7.

Key Words: Ovarian Folliculogenesis, Twin Births, Cattle

22   Influence of size of the dominant follicle, serum estradiol, and exogenous GnRH on luteal sensitivity to prostaglandin F2α in beef heifers. S. W. Williams*[1], M. Amstalden[1], R. L. Stanko[1,2], D. L. Vallejo[1], and G. L. Williams[1], [1] *Texas A&M University Agricultural Research Station, Beeville*, [2] *Texas A&M University-Kingsville*.

The efficacy of exogenous prostaglandin F2 α (PGF) to induce luteal regression in beef cattle is variable and dependent on the stage of diestrous during which PGF is given. Our objectives were to investigate the effects of size of the dominant follicle, circulating concentrations of estradiol, and exogenous luteotrophic antagonism on PGF-mediated regression of the bovine corpus luteum (CL). Thirty-five Brahman x Hereford (F-1) heifers were allocated randomly to be treated on d 6, 10 or 14 of the estrous cycle. Within each day of the cycle, heifers (n = 11 or 12/grp) received 2 treatments in a Latin square arrangement. Treatments were: 1) PGF (25 mg Lutalyse® i.m. plus a sham implant placed s.c. in the ear); 2) PGFG (25 mg Lutalyse plus simultaneous administration of an Alzet® osmotic minipump, placed s.c. in the ear, delivering 2.5 μg GnRH/h). Alzet pumps or sham implants remained in the ear for 2 d. Daily blood samples for progesterone analysis and daily ultrasonography were utilized to monitor luteal activity and follicular dynamics. In a subset of animals (n=24), coccygeal blood samples were collected at 1-h intervals for 11 h after pump or sham implant insertion to monitor changes in circulating LH. PGFG treatment increased (trt x time, $P < .10$) serum LH during the first 11 h. Regardless of treatment, the percentage of heifers exhibiting luteal regression was greater ($P < .01$) on d 14 (91.7%) than on d 6 (54.2 %) or 10 (63.6%). Proportion of CL's regressing did not differ ($P > .05$) between PGF and PGFG on any

day of the cycle. Mean diameter of the largest follicle on d 6 ($10.7 \pm .3$ mm) differed (P <.01) from mean diameters observed on d 10 and 14 ($6.3 \pm .4$ and $6 \pm .5$ mm, respectively). Similarly, mean concentrations of estradiol-17β in serum were greater on d 6 ($7.1 \pm .2$ pg/ml) than on d 10 and 14 ($5.4 \pm .3$ and $5.5 \pm .1$ pg/ml, respectively). Mean concentrations of estradiol did not differ (P > .05) between periods in which luteal regression occurred vs those in which it did not occur. Luteal sensitivity to PGF is dependent upon stage of diestrus, but this dependence does not appear to be influenced by size of the dominant follicle, circulating estradiol, or level of gonadotrophic support.

Key Words: luteal regression, dominant follicle, estradiol

23 Early increases in estradiol in follicular fluid from cattle with low peripheral concentrations of progesterone. R. Taft*, B. Sayre, and E. K. Inskeep, *West Virginia University, Morgantown.*

Butcher and Pope (BOR 21:491, 1979) showed congenital anomalies as well as embryonic and fetal deaths after aging of rat oocytes were due to longer preovulatory exposure to estrogen (E_2). Synchronization of estrus in cattle with low dosages of progestogens can result in persistence of follicles, higher peripheral estrogen and low fertility. Concentrations of E_2 in follicular fluid (FF) of the largest first wave follicles (LF1) were compared in cows with normal luteal function (n=12) and cows with low progesterone (P_4) to determine if oocytes were exposed to increased estrogen soon after the initiation of treatment. Cows on low P_4 (LP, n=12) received used intravaginal progesterone releasing devices (CIDR) on d 4 after estrus, followed by two injections of PGF2α (25 mg, i.m.) 12 h apart on d 6. Beginning on d 4, ovaries were examined by ultrasonography and blood samples were taken daily. The ovary with the LF1 was removed on d 8 or 10; FF was recovered and frozen. Size of LF1 did not differ until d 10 when it was larger in the LP group (14 vs. 12 mm; P < .05). Serum E_2 increased by d 7 in LP cows and remained greater than controls through d 10 (P < .01). Serum P_4 declined in LP following PGF2α on d 6 and remained low. The ratio of E_2 to P_4 in FF was > 1 in all follicles and P_4 in FF (mean = 42 ng/ml) did not differ with treatment or day. Follicular function was altered early during low P_4 as E_2 in FF was greater (P < .001) in LP on d 8 and 10 than in controls (1019, 962, 273 and 109 ng/ml for LP d 8 and 10 and control d 8 and 10, respectively). E_2 was increased in FF of LF1 on d 13 in LP cows compared to d 7 in cows that received only PGF2α on d 6 (meiosis had resumed in the d 13 oocyte; Revah and Butler, JRF 106:39, 1996), but E_2 in FF of second wave LF on d 28 in LP cows did not differ from E_2 in FF of growing second LF in controls on d 14, 15 or 16 (Bigelow and Fortune, BOR 58:1241, 1998). Early and prolonged exposure to increased E_2 during low dosages of progestogen may compromise oocyte quality, ultimately reducing fertility.

Key Words: Estrogen, Follicle, Progesterone

24 Synchronization of a follicular wave and temporary calf removal to induce ovulatory estrous cycles in postpartum beef cows. B. E. Salfen*, F. N. Kojima, J. F. Bader, M. F. Smith, and H. A. Garverick, *University of Missouri, Columbia.*

A synchronized follicular wave emerges following a single injection of estradiol benzoate (E_2) and progesterone (P_4) in cows at random stages of an estrous cycle. The objectives were to: 1) Determine if a follicular wave could be synchronized in anestrous cows following a single injection containing 1 mg E_2 and 200 mg P_4 in sesame oil (E_2+P_4); 2) Characterize the fate of the dominant follicle following 48 h calf removal (CR) at three stages of the synchronized follicular wave; and 3) Determine if a normal length estrous cycle would follow ovulation in cows receiving E_2+P_4. Ovaries of fifty anestrous beef cows were examined daily by transrectal ultrasonography starting at d 20 postpartum. Treatments were: sesame oil (i.m.) injected at d 25 postpartum and no CR (SO; n=9); E_2+P_4 and no CR (E_2+P_4; n=9); E_2+P_4 and CR six days post injection (E_2+P_4/CR6; n=12), E_2+P_4 and CR eight days post injection (E_2+P_4/CR8; n=9), and E_2+P_4 and CR twelve days post injection (E_2+P_4/CR12; n=11). Day of follicular wave emergence post injection was not different among cows that received SO or E_2+P_4 ($3.1 \pm .9$ vs $3.1 \pm .5$ d); however, variability in the day of emergence was greater (P<.05) in SO compared to cows receiving E_2+P_4. The percentage of cows that ovulated was not different (P=.16; 55.6, 11.1, 41.7, 55.6 and 63.6 for SO, E_2+P_4, E_2+P_4/CR6, E_2+P_4/CR8, and E_2+P_4/CR12, respectively). Maximum diameter of dominant follicles

was not different among treatments but was larger (P=.05) in ovulatory follicles compared to non-ovulatory follicles ($15.24 \pm .57$ vs $13.91 \pm .60$ mm). Serum LH was higher (P<.05) during CR in cows that ovulated compared to cows not ovulating. In cows that ovulated, luteal phase length (ovulation to luteolysis) was longer (P<.03) in animals that received E_2+P_4 compared to animals that received SO (10.6 ± 1.2 vs 4.4 ± 2.2 d). In summary, follicular waves were synchronized with an injection of E_2+P_4 in postpartum beef cows; however the subsequent luteal phase may not be of normal duration.

Key Words: Postpartum, Calf Removal, Follicle

25 Effect of estradiol benzoate (E_2) and (or) prostaglandin $F_2\alpha$ (PG) on corpus luteum function in beef heifers. D. F. Hentges*, F. N. Kojima, B. E. Salfen, J. F. Bader, T. J. Safranski, and M. F. Smith, *University of Missouri-Columbia.*

The corpus luteum (CL) is not responsive to a luteolytic dose of PG prior to d 5 of the estrous cycle. This study was designed to determine the effect of E_2 administration on CL responsiveness to PG injection on d 4 of the estrous cycle. Estrus was synchronized in normally cycling heifers following two injections of PG 14 days apart. Heifers were randomly assigned at estrus to a 2 x 2 factorial arrangement of treatments [E_2 and (or) PG; n = 6/group]. Heifers received either E_2 (1 mg) or sesame oil (im) on d 1 and PG or no injection on d 4 post-estrus. Daily transrectal ultrasonography was performed from the second injection of PG to the second estrus to characterize follicular and CL development. Blood samples were collected every 12 h beginning d 1 until the next estrus, and analyzed for concentrations of progesterone (P_4). PG did not induce luteolysis on d 4 in either the PG or E_2 + PG groups. Timing of first follicular wave emergence was later (P < .01) in E_2 vs non-E_2 treated heifers ($4.4 \pm .3$ and $1.4 \pm .3$ d, respectively). Although E_2 delayed emergence of the first follicular wave, the estrous cycle length was similar (P > .08) among treatment groups. Mean diameter of CL was larger (P < .02) in the E_2 ($19.9 \pm .5$mm) compared with E_2 + PG and Control groups ($17.8 \pm .5$ and $18.1 \pm .5$ mm, respectively), but similar to the PG group ($19.1 \pm .5$ mm). There was an E_2 by time interaction (P < .0001) on concentrations of P_4 (d 0 through estrus). Concentrations of P_4 in the E_2 and E_2 + PG groups were similar from d 0 to d 16.0, but higher (P < .03) from d 16.5 to d 21 post-estrus compared to the Control and PG groups. In summary, E_2 administration did not result in PG-induced luteolysis on d 4; however, E_2 delayed emergence of the first follicular wave.

Key Words: Estradiol, Prostaglandin $F_2\alpha$, Beef Heifers

26 Effects of parity status on postpartum follicular development and endocrine profiles in the Brahman. S. M. Webb, D. A. Neuendorff*, A. W. Lewis, and R. D. Randel, *Texas Agricultural Experiment Station, Overton.*

Eight multiparous and six primiparous Brahman cows suckling male calves with body condition scores (BCS) of $6.4\pm.7$ and $6.2\pm.4$, respectively, and weighing 504 ± 36 kg and 463 ± 28 kg, respectively, were used to evaluate the influence of parity on postpartum follicular development and endocrine profiles leading to the resumption of estrus. All animals grazed coastal bermudagrass overseeded with rye-ryegrass with free choice hay and water and were supplemented with 4.17 kgxhd[1]xd[1] of 4:1 corn:soybean meal. BW and BCS of cows and BW of calves were recorded at 14 d intervals from d 1 after calving through first estrus and at weaning. Cows were bled on d 1, 3, 5, 7, 14 after calving and at weekly intervals until estrus and on d 7 (E7) and d 10 (E10) post estrus. Ovarian follicular populations were monitored by transrectal ultrasonography on d 14 after calving then on d 21-28, 35-42, and continued on an 8 day examination and 6 day rest schedule through detection of estrus. Plasma PGFM and progesterone (P4) concentrations were quantified using RIA. On d 7 PGFM concentrations tended (P<.10) to higher in the primiparous group. Plasma P4 concentrations on E7 and E10 and changes in BW and BCS through d 42 and at estrus were not affected (P>.10) by parity status. From d 1 to weaning, ADG was greater (P<.04) for the primiparous group. Calf performance was not influenced (P>.10) by parity status. The number of medium size follicles (4.1-6 mm) through d 49 was greater (P<.01) in the multiparous group. Interval to resumption of follicular waves (P<.04), estrus (P<.03), and to development of an 8mm or 10mm follicle (P<.01) was

greater in the primiparous group. Follicular development and waves began later after calving in primiparous cows, but the interval from these events to estrus were similar to multiparous cows.

Key Words: Primiparous, Multiparous, Follicles

27   Identification of the optimal dose of estradiol benzoate in combination with a progestin to program follicular turnover in cyclic cattle. V. L. Bogacz*, J. E. Huston, D. E. Grum, and M. L. Day, *The Ohio State University, Columbus*.

An experiment was designed to determine the optimal dose of estradiol benzoate (EB) used in conjunction with an intra-vaginal progesterone insert (CIDR-B$^{®}$) to program follicular wave turnover in cyclic cows. Estrus was synchronized in twenty-five cyclic cows with day of estrus designated as d 0 of the experiment. On d 14, all cows received an i.m. injection of $PGF_2\alpha$ and a CIDR-B with either 0 (0EB; n=5), 0.5 (.5EB; n=7), 1 (1EB; n=6) or 2 (2EB; n=7) mg of EB/500 kg bodyweight. Transrectal ultrasonography was used to monitor ovarian follicular dynamics from d 7 through the subsequent ovulation. Observations for estrus were made twice daily from CIDR-B removal on d 21 until ovulation. The second wave of follicular growth for the synchronized estrous cycle emerged on d 10.4 ± 0.25 and the dominant follicle of this wave ovulated following CIDR-B removal in 4/5 cows in the 0EB treatment. Atresia of the dominant follicle of the second wave, emergence of a third wave of follicles, and ovulation of the dominant follicle of the third wave were induced in 4/7, 6/6 and 6/7cows in the .5EB, 1EB and 2EB treatments, respectively. Day of emergence of the third wave was later in the 2EB ($P < 0.05$) than in the 1EB treatment (18.2 ± 0.31 vs. 16.7 ± 0.33, respectively). Day of ovulation (24.8 ± 0.11) and diameter of the ovulatory follicle (16.3 ± 0.58) did not differ among treatments. However, across treatments, cows with only 2 follicle waves ovulated a larger follicle ($P < 0.05$) approximately 1 d earlier ($P < 0.05$) compared to cows with 3 waves of follicle growth. Both the 1EB and 2EB treatments induced turnover of follicular waves. Since the interval to new wave emergence is prolonged with higher doses of EB, it is suggested that the 1 mg dose would be optimal for use in an estrous control system in cyclic beef cows.

Key Words: Estradiol Benzoate, Progestin, Follicular Turnover

ROCHE-ASAS FOUNDATION BEEF SYMPOSIUM
Beef Carcass Quality and Yield

28   The importance of beef carcass quality and yield: Cattle performance, carcass-based pricing, and consumer issues. H. G. Dolezal*, *Oklahoma State University*.

Merit based marketing programs have gained popularity in the U.S. beef industry with increasing opportunities for vertical cooperation. In addition to input costs, numerous factors (gain, feed efficiency, and animal health) impact profitability as well as ultimate carcass quality and yield grade. Commodity marketing rewards volume production and encourages maximizing tonnage produced, harvested, and fabricated to dilute fixed costs, despite consumer preferences for cut sizes originating from carcasses weighing less than 363 kg. Grid and formula based carcass pricing shifts many risks to producers compared with live weight based sales; hence, non-conformers (excessive finish, dark cutters, extremes in weight, inadequate quality) must be minimized. Over the past three years, the spread between U.S. Choice and U.S. Select has averaged $8.49/45.4 kg for closely-trimmed boxed beef with seasonal spreads of $4.32 (first quarter) to $13.44/45.4 kg (fourth quarter). Consumer preferences for taste and consistency have strengthened demand for branded or premium Choice programs and U.S. Prime. Red meat yield, measured as U.S. yield grade should contribute as much as $5.00 per head for a mere .1 change. Objective value determination should originate with predominantly boneless, closely-trimmed boxed beef subprimals. These may be classified as middle meats, end meats, thin meats, and lean trim, comprising approximately 17.1, 43.3, 17.6, and 22.0% of total weight as boxed product yield and 40.6, 35.7, 15.2 and 8.5% of carcass value, respectively, over the past three years. By-product value has accounted for approximately 13.3% of total harvest animal value during the same period. Models to predict carcass value and value per 45.4 kg will be discussed relative to contributions of weight, quality, and red meat yield. The industry must implement a true value-based beef marketing system on an individual animal basis to reward producers investing in merit genetics and progressive management to produce beef with safe, consistent eating quality, and high red meat yield.

Key Words: Beef, Pricing, Quality

29   Effect of backgrounding and growing programs on beef carcass quality and yield. T. J. Klopfenstein*, R. Cooper, D. J. Jordon, D. Shain, T. Milton, C. Calkins, and C. Rossi, *University of Nebraska, Lincoln, NE*.

Clearly the future of the beef cattle industry in the U. S. is dependent upon quality of product produced. The majority of calves are born in the spring and therefore, to have a consistent supply of feeders entering feedlots, and to take advantage of forages, a variety of stocker programs exist. Because cattle enter the feedlot at varying weights, ages, and nutritional backgrounds, it is logical that this variation could produce differences in carcass quality. The economically important measures of carcass quality are yield grade and quality grade. They are directly related because as cattle fatten in the feedlot, both quality grade and yield grade increase. Because cattle are commercially fed to fat endpoints, it is logical to make comparisons at equal fat endpoints. Then marbling (% choice) becomes the primary quality criterion. We analyzed data from 534 cattle serially slaughtered and found that percent grading choice increased 12 ± 1 percentage units for each 1 mm increased rib fat. Marbling score increased 30 units (200 = slight 00) for each 1 mm increase in fat. To determine the effect of rate of winter gain on carcass quality, 372 calves over 5 years were wintered at .23 kg/d gain or .61 kg/d. When adjusted to equal rib fat, there was no difference in quality grade. To test the effect of summer gain on carcass quality, 418 calves over 7 years were followed through the feedlot after gaining .57 kg/d or .84 kg/d on grass. When compared at equal rib fat, there was no difference in quality grade. Shear force and consumer taste panel were used to evaluate steaks from 90 cattle from calf-fed and yearling production systems. Calf-feds were 14 mo. of age at slaughter and yearlings were 19 or 21 mo. Each group was serially slaughtered. There was no effect of an additional .39 cm of rib fat on shear force or juiciness, tenderness, flavor or overall palatability. Calf-feds were significantly more tender than yearlings but risk of an undesirable steak from yearlings was <.2% based on shear force and <2.8% based on the consumer taste panel. If cattle are fed to a common rib fat endpoint, and within the range of rates of winter and summer gains reported herein, we conclude that backgrounding program has little or no effect on marbling or carcass quality grade.

Key Words: Carcass quality, Backgrounding, Cattle

30   Effects of nutrition on beef carcass quality and yield. F. N. Owens*[1] and B. Gardner[2], [1]*Optimum Quality Grains, L.L.C., Des Moines, IA,* [2]*Oklahoma State University, Stillwater, OK*.

Carcass yields and meat quality relationships within 54 published trials were examined statistically. Carcass measurements will be discussed first followed by meat quality factors. Although lean darkens as cattle age, color can be restored partially by feeding concentrate diets. Feed components (lower iron availability; vitamin E supplements) also may lighten beef color. Fat color varies with breed and carotenoid content of the diet while melting point varies with breed and saturation of dietary lipid. Marbling scores vary with breed, animal age, rate of gain, and days on feed. Higher marbling scores were related positively to beef tenderness, juiciness, flavor intensity, and overall desirability. Shear force increased with fat thickness, opposite the direction one would expect from added fat attenuating carcass cooling. Indeed, the only carcass measurement related significantly albeit weakly ($R^2 = .04$) to tenderness was marbling score. Juiciness and flavor intensity both decreased as dressing percentage increased, while both flavor desirability and intensity decreased as ribeye area increased. Overall beef desirability for sensory panels increased with marbling score and decreased with fat thickness ($R^2 = .24$). Amazingly, each individual component of meat quality could be predicted more precisely from animal and production

system factors than by carcass measurements (R^2 = .29 to .95). Tenderness, juiciness, flavor desirability, flavor intensity, and overall desirability all were adversely affected increased weight per day of age; fast growing, young cattle did not have optimum meat quality. Nevertheless, tenderness was improved by faster daily gains during the finishing period. Heavier final weights decreased both tenderness and flavor intensity, while longer feeding periods (pasture plus feedlot days) decreased juiciness and flavor intensity. Higher concentrate diets improved flavor desirability. For optimum meat quality, the ideal animal appears to be one that is older and has gained rapidly but is not excessively heavy at harvest.

Key Words: Carcass quality, Beef, Tenderness

31 A beef quality synopsis: what we know and where we need to go. J. B. Morgan* and D. N. Vargas, *Oklahoma State University, Stillwater, OK USA 74078.*

Today's domestic and international consumers are demanding more in terms of beef quality than ever in the past. Beef consumers quality equation now contains additive factors such as safety, nutrition and convenience as well as dependability. These relentless demands have prompted the beef industry to find new and innovative ways to produce high-quality beef products which always clear the quality hurdle. Recent research has focused on the use of vitamins to improve beef quality. Studies have shown the efficacy of supplementing vitamin E in extending the retail shelf-life of beef. By decreasing the rate of lipid oxidation and lean discoloration, a \$4.00 investment of supplemental vitamin E ensures that fewer beef cuts are discounted or discarded due to premature browning, resulting in a \$30.00 to \$35.00 saving per carcass marketed through commercial retail outlets. Secondly, it appears that supplementing cattle with high-doses of vitamin D_3 enhances meat tenderness; preliminary results demonstrate that supplementing 5 million IU/hd/d of vitamin D_3 for the final 6 d prior to harvest decreases (P < .05) shear force values of steaks aged for 7 d. Vitamin D_3 increases calcium levels in muscle which is associated with accelerated postmortem tenderization. Increasing the rate of tenderization in this fashion should facilitate the shipment of consistently tender beef to retail outlets even under feature sale conditions. Case-ready products are leading the beef industry into a new era of marketing. In order for beef to remain competitive at the retail counter one must continue to develop "consumer-friendly" items that can be prepared with minimal time and effort. Another factor critical to the beef industry's future is the advent of on-line tenderness characterization systems. Predicted carcass tenderness should facilitate true value-based marketing and allow consumers to select the product quality of their choice. Understanding factors which contribute to beef quality and consistency and more importantly, learning how to control these factors, will save the industry millions of dollars annually. As the 21st century arrives, beef producers, processors and retailers must strive to provide consumers with a consistent, high-quality product if beef is to maintain its viability as a protein supplier.

Key Words: Beef, Quality, Overview

RUMINANT NUTRITION/PASTURES AND FORAGES SYMPOSIUM
Designing Supplements for Grazing Beef Cattle

32 Designing supplementation programs for beef cattle fed forage based diets. W. E. Kunkle*[1], [1]*University of Florida.*

Supplements are offered to cattle fed forage based diets to improve performance and economic return. This review will focus on identifying the limiting nutrients, sources of carbohydrates in energy supplements, feed additives and feeding systems. The first step in designing a supplement is to determine nutrients (protein, vitamins and minerals) that limit intake, digestibility and utilization of the forage energy. Although this seems simplistic, grazing cattle select their diet and nutrient composition of consumed forage often is unknown. Blood urea nitrogen and fecal analysis offer point-in-time indicators of protein-energy balance of the diet. Energy supplements (balanced with protein, vitamins and minerals) are often needed to meet desired performance. Several experiments indicate that when the sum of starch plus sugars in supplements are offered above .4% of body weight, forage intake and digestibility are reduced. In this situation, choosing a highly digestible supplement low in starch such as soybean hulls compared to a supplement high in starch such as corn gives 15 to 30% better performance per unit of supplemental TDN. Several antibiotics increase gain and efficiency of growing cattle fed forage diets. Supplementing approved levels of ionophores or bambermycins has improved gains .07 to .11 kg/day at a cost (wholesale) of 2 to 3 cents/day. These antibiotics increase gains of growing cattle similar to feeding an additional .45 kg of TDN/day. Adding these antibiotics to supplements formulated for growing cattle usually improves net return. Other antibiotics and feed additives that control diseases, bloat, and parasites may increase net returns in selected situations. Formulating self-fed supplements that are consumed at desired amounts reduces feeding costs but challenges for the nutritionist include variation in consumption across situations, variation in consumption amount and frequency within the herd, and availability of reasonable cost intake limiters that do not cause management or disease problems. Hand-fed supplements offered at 1.5 kg/day or less usually give similar improvements in performance when fed on alternate days compared to daily feeding but less frequent feeding may result in reduced performance.

Key Words: Supplement, Antibiotics, Cattle

33 Designing mineral supplements for beef cattle. L. W. Greene*, *Texas A&M University System.*

Mineral supplementation programs in the cow-calf/stocker industry range from nothing or plain salt/sulfur blocks to highly formulated free-choice mineral supplements containing organic and inorganic sources of minerals. The primary question is, "Which of these will generate the greatest return on investment by optimizing production efficiency and maintaining cattle health?". Many variables must be considered when attempting to answer this question. In most cases, every production system is different due to environment, forage type, animal genetics, physiological state of production, etc., making it difficult to "fine tune" mineral supplements for the generic production system. However, to prevent tremendous complexity in managing mineral supplementation programs, average environments, forage mineral supplies, animal characteristics and production levels must be used as a starting point. In unique situations, formulations can be altered to account for variances from the norm. However, care must be taken to avoid critical negative mineral to mineral interactions that are known to exist. It is not uncommon to create a completely new problem when changing a mineral supplement program to fix an old problem. Choice of supplement ingredients is also critical to ensure adequate mineral availability and supplement weather-ability. In addition, the mineral supplement providing the best mixture of mineral salts to meet production needs is of little value if consumption is not adequate. These issues and others will be discussed with respect to current literature on mineral supplementation programs for beef cattle.

Key Words: Mineral supplement, Beef cattle

34 Designing protein supplements. M. K. Petersen*, C. R. Krehbiel, J. Sawyer, and R. Waterman, *New Mexico State University, Las Cruces, NM USA.*

Protein supplementation of grazing livestock is used to complement the nutrient content of grazed vegetation. When effectively implemented, economic improvements in gain and reproduction can be realized. Timing of supplement availability (within day, within week, or within season) can influence the outcome. The source and quantity of protein can also modify the response by the animal. Nitrogen, protein, and/or amino acids may be included into supplements to achieve various results. The objectives may include an enhanced supply of ammonia or nitrogen containing growth factors to ruminal microbes, satisfying a protein requirement of the animal, or to manipulate metabolism (metabolic hormones or supply of intermediates). These goals must be met within the context of management effective delivery systems and highly palatable formulas. Protein supplements are designed first by the quantity of feed which is acceptable to management. The quantity of ruminally degradable intake protein is considered next to optimize ruminal function and intake. Then, depending upon vegetation type, quantity, and animal

physiological state, the purpose of appropriate ruminally undegradable intake protein (UIP) is considered. After the UIP sources and quantity are determined, the carrier/energy sources are selected to achieve the required amount of feedstuffs to serve as dilution agent, binder, and space filler. The form of the supplement (e.g. small, standard, or large pellets, blocks, molasses liquid or solidified and loose) will be dependant upon feeding management intensity and the physical characteristics of the selected feeds. Protein supplements should be designed with a specific purpose. This goal will dictate the amount and type of protein used and the form supplied. Feeding management will determine the frequency and timing of supplementation. The overall aim is to supply the most biologically potent mix of nutrients that will allow for the provision of the least amount of supplement at the lowest cost while successfully achieving production goals.

Key Words: protein supplementation, grazing ruminants

35   Dietary fats as reproductive nutraceuticals in cattle. G. L. Williams* and R. L. Stanko, *Texas A&M University Agricultural Research Station, Beeville, TX, U. S. A.*

Inadequate dietary energy intake and poor body condition are two of the most pervasive factors influencing reproductive efficiency in cattle production systems. Therefore, an important goal has been to discover novel methods for enhancing reproductive performance in cattle that are exposed to these conditions, often repeatedly. This review will examine dietary fat as a reproductive "nutraceutical", including the roles of fatty acid content and minimum effective intake. Although the consumption of lipids by ruminants is limited under natural conditions, their addition to formulated diets to increase caloric content or to positively modify diet physical characteristics is a long-standing practice. More recently, fat supplements have been used in attempts to influence specific metabolic pathways, and ultimately, hormones that directly modulate reproductive processes. The basis for this approach lies within an array of digestive, metabolic, and reproductive sequelae that occur when cattle consume significant quantities of fat, particularly fermentable fat. Evidence suggests that the consumption of polyunsaturated plant oils can positively influence ovarian follicular growth, luteal function, and postpartum reproductive performance, independent of caloric effects. Mechanistically, these effects have been attributed to a cascade of events that change rumen fermentation patterns, heighten lipoprotein-cholesterol synthesis, increase secretion of ovarian steroids, modify circulating concentrations of insulin and growth hormone (GH), and enhance the synthesis or accumulation of insulin-like growth factor-I (IGF-I) within the ovarian follicle. Both natural and manufactured products that can be used to exploit these physiological concepts are available commercially.

Key Words: Dietary Fat, Cattle, Reproduction

SHEEP SYMPOSIUM
Changing the Industry

36   Potential for hair sheep in the U.S. D. Notter*, *Virginia Polytechnic Institute and State University, Blacksburg.*

The U.S. sheep industry must improve its competitiveness relative to other meat and fiber sources within the U.S. and internationally. Current opportunities to develop innovative programs include funding from the National Sheep Industry Improvement Center and 4 yr of protection from imports by the International Trade Commission. It is essential that the sheep industry seize these opportunities to build a secure base for future development. Production characteristics that currently limit expansion of the sheep industry include high labor requirements, susceptibility to internal parasites, and low wool prices. These problems could be reduced by development of "easy-care", wool-free sheep breeds with greater parasite resistance, so long as these breeds were also able to maintain satisfactory growth, reproduction, maternal ability, and carcass yield and quality. Hair sheep have many characteristics that are desired in easy-care sheep types, including high fertility and prolificacy, excellent lamb vigor, and substantial resistance to internal parasites. Meat quality appears to range from very acceptable to excellent. These animals are small, however; associated growth rates and optimal slaughter weights are low relative to those of other U.S. breeds. Little has been reported about herding characteristics of hair sheep, and genetic control of fiber type (wool versus hair) is not well understood. Purebred hair sheep may be useful in restaurant and specialty markets, but use of hair sheep genetics in traditional markets will likely involve composite breeds with 50 to 75% hair sheep genetics. Existing composite breeds such as the Katahdin and Dorper may fill this role, but development and evaluation of new composite types using other sources of hair sheep genetics should also be considered. Potential for hair sheep is greatest in the southeastern U.S. and the southern Corn Belt. Low cold tolerance may limit their usefulness in colder regions, where hair sheep crosses, which often have a partial wool coat in winter that is shed in summer, may be preferred.

Key Words: Hair sheep, Composite breeds, Disease resistance

37   East Friesian germplasm: effect on milk production, lamb growth, and lamb survival. D. L. Thomas*, Y. M. Berger, and B. C. McKusick, *University of Wisconsin-Madison.*

The East Friesian (EF) breed originated in the Friesland area of Germany. It generally is regarded as the highest milk-producing breed of dairy sheep in the world. Average milk yields as high as 550 to 650 liters have been reported in northern Europe. It is medium to large in body size with rams weighing 90 to 120 kg and ewes weighing 65 to 75 kg. The face and legs are white and free of wool, and a distinguishing characteristic is a long, thin tail that is free of wool - a "rat" tail. They have a high prolificacy; generally over 2.0 lambs per ewe. The first importation of EF genetics into the U.S. was in 1993 by the University of Wisconsin-Madison (UW), the University of Minnesota, and a few private producers. It consisted of F1 EF ram lambs from B.C., Canada sired by one Swiss EF ram. There were later importations into the U.S. of crossbred and purebred rams and ewes, embryos, and semen from Canada and Europe, so EF genetics are now readily available. Early studies at UW compared the performance of progeny sired by EF crossbred (1/2, 3/4 and 7/8 EF) and purebred Dorset (D) rams. EF-cross lambs had greater birth, weaning, and postweaning weights than D-cross lambs. When lambing at one and two years of age, EF-cross ewes gave birth to and reared more lambs per ewe mated, had longer lactation lengths, produced more milk, fat and protein, and had a lower percentage of milk fat and protein than D-cross ewes. With the low levels of EF genetics evaluated in this early study (mostly 25%, some 50%), it appears that EF-cross sheep are superior to D-cross sheep for lamb and milk production in northwestern Wisconsin. The same may not hold true for EF-cross sheep of over 50% EF genetics. Some studies conducted in the Mediterranean region found that sheep containing more than 50% EF breeding had lower survival, lower lamb production, and, in some cases, lower milk production than local breeds. It appeared that the EF was not adapted to the high environmental temperatures of the region and was more susceptible to some diseases; most notably, pneumonia. Evaluations of high percentage and purebred EF sheep are needed in North America.

Key Words: East Friesian, Dairy sheep

TECHNOLOGY FORUM

38   Evidence of quantitative trait loci affecting growth and carcass composition traits in cattle segregating the muscle hypertrophy locus. E. Casas*, S. D. Shackelford, J. W. Keele, R. T. Stone, S. M. Kappes, and M. Koohmaraie, .

The locus causing muscle hypertrophy (*mh*) on chromosome 2 has been previously assessed for growth and carcass traits. The objective was to identify other quantitative trait loci (QTL) in two families segregating the *mh* allele. Two half-sib families were developed from a Belgian Blue

x MARC III (n = 246) or a Piedmontese x Angus (n = 209) sire. Traits analyzed were birth (BW; kg) and yearling weight (YW; kg); hot carcass weight (HCW; kg); fat depth (FD; cm); marbling score (MA); rib eye area (REA; cm^2); estimated kidney, pelvic, and heart fat (KPH; %); yield grade (YG); retail product yield (RP; %); and fat yield (FY; %). Meat tenderness was measured as Warner-Bratzler shear force at 3 (WB3) and 14 (WB14) d postmortem. The effect of the *mh* locus on these traits was removed using the phase information based on six markers flanking the *mh* locus. To identify putative regions harboring QTL associated with retail product yield and fat, selective genotyping was done on 92 animals from the extremes of the phenotypic distribution from both families, using a total of 150 informative genetic markers. Regions in which selective genotyping indicated the presence of QTL were evaluated further by genotyping the entire population and additional markers. In the Belgian Blue cross family, a significant QTL (P < .00005; expected number of false positives = .05) for BW and YW was identified on chromosome 6 and suggestive QTL (P < .002; expected number of false positives = 1) were identified for REA and HCW, and for MA on chromosomes 17 and 27. In the Piedmontese cross family, a suggestive QTL was identified for FD, RP, and YG on chromosome 5; and for WB3 and WB14 on chromosome 29. Interactions suggesting the presence of QTL were observed between the *mh* locus and chromosome 5 for WB14; and the *mh* locus with chromosome 14 for FD. Thus, other loci influencing carcass traits have been detected in families segregating the *mh* locus.

Key Words: Genetic Markers, QTL, Carcass Traits

39   Effects of electrical stimulation on tenderness, color and quality attributes of beef longissimus muscle. D. L. Roeber*, R. C. Cannell, K. E. Belk, J. D. Tatum, and G. C. Smith, *Colorado State University, Fort Collins, CO.*

This study evaluated effects of four beef carcass electrical stimulation (ES) treatments on carcass grade factors, muscle color, and subprimal purge loss as well as cooked steak tenderness and weight loss. One side per beef carcass was subjected to ES using one of four treatments; low voltage - medium duration (LVMD), low voltage - long duration (LVLD), high voltage - medium duration (HVMD) or high voltage - long duration (HVLD) and compared with the non-ES control side. Electrical stimulation was achieved by inserting a positive electrode between the *latissimus dorsi* adjacent to the second and third rib and a negative electrode into the *biceps femoris* adjacent to the sacrum of beef sides. One 2.54 cm thick longissimus steak was fabricated from each of 120 treated and 120 control matched carcass sides such that samples from 10 pairs of matched carcass sides were included to represent each of twelve USDA Quality Grade (Select, low Choice, upper two-thirds Choice) by ES treatment subclasses. Mean marbling scores for stimulated sides did not differ (P > .05) from those for control sides within ES treatment class. Mean values for CIE L*, a* and b* of lean color were higher (P < .05) for HVLD treated sides than for control sides. When Warner-Bratzler shear force (WBS) values for steaks were adjusted to a common degree of doneness, WBS values were lower (P < .05) for ES treated sides than for control sides in all four treatment classes. Within quality grade subgroups, adjusted WBS values for Select beef were improved (P < .05) only when the HVMD and HVLD treatments were utilized. When adjusted WBS values for steaks from control carcass sides were greater than 4.5 kg, treatment of matching carcass sides with LVMD, LVLD, HVMD or HVLD reduced WBS to below 4.5 kg 50, 88, 60 and 75% of the time, respectively. Mean values for cooked steak weight loss, adjusted to a common degree of doneness, did not differ by treatment and mean purge loss in inside rounds only differed (P < .05) only when the LVMD treatment was applied.

Key Words: Electrical Stimulation, Shear Force, Purge

40   Use of sperm rich or entire ejaculates for breeding sows. J. D. McDonald*[1], T. J. Safranski[1], and S. L. Terlouw[2], [1]*University of Missouri-Columbia,* [2]*Premium Standard Farms, Princeton, MO.*

The bulk of reproduction research has focused on the female. Increased value of individual boars and use of artificial insemination have heightened the need to fine tune semen collection and processing procedures. This study was designed to determine whether the total fluid ejaculate (TE) or sperm rich fraction only (SR) should be collected for maximum reproductive performance. Semen collected from 425 individual terminal

boars was used to mate to hybrid maternal sows with Landrace, Large White and Duroc genetic background. Each boar was used randomly for each treatment. Semen was evaluated and extended to a minimum of 3.2x10^6 viable cells per 85 mL in BTS, and was used within 48 hours of collection. Semen was sent to 34 separate sow units. Every-other-week, the treatments that were sent to the farms were alternated, and only sows mated Monday through Friday were included in the data set. Three matings were performed at either 24 hour intervals (AM/AM/AM) or 24 and eight hour intervals (AM/AM/PM) depending on day of estrus post-weaning from June 18 through August 20, 1998. The number of matings for the TE and SR were 7,856 and 7,577, respectively. A model including sow unit, treatment, week, sow unit x week (error term), parity and previous lactation length was used to compare whether or not sows farrowed (FARO), total number born (TNB), born alive (NBA), stillborn (NSB) and mummies (MUMM). FARO varied among sow units and parity, but there was no significant treatment effect. Parity, previous lactation length and sow unit each had significant effects on TNB and NBA, but again there were no treatment differences (10.95±.073 vs 10.90±.073 for TNB, P=.38 and 10.22±.067 vs 10.19±.067 for NBA, P=.54 for TE and SR, respectively). Similar relationships were seen for NSB and MUMM, except that previous lactation length was no longer significant. Use of either TE or SR resulted in similar sow reproductive performance in this study. There may be an advantage to one type of collection if semen is stored for longer periods of time prior to use.

Key Words: Semen fractions, Boar, Fertility

41   Absence of virus on pig embryos recovered from gilts vaccinated with a modified-live PRRSV vaccine. B. A. Didion*[1], S. T. Finn[1], M. Eisenhardt[2], and J. Christopher-Hennings[3], [1]*DEKALB Swine Breeders, Inc., DeKalb, IL,* [2]*DEKALB Swine Breeders, Inc., Plains, KS,* [3]*South Dakota State University, Brookings, SD.*

Porcine reproductive and respiratory syndrome virus (PRRSV) is a pathogen threat to the swine industry. Porcine embryo transfer has merit for reducing disease transmission risks (i.e. PRRSV) associated with transportation of live animals. The objective of this study was to examine the efficacy of surgical recovery of pig embryos from PRRSV infected gilts towards generating a source of PRRSV-free germplasm. Seven serologically PRRSV-negative prepuberal line gilts (180 days of age) were relocated to an off-site facility and estrus was induced using P.G. 600 (Day=0). Also on Day 0, gilts were bled and samples submitted for PRRSV testing via reverse transcription polymerase chain reaction (RT-PCR). On Day 4, all gilts were artificially inseminated once. A portion (5 ml) of each insemination dose was frozen in liquid nitrogen for PRRSV testing via RT-PCR. Also on Day 4, all gilts were vaccinated intramuscularly with a single dose of PrimePac (Schering Plough). On Day 8, all gilts underwent mid-ventral laparotomies. Serum, uterine fluids and embryos were collected from each gilt for PRRSV testing via RT-PCR. Uterine flushings from each horn were kept separate (14 samples collected) and tested for PRRSV via RT-PCR. Embryos isolated from each horn were divided into two treatment groups towards testing for PRRSV via RT-PCR: Group I embryos were washed with trypsin and Group II embryos were washed without trypsin (control). The RT-PCR results for serum collected on Day 0 was negative for all seven gilts. All semen samples tested negative for PRRSV. Day 8 serum samples were collected on six of the seven gilts. Four of the six gilts tested positive for PRRSV in serum. There was 1 of 14 uterine flush samples testing positive for PRRSV. No embryos from Group I or II tested positive for PRRSV. Results suggest that pig embryo recovery and transfer may be a viable option for transporting germplasm with reduced health risks.

Key Words: Porcine, PRRSV, Embryo transfer

42   Estrous cycles in gilts with or without PG-600$^®$ and boar exposure. D. F. Hentges and T. J. Safranski*, *University of Missouri-Columbia, MO.*

A commercially available product, PG-600 (Intervet), containing PMSG and hCG is available to stimulate puberty in gilts. Our objectives were to determine whether the best induction and maintenance of estrous cycles came from PG-600 alone or in conjunction with other stimuli. In July, 109 gilts housed 16 to 21 per pasture lot were randomly allocated to treatments in a 2 x 2 factorial arrangement. Treatments were presence or absence of PG-600 and boar exposure (BE) beginning at 165 d of age. Blood samples were collected weekly, starting the week prior to initiation of treatments. Serum was assayed for progesterone (P$_4$) to

determine whether ovulation had occurred. Forty-seven gilts with initial P_4 concentrations above two ng/ml and two injured gilts were removed. The BE gilts were exposed to a mature boar 15 min daily with all gilts receiving daily BE beginning 18 days after initial treatment. During the 56 d study 54 gilts were observed in estrus. Three gilts from each of the BE and control treatments did not exhibit estrus and were not included in the estrus data. Mean days to first estrus were reduced (P < .006) with PG-600 vs no PG-600 (5.09 ± 1.01 and 9.42 ± 1.13, respectively). Days to first estrus were no different (P > .05) for BE vs no BE (6.96 ± 1.09 and 7.54 ± 1.06, respectively). The BE x PG-600 interaction was not significant. PG-600 increased (P < .01) the number of gilts expressing estrus within six days of treatment. A second estrus was seen within 18 to 23 days in 31 gilts that responded to initial treatments. There were no significant differences among treatments; however, the BE x PG-600 interaction approached significance (P < .09). Ninety-two percent of gilts receiving only PG-600 had a normal estrous cycle; whereas, only 67% of gilts receiving both PG-600 and BE had a normal estrous cycle. In this experiment PG-600 was more effective at synchronizing estrus when used alone. Future research is needed to optimize timing for PG-600 and to confirm the effects of additional stimuli.

Key Words: Puberty, Gilt, PG-600

43 **Boar sperm acrosomal status relative to fertility.** S. T. Finn* and B. A. Didion, *DEKALB Swine Breeders, Inc., DeKalb IL/USA.*

Little information exists on the correlation between acrosome status and boar fertility. The objective of this research was to evaluate the effect of acrosomal integrity of boar spermatozoa on fertility. Twenty-seven boars with varying levels of fertility were used in this study. Fertility was measured as the percentage of sows bred (via artificial insemination) by each boar that farrowed. The mean farrow rate percentage was 72. Two semen samples were collected from each boar with at least a seven-day interval between collections. Motility (measured microscopically) and acrosome integrity were evaluated for each boar. For acrosome staining, semen was diluted 1:1 with a sodium citrate solution (29g/l). A smeared slide was made for each collection. The slides were treated with methanol and allowed to air dry. The slides were treated with FITC-labeled PSA (50 micrograms /ml) for 45 minutes. They were rinsed with dH2O for 10 minutes and air-dried. The slides were then examined at 400x magnification using an Olympus BH2 UV microscope fitted with a FITC filter set. A total of 200 sperm were categorized as acrosome-intact or acrosome-loss for each sample. Acrosome-intact sperm fluoresced more intensely than acrosome-loss sperm. The mean percent motility and mean percent acrosome-intact sperm was 92.8% and 98%, respectively. The range of percent acrosome-intact sperm was 92% to 100%. No functional relationship existed (r=-0.2) between boar fertility and acrosome status.

Key Words: Boar, Fertility, Acrosome

44 **Factors associated with incidence of PG00 intervention in weaned sows.** C. J. Bracken*, W. R. Lamberson, and T. J. Safranski, *University of Missouri, Columbia, MO, USA.*

During September of 1998, sows in a commercial herd were studied to determine factors affecting time of ovulation after weaning (n = 146). This group included a sub-population (n=31) that did not exhibit signs of estrus by d 7 post weaning and received PG600 intramuscularly. The first objective of this study was to identify factors associated with delayed estrus and intervention with PG600. A second objective was to characterize factors contributing to variation in the estrus to ovulation interval (EOI). The number and diameter of follicles present on both ovaries of each sow at d 3 post weaning, and of each sow receiving PG600 on the day of injection, were determined via transrectal ultrasound. Beginning 36 hours after the initial ultrasound (4.5 d after weaning), ovaries were examined at 07:00 h and 16:00 h until ovulation was observed or d 6 post injection. Time of ovulation was defined as the midpoint between the last observation of a complete cohort of preovulatory follicles and the first observation of the absence of ovarian follicles. Estrous detection was conducted once daily using fence line boar contact. Parity, number of pigs weaned, lactation length, predominant follicle size (small, 3-4 mm; medium, 5-6 mm; or large, ≥7 mm), total d 3 follicular volume, back fat, and loin eye area were used as independent variables in analyses of PG600 intervention. Increased parity (P<.05), backfat (P<.05),

and d 3 follicular volume (P<.001) reduced the likelihood of PG600 intervention. Only 9 of 90 sows with predominantly large follicles at d 3 post-weaning received PG600, while 17 of 26 sows with predominantly medium and 3 of 6 sows with predominantly small follicles received the drug (P<.001). Sows that received PG600 on average ovulated 15.82 h before expressing estrus whereas sows not receiving PG600 expressed estrus 30.03 h before ovulation (P<.001). Using PG600 intervention may affect EOI thus, influencing the appropriate time of insemination.

Key Words: PG600, estrus, ovulation

45 **Who's there? - Community analyses of bacteria in swine feces and waste handling pits using PCR and pure culture isolation.** T. R. Whitehead*, R. L. Zeltwanger, and M. A. Cotta, .

Storage of swine waste is associated with the production of a variety of odorous compounds, including ammonia, organic acids and alcohols, and sulfides. These odorous compounds can contribute to health problems for swine facility workers and animals, as well as affect local populations. Although the generation of these chemicals is the result of microbiological activity, little is known about the types of microorganisms responsible for their production. Microbial populations of pig feces and waste storage pits were analyzed by conventional microbiological analyses and 16S rDNA sequence analyses. Fecal and waste storage pit samples were collected from a local swine production facility. For pit samples, total colony counts on medium containing clarified swine slurry were 2-20 times higher than those obtained on rumen fluid medium. In contrast, the highest counts for fecal samples were obtained on rumen fluid containing medium. Samples were also plated onto media containing tetracycline, erythromycin, or tylosin, and antibiotic resistant bacteria enumerated. Antibiotic resistant organisms were found in all samples, and the level of resistance ranged from 4% erythromycin resistance in 6 ft pit samples to 32% tylosin resistance in 3 ft pit samples. Randomly selected colonies from the highest dilutions were isolated. Similarity analyses of 16S rDNA sequences derived from the bacteria indicated the presence of primarily low G+C Gram-positive bacteria, such as *Clostridium* sp., *Streptococcus* sp., and *Lactobacillus* sp. in both pit and fecal samples. Total DNA was also isolated from the fecal and pit samples. DNA sequence analyses of PCR amplified 16S rDNA genes were carried out to identify predominant bacteria. Similarity analyses of the 16S sequences indicated the presence of primarily low G+C Gram-positive bacteria, such as *Clostridium* sp., *Streptococcus* sp., and *Lactobacillus* sp. in both ecosystems. Many of the sequences were of unidentified microorganisms. A variety of methanogenic archaebacteria were identified from the pit DNA. A large number of unidentified sequences were also found. These results indicate that the primary eubacteria identified in swine feces and waste pits are low G+C, Gram-positive bacteria.

Key Words: swine, waste, bacteria

46 **Mucosal competitive exclusion to reduce salmonella in swine.** D. E. Reeves*[1], P. J. Fedorka-Cray[2], J. S. Bailey[2], N. J. Stern[2], N. A. Cox[2], S. R. Ladely[2], and W. Pullen[1], [1]*University of Georgia, College of Veterinary Medicine,* [2]*USDA-ARS, Russell Research Center.*

In two separate trials, a mucosal competitive exclusion culture (MCES) was studied for its effectiveness in reducing Salmonella in suckling pigs. The MCES culture was derived from the cecum of a 6 week-old pig known to be free of Salmonella. MCES was produced in large scale, adjusted to approximately 10^9 CFU/ml, and frozen at -70^0C until use. In trial one (T1), pigs were given 5ml MCES by oral gavage within 6 hours post-farrowing (PF) and again at 24 hours PF. Control pigs were given 5 ml sterile PBS by oral gavage at same time interval. At 48 hours PF, pigs were inoculated intranasally with 1 ml of S. choleraesuis (10^3 CFU/ml). In trial two (T2), all treatments were the same as T1, except that the challenge dose of S. choleraesuis was increased to 10^6 CFU/ml. Fecal samples were obtained from sows at weekly intervals prior to farrowing and from suckling pigs and sows at daily intervals after farrowing for culture. At day 7 PF necropsy samples of tonsil, lung and lymph nodes, liver, spleen, colon, cecum and ileocecal junction were obtained aseptically from each pig and qualitatively cultured. A cecal fecal sample was quantitatively cultured. No clinical signs of salmonellosis were apparent in either trial nor was S. choleraesuis recovered from fecal samples in either trial. In T1, 9.5% of the tissues were positive from the MCES treated pigs versus 21% positive tissues from the control pigs.

In T2, 28% of the tissues were positive from the MCES treated pigs versus 51% from the control pigs. A slight ($\leq$1 log) quantitative difference in total numbers per cecum between treated and control groups was observed. The increase in the number of positive tissues between trials is attributed to the higher challenge dose given in T2. These data confirm previous findings in which a $\geq$50% reduction in positive tissues between treated and control pigs was observed. The continued observation in reduction of numbers of positive tissues indicates that the use of MCES may be a practical solution for control of Salmonella. Additional studies to determine the optimal time of administration and duration of protection is warranted.

Key Words: competitive exclusion, salmonella, swine

47   Development of electronic nose technology as a diagnostic tool in detection and differentiation of *Escherichia coli* O157:H7. S. M. Younts*[1], E. C. Alocilja[1], W. N. Osburn[1], S. Marquie[1], and D. L. Grooms[2], [1]*Michigan State University,* [2]*Large Animal Clinical Sciences, Michigan State University.*

Cattle have been identified as a primary reservoir for *Escherichia coli* O157:H7. Pre-harvest detection of pathogens using electronic nose technology would enhance efforts to reduce the risk of human exposure. The objective of this research was to develop a neural network-based gas sensing electronic nose to differentiate *E. coli* O157:H7 from non-O157:H7 strains. In phase 1, computer controlled gas sensors were used to monitor gas emissions from four isolates of *E. coli* O157:H7 and four non-O157:H7 *E. coli* isolates. A standard concentration of each isolate was grown in 10ml of nutrient broth at 37°C for 16 hours with gas sampling conducted every five minutes. Readings were continuously plotted to generate gas signatures. Gas chromatography/mass spectrometry analysis was used to validate the gas signatures and verify the gas composition. Standard growth curves were established through viable plate counts to demonstrate the relationship between bacteria growth and gas emissions. Detectable differences were observed between the gas patterns of the *E. coli* O157:H7 and the non-O157:H7 isolates. Phase 2 involved the training and testing of the artificial neural network (ANN) for interpretation of the gas signatures. Five signatures from each isolate (n=40) were used as training vectors for the ANN. In the training process the ANN was configured for pattern recognition, data classification, and forecasting. A second data set was used in testing the ANN for rapid identification and classification output. Analyzing the response of the ANN, the sensitivity, specificity, and predictive value of the electronic nose were calculated. Based on the ability to detect differences in the gas patterns, this technology has a broad scope of potential applications with promise as a diagnostic tool for pre-harvest pathogen detection in cattle intended for human consumption.

Key Words: *E. coli* O157:H7, Electronic nose, Food Safety

48   Modeling the relation between energy intake and protein and lipid deposition in growing pigs. J. van Milgen*, N. Quiniou, and J. Noblet, *INRA, Saint-Gilles, France.*

A data analysis model is proposed where, for an animal of given BW and genotype, the relation between protein deposition (PD) and ME intake above maintenance (MEp) is curvilinear, so that PD intersects the origin and reaches its maximum at the maximum protein deposition rate (PDmax). An increase of MEp beyond that required to attain PDmax would not change PD. The MEp not used for protein synthesis can be used for lipid deposition (LD). The relation between PD and LD on the one hand and ME on the other hand can then be described as a function of the maintenance energy requirement (MEm), PDmax, the level of ME required to attain PDmax (F; as a multiple of MEm), and the energetic efficiencies of PD (k_p) and LD (k_f). Of these statistics, only k_p and k_f were assumed to be independent of BW and genotype. Variation in PDmax was described as a Gompertz function (of age) whereas variation in F was assumed to be a linear function of BW. Maintenance energy requirement was expressed as a power function of BW. To verify the model, 145 nitrogen and energy (indirect calorimetry) balances were obtained from 3 types of pigs (Large White castrates (LWc) and Large White x Piétrain castrates (LPc) and males (LPm)) ranging in BW between 45 and 100 kg and housed under thermoneutral conditions. Animals were allotted to one of four energy levels ranging from 70 to 100% of ad libitum intake. The MEm was not different between genotypes (850 kJ/kg BW$^{.60}$) whereas the k_p and k_f were .56 and .75, respectively. The maximum values for PD were 174, 179, and 192 g/d for LWc (54 kg BW; 103 d), LPc (37 kg BW, 83 d) and LPm (77 kg BW; 109 d), respectively. In most ad libitum fed animals, PD was limited by MEp and not by PDmax. In LPm, the difference between PD and PDmax was small (less than 8%). In LWc and LPc, PDmax started limiting PD at approximately 130 d of age (80 kg). The F did not change with BW for LPm (2.8 x MEm). For the other genotypes, it decreased linearly from 4.6 at 40 kg to 2.0 at 100 kg of BW. Because PDmax was a function of age, even some restrictively fed LWc were limited by PDmax and not by energy intake. At a same BW, these animals are older and therefore have a lower PDmax. Due to its nature, the model allows estimation of PDmax even when energy is restricting PD.

Key Words: Growing Pigs, Energy, Model

49   Effect of supplemental vitamins and trace minerals on performance and carcass quality in finishing pigs. M. S. Edmonds* and B. E. Arentson, *Kent Feeds, Inc., Muscatine, Iowa.*

Two trials with finishing pigs (PIC line 355 x Camborough 22) were conducted to evaluate the effects of vitamin, trace mineral (VTM) deletions on performance, economics, carcass quality, and tissue nutrient levels. In trial 1, a 3 x 2 factorial (three VTM regimens, two stress regimens) was conducted for 12 weeks with 252 pigs (mixed sex). Average initial weight was 55 kg. The VTM regimens consisted of control (adequate level of VTM throughout trial), VTM deleted for final 6 weeks of trial and VTM deleted for entire 12 weeks of trial. The stress regimens consisted of leaving half the treatments in their original location or moving the other half of the treatments to a new pen location every three weeks. There were three replications per treatment with 14 pigs per pen (.80 m^2). Diets were medicated with bacitracin methylene disalicylate. Overall, there were no significant (P $\geq$ .05) treatment differences for ADG, ADFI, G/F, cost per kg of gain, loin eye area, and last rib backfat. However, there was a significant decrease (greater than 75%) in vitamin E content (loin muscle) from deleting vitamins for 6 and 12 weeks. In trial 2, a 3 x 2 factorial (three VTM regimens, sex) was conducted for 12 weeks with 306 pigs. Average initial weight was 58 kg. The VTM regimens were identical to those used in trial 1. Each treatment consisted of three replications of 17 pigs per pen (.66 m^2) and all diets were unmedicated. Overall, pigs fed diets without VTM for 12 weeks had reduced (P $\leq$ .06) ADG and lower (P $\leq$ .10) ADFI than those fed the control diets. Compared to barrows, gilts had significantly lower ADFI and improved (P $\leq$ .05) G/F and fat-free lean index. Vitamin E content (ham muscle) was markedly (P $\leq$ .05) reduced (greater than 50%) when pigs were fed diets without VTM for 6 and 12 weeks compared to those fed the control. Levels of copper in ham muscle were reduced (P $\leq$ .05) in barrows but not in gilts fed diets without VTM. These data suggest that deleting VTM during the finishing stage reduces performance and markedly lowers the nutritional quality (vitamin content) of pork.

Key Words: Pigs, Vitamins, Pork quality

50   Efficacy of acidified sodium chlorite as a decontamination treatment for pork tongues. H. N. Zerby*[1], K. E. Belk[1], J. N. Sofos[1], G. R. Schmidt[1], N. Kotrola[2], M. L. Aldrich[2], and G. C. Smith[1], [1]*Colorado State University, Fort Collins, CO,* [2]*Alcide Corporation, Redmond, WA.*

This study was conducted to evaluate decontamination on pork tongues after they were treated with an acidified sodium chlorite, lactic acid or trisodium phosphate solution. Acidified sodium chlorite (ASC) consist of a combination of acid and sodium chlorite in an aqueous solution (in this study acetic acid and 1200 ppm of sodium chlorite were used). Individual pork tongues (n = 25) were immersed in solutions of ASC (22°C), 2% lactic acid (LA; 50°C), or 12% trisodium phosphate solution (TSP; 50°C) for 10 sec. Other pork tongues were sprayed with a solution of 2% LA (50°C) on each side for 10 sec at 35 psi. The effcetiveness of the treatments was determined by analyzing pork tongue samples for aerobic plate counts (APC), total coliform counts (TCC) and *Escherichia coli* counts (ECC). The APC, TCC and ECC from all treatments were compared with counts obtained from untreated controls. The controls had mean values (log CFU/g) for APC, TCC and ECC of 4.8 $\pm$ .4, 2.6 $\pm$ 1.0 and 2.5 $\pm$ 1.1, respectively. All decontamination treatments were successful in reducing (P < .05) APC, TCC and ECC by a minimum of 68, 98 and 98% of the absolute counts associated with the controls, respectively. Spraying or immersing pork tongues in a 2% LA solution

resulted in a 92% reduction in APC CFU/g compared to the controls, which was more effective (P < .05) than was immersing pork tongues in a 12% TSP which resulted in a 68% reduction. Reductions in mean APC CFU/g due to immersion in ASC solution were similar to reductions obtained with LA. For TCC and ECC, all treatments were equally (P > .05) effective, reducing counts by a minimum of 1.9 and 1.8 mean log CFU/g, respectively. Overall the results indicated that immersion of pork tongues in an ASC, LA and TSP or spraying the pork tongues with LA were similarly effective in reducing microbial counts. Therefore, all three treatments can be considered as an effective decontamination intervention for reducing microbiological counts on pork tongues.

Key Words: Pork, Safety, Bacteria

BREEDING AND GENETICS

51 Power of detecting marker associated QTL effects in granddaughter design. Z. Zhang*[1], R. J. Tempelman[2], I. L. Mao[2], and D. B. Banks[2], [1]*Cornell University*, [2]*Michigan State University*.

Statistical power was examined for detecting the linkage of markers to the QTL effect on a single trait. Granddaughter design populations were simulated from a linear model with polygenic and QTL effects for each of the combinations with respect to selection scheme, marker interval, number of daughters, magnitude of QTL effect, and polygenic heritability. The alternative schemes on the selection of sons are random, disruptive, truncation and stabilized. Fifty replicates were generated for each population and were analyzed separately using restricted maximum likelihood. Significantly greater power was generated under disruptive selection scheme, than that from random selection, whereas truncation and stabilizing selection generated less power than random selection. Power of test using restricted maximum likelihood also was found to be dependent on all other factors considered such that the power was higher with more daughters per sire; smaller marker interval; greater magnitude of QTL effect; and higher level of heritability.

Key Words: QTL, Marker, Power

52 Medium density comparative map of bovine chromosome 25. E. Antoniou*[1], D. Gallagher[2], J. Taylor[2], S. Davis[2], J. Womack[2], and M. Grosz[1], [1]*USDA-ARS Fort Keogh Livestock And Range Research Laboratory, Miles City, MT,* [2]*Texas A&M University, College Station, TX.*

A complete and accurate comparative map of high resolution is necessary for implementation of comparative positional candidate gene cloning. Recent studies have shown complex situations where several interrupted regions of a human chromosome are conserved on one bovine chromosome. This observed complexity underscores the difficulty in using human gene maps in a comparative positional candidate gene approach. There is a crucial need for more detailed comparative maps. We developed a medium density comparative map of bovine chromosome 25 (BTA 25). A radiation hybrid panel containing 90 cell lines was used to map nine genes and ten microsatellites. We isolated Bacterial Artificial Chromosomes containing these genes and eight of them were also mapped by Fluorescence In Situ Hybridization. The map reveals three segments of homology with human chromosomes 7 (HSA 7) and 16 (HSA 16). We describe a rearrangement in gene order on BTA 25 of the genes on HSA 7 as well as a paracentric inversion. The breakpoints of synteny conservation on HSA 7 are defined within less than 2 centimorgans. This new comparative map should simplify the cloning of genes of interest on BTA 25.

Key Words: Comparative Mapping, Cattle, Gene

53 Insight into the biology behind QTL affecting fat deposition in swine. G. A. Rohrer*, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

In a previous study, three chromosomal regions which significantly affected backfat thickness in a Meishan-White composite resource population were reported. That study utilized data collected on more than 530 carcasses from backcross pigs (both Meishan and White composite sired pigs were represented). The chromosomal regions detected were 1:136-138, 7:40-60 and X:59-63 where the values are chromosome:relative position in cM. In the present study, phenotypic data for all of the animals included in the previous study, along with littermates which were retained for breeding (n=730 records), was analyzed. Traits studied were ultrasonic backfat measurements (first rib, last rib and last lumbar vertebra) and weights of pigs at 14 and 26 wk of age. The statistical analyses utilized a least-squares interval mapping procedure and F-ratios were converted to genome-wide significance levels. Fixed effects fitted were breed composition, sex and season of birth for the unadjusted model (UNA) and weight was included as a covariate in the adjusted model (ADJ; backfat measures only). The 1:136-138 region affected all measures of backfat at 14 and 26 wk and was most significant in the UNA model, as it also affected 14 and 26 wk weights. The 7:40-60 region was significant for all backfat measures at 14 and 26 wk in the ADJ model, and to a lesser degree for backfat at 26 wk in the UNA model. While 7:40-60 was not associated with 14 wk weights, it was associated with 26 wk weights. The X:59-63 affected all measures of backfat with similar significance levels for the UNA and ADJ models, but did not affect live weight. In summary, the 1:136-138 region affects backfat and weight at an early age and this effect continues until market largely due to their increased size, the 7:40-60 region affects backfat per unit of live weight at early ages and then growth rate and backfat at 26 wk of age, while the X:59-63 affects backfat at both ages independent of the weight of the animal. The QTL at 1:136-138 is likely a gene which controls early growth, where as the other two regions are more important in partitioning metabolic energy into fat vs lean.

Key Words: Swine, QTL, Backfat

54 Genotypic effects at the *callipyge* locus for meat quality traits in lambs. B. A. Freking*, J. W. Keele, S. D. Shackelford, T. L. Wheeler, M. Koohmaraie, and K. A. Leymaster, .

A resource flock of 362 F_2 lambs provided phenotypic and genotypic data to estimate effects of four *callipyge* genotypes (NN, NC, CN, and CC) on meat quality traits. The mutant allele is represented as C, the normal allele(s) as N, and the paternal allele of a genotype is given first. Lambs of each genotype born in 1994 and 1995 were serially slaughtered in six groups at 3-wk intervals starting at 23 wk of age. Warner-Bratzler shear force and subjective evaluation of marbling were collected during both years from longissimus. Calpastatin activity was collected on longissimus in 1994 and ELISA quantification of calpastatin protein was obtained in 1995. Significant additive and paternal polar overdominance (PO) effects on meat quality traits were detected. The magnitude of genotypic effects on shear force differed significantly between years; however, additive (P < .01), PO (P < .001), and maternal dominance (P < .01) effects adjusted for variation in carcass weight were detected within each year. Shear force data adjusted to the mean slaughter age or carcass weight indicated that the means and variances of CN and CC genotypes were greater than values of NC and NN. Shear force values were greatest for CN and were intermediate for CC. The difference between homozygous genotypes was supported by calpastatin activity data with 2-df F tests of 3.66 (P < .05) and 11.84 (P < .001) at d 0 and d 7 postmortem, respectively. Corresponding values for the PO effect on calpastatin activity were 53.80 (P < .001) and 87.43 (P < .001). Calpastatin ELISA data exhibited a PO effect exclusively with a 2-df F test of 57.63 (P < .001). Additive and PO effects on marbling had F tests of 6.41 (P < .01) and 93.29 (P < .001), respectively. Further research is needed to establish if selection targeted at changing the background genome can ameliorate the negative effects of the C allele on tenderness of the longissimus and maintain favorable muscle growth.

Key Words: *Callipyge*, Sheep, Meat Quality

55 Evaluation of paternal polar overdominance based on all possible matings among *callipyge (CLPG)* genotypes. K. A. Leymaster* and B. A. Freking, .

Paternal polar overdominance uniquely associates the CN genotype (C represents the mutant *CLPG* allele and N the wild type allele, with the paternal allele given first) with the *callipyge* muscle-hypertrophy phenotype and CC, NC, and NN genotypes with the normal phenotype of sheep. This form of parental imprinting was originally proposed based

on data recorded on progeny of five *CLPG* mating types (CC x NN, CN x CN, CN x NN, NC x NN, and NN x CN, with the sire genotype given first). We used a complete 4 x 4 mating design of *CLPG* genotypes to evaluate the paternal polar overdominance model of gene action. Data were recorded on 287 F_3 lambs produced by 8 F_2 sires and 152 F_2 dams of Dorset-Romanov origin. Genotypic data from eight markers flanking the previously determined *CLPG* interval were used to calculate *CLPG* genotypic probabilities in the four-generation pedigree. Lambs were slaughtered and leg muscling scores assigned to carcasses. Lambs with scores less than 13 (13 = low prime) were considered of normal phenotype, whereas lambs with scores greater than 13 were classified as *callipyge* phenotype. Phenotypic classification was regressed on CN probability to test the hypothesis of paternal polar overdominance. The model accounted for 78% of the variation in phenotypic classification ($P < .0001$). Residual analysis identified 15 observations associated with 96% of the error sum-of-squares. CN probabilities were intermediate for 7 lambs due to recombinations between flanking markers or lack of flanking marker information. Leg scores of 12 were assigned to 7 lambs with CN probabilities greater than .997 and the remaining lamb received a leg score of 14, but had a CN probability of less than .001; these results suggested errors in phenotypic classification. The 15 descrepancies were associated with several mating types, roughly proportional to sire and dam genotypic frequencies. The experiment failed to provide conclusive evidence against paternal polar overdominance as the model of gene action at the *CLPG* locus.

Key Words: *Callipyge*, Sheep, Imprinting

56   Prediction of ovulation rate in cattle using genetic markers. G. L. Bennett*, R. M. Thallman, S. M. Kappes, and K. E. Gregory, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

To evaluate the use of genetic markers in breeding value prediction, breeding values for heifer ovulation rate calculated using BLUP with or without fixed covariates for expected inheritance of founding animal alleles at selected positions in the genome (FACOV) were compared to subsequent measurements of ovulation rate. Expected inheritance of founding animal alleles was determined from a multi-locus peeling algorithm using marker genotypes. Averages of six ovulation rate measurements made from 12 to 18 months of age were calculated for 426 heifers born in four calving seasons. Sixteen FACOV were selected for the final analysis based on preliminary analyses using data collected prior to the comparison data. These sixteen covariates consisted of five founding animal alleles at one location on one chromosome, six at another distant location on the same chromosome, and five on a second chromosome. Including the 16 FACOV reduced the estimate of polygenic variance by 13%. Predictions were updated for the four calving groups using only information collected prior to each calving group. The regressions of observed ovulation rate on predicted breeding value were not substantially or significantly different from the expected value of 1.0 either with (.93±.19) or without (.92±.21) FACOV. The proportion of observed variation in ovulation accounted for by prediction was .052 with FACOV and .043 without FACOV. Without FACOV, predicted breeding values of heifers were based only on the averages of their sire and dam breeding values. Predicted breeding values using FACOV were partitioned into parental average and deviation from parental average. The deviation from parental average results from Mendelian sampling of the selected founding animal alleles and accounted for 28% of the variance accounted for by prediction with FACOV. Using marker information to track a small number of founding animal alleles increased the accuracy of predicted breeding values by accounting for some within family segregation.

Key Words: Marker Assisted Selection, Genetic Prediction, Cattle

57   Candidate gene analysis for loci affecting reproductive traits in swine selected for litter size and ovulation rate. R. C. Linville*, R. K. Johnson, and D. Pomp, .

A candidate gene approach was used to identify loci that influence ovulation rate (OR). Two selection lines (IOL and COL) and a control line (C) were used. IOL was obtained from a line previously selected on ovulation rate and embryonic survival for 8 generations. COL and C were derived from the previously randomly selected control line. Both IOL and COL have undergone 8 additional generations of selection in which stage 1 included all gilts from 50% of litters with greatest number of

fully formed pigs (FF), and stage 2 included 50% of these gilts with the greatest OR. Line C continued to be randomly selected. IOL and COL differ in mean EBV by 6.1 ova and 4.1 FF, whereas COL and C differ by 2.2 ova and 2.2 FF. Animals from generation 7 were genotyped for retinol binding protein 4 (*RBP4*, n=190) and epidermal growth factor (*EGF*, n=189). Animals from generations 7 and 8 were genotyped for estrogen receptor (*ESR*, n=523), prolactin receptor (*PRLR*, n=491), follicle stimulating hormone beta subunit (*FSHb* , n=272), and prostaglandin-endoperoxide synthase 2 (*PTGS2*, n= 513). Chi square analysis for homogeneity of genotypic frequencies across lines was conducted in 3 X 3 contingency tables. Distributions for *EGF, ESR, and RBP4* were not significant. Genotype frequencies for *PRLR, FSHb, and PTGS2* were different among the lines (P<.005). Changes in gene frequencies (s.e. adjusted for genetic drift) between IOL verses C and COL verses C are: .33 ± .29 and .15 ± .27 for *PRLR*, .30 ± .28 and .1 ± .26 for *FSHb*, and .16 ± .22 and .09 ± .21 for *PTGS2*. The average effect of gene substitution for *PRLR, FSHb, and PTGS2* on OR were calculated using the MTDFREML program with an animal model including year and line as fixed effects and number of favorable alleles in the genotype (0, 1, or 2) as the covariate. The favorable allele was defined as the one with the highest frequency in the selection lines. Estimates of a were -.12 ± .46 (*PRLR*), .35 ± .76 (*FSHb*), and -.37 ± .68 (*PTGS2*). Selecting for *PRLR, PTGS2 and FSHb* may benefit genetic improvement for litter size; however, additional studies to verify these results are needed.

Key Words: Candidate Gene, Ovulation Rate, Swine

58   The effect of estrogen receptor genotype, breed, and parity on litter traits and reproductive tract traits in swine. B. J. Isler*, K. M. Irvin, S. M. Neal, S. J. Moeller, M. E. Davis, and D. L. Meeker, *The Ohio State University, Columbus.*

An association between the estrogen receptor (ESR) gene and reproductive components in swine has been evaluated. Two hundred twelve litter records from females genotyped at the ESR locus were analyzed using a model that included the effects of ESR genotype of dam, parity, farrowing month, dam breed, sire breed, and significant two-way interactions. Some litter traits displayed favorable, but not statistically significant trends with respect to ESR genotype: litter weight born alive, litter weight born, number of stillborn pigs, number of pigs at weaning, and total litter weight at weaning. Reproductive tract data were also analyzed for associations with ESR genotype. The ESR genotype of 36 Yorkshire, 28 Large White, and 42 crossbred females was determined to be either AA (n=21), AB (n=69), or BB (n=16). Females of parities 1 (n=46), 2 (n=41), and ≥3 (n=19) were included. All females were mated to Hampshire boars and slaughtered at d 75 of gestation. Measured reproductive tract traits were: ovulation rate, horn length, number of fetuses, fetal weight, uterine weight, number of mummies, fetal sex, fetal placement, fetal survival, and fetal space. Data were analyzed using a model that included ESR genotype, breed, parity, and significant two-way interactions. Uterine horn was also included in some analyses. Fetal space and fetal number per horn were not significantly different between animals of AA (58.3±3.84, 5.11±.30), AB (54.9±1.94, 5.57±.16), and BB (52.1±5.47, 5.84±.34) genotype. Fetal space and number of fetuses per horn were significantly (P=.01, P=.03) different between animals of parity 1 (61.6±2.66, 5.21±.21), and parity ≥3 (45.6±5.84, 5.97±.32). Some traits displayed favorable, but not statistically significant trends with respect to ESR genotype: fetal survival, total uterine length, total fetal weight, total number of mummies, fetuses per horn, horn length, and fetal space. The ESR gene is positively associated with several litter and reproductive tract traits.

Key Words: Swine, Genetic Marker, Reproductive Traits

59   Evidence of QTL affecting reproduction in pigs. J. P. Cassady*[1], R. K. Johnson[1], D. Pomp[1], L. D. Van Vleck[2], E. K. Spiegel[1], K. Gilson[1], and G. Rohrer[3], [1]*University of Nebraska, Lincoln,* [2]*USDA, ARS, USMARC, Lincoln, NE.,* [3]*USDA, ARS, USMARC, Clay Center, NE.*

The objective was to identify chromosomal regions containing QTL affecting reproduction in pigs. A three-generation resource population was developed by crossing low indexing animals from a randomly selected control line (C) with high indexing animals of a line selected for increased index of ovulation rate and embryonic survival (I). Differences between lines I and C at Generation 10 were 6.7 ova and 3.3 fetuses at 50

d of gestation and 3.1 fully formed pigs and 1.6 live pigs at birth. Phenotypic data were collected in F_2 females for ovulation rate (n = 428), age at puberty (n = 295), litter size (n = 362) and number of teats (n = 428). Litter size data included number of fully formed, live, stillborn, and mummified pigs. Grandparents, F_1, and F_2 animals were genotyped for 96 microsatellite markers distributed across all chromosomes except 9, 18, and X. A LOD score of 3 corresponds to genome wide suggestive linkage (determined by the method of Lander and Kruglyak, Nature Genetics, 11:241-247). Calculations of LOD scores were by least squares including fixed effects of litter and replicate. Suggestive evidence was previously reported for QTL influencing age at puberty on chromosome 8 (120 cM, LOD = 3.74) and for number of stillborns on chromosome 13 (104 cM, LOD = 4.04) using the USDA-MARC linkage map as reference. After further investigation suggestive evidence was found for a QTL affecting number of stillborns on chromosome 10 (65 cM, LOD = 3.80). Evidence of a QTL affecting number of mummies on chromosome 5 was just below the suggestive level of significance (134 cM, LOD = 2.91). All traits for which QTL were detected are lowly to moderately heritable and are expressed only in females. Response to selection for these traits might be enhanced by marker-assisted selection (MAS). Age at puberty is the most labor intensive trait to measure of those traits and may benefit most from MAS.

Key Words: pigs, QTL, reproduction

60   Genetic and phenotypic relationships among bull and heifer reproductive traits in a multibreed beef cattle population. P. B. Mwansa*[1], R. A. Kemp[1], D. H. Crews Jr.[1], J. P. Kastelic[1], D. R. C. Bailey[2], and G. H. Coulter[1], [1]*Agriculture And Agri-Food Canada, Lethbridge Research Centre,* [2]*Lacombe Research Centre.*

Genetic and phenotypic correlations among and between bull and heifer reproductive traits in a multibreed (.25 Charolais, .25 Simmental, .44 Hereford/Angus, .06 Limousin) beef cattle population were estimated. At about one year of age (365±44 d) yearling scrotal circumference (**YSC**), tonometer score (**YTON**) and weight (**YWT**) measurements were collected on 1547 bulls born from 1983 to 1994. Data on age at puberty (**AGEPH**), estimated weight at puberty (**ESTWT**), Julian birth date (**JBD**), birth weight (**BWT**) weaning weight (**WWT**), yearling weight (**YWT**), pre-weaning (**ADG1**) and post-weaning daily gain (**ADG2**) on 1883 heifers born between 1987 and 1994 (inclusive) from Brandon (Manitoba) and Manyberries (Alberta) were also available. All traits were analyzed using a multi-trait animal model with age at time of measurement included as a covariate for **YSC**, **YWT** and **YTON**. Means and standard errors were 32±3 cm, 381±50 kg, and 21±2 for **YSC**, **YWT** and **YTON**, respectively. Heifer average **BWT**, **WWT** and **YWT** were 37±5 kg, 225±28 kg and 341±33 kg, respectively and their **ADG1** and **ADG2** were 0.95±0.13 and 0.68±0.15 kg, respectively. On average heifers reached puberty at 297±47 d weighing 293±42 kg. Direct heritabilities were 0.65, 0.35 and 0.17 for **YSC**, **YWT** and **YTON**, respectively and 0.06, 0.36 and 0.27 for **JBD**, **ESTWT** and **AGEPH**, respectively. **YSC** had a negative genetic correlation (rg=-0.47) with **YTON** indicating that large **YSC** was associated with lower **YTON**. **YTON** may aid in setting the lower and upper bounds of desirable scrotal size in beef cattle. Of all heifer traits studied, only **JBD** and **ESTWT** were significantly (P<.05) related to **AGEPH**, with rg=-0.24 and rg=0.72, respectively. **YSC** showed a favorable genetic relationship (rg=-0.28) with **AGEPH** suggesting that improvement in **AGEPH** can be achieved as a correlated response to selection of bulls with above average **YSC**. The genetic and phenotypic correlations between **YTON** and **AGEPH** were not different from zero (P>.05) suggesting that **YTON** was not associated with age at first estrus.

Key Words: Scrotal circumference, Age at puberty, Reproduction

61   Genotype x environment interactions in Angus, Brahman, and reciprocal-cross cows and their calves grazing endophyte-infected tall fescue, common bermudagrass, or both forages. M. A. Brown*[1], A. H. Brown, Jr.[2], W. G. Jackson[3], and J. R. Miesner[3], [1]*USDA-ARS, Grazinglands Research Laboratory, El Reno, OK,* [2]*University of Arkansas, Fayetteville,* [3]*USDA-ARS, Dale Bumpers Small Farms Research Center, Booneville, AR.*

Approximately 190 Angus (AA), Brahman (BB), and reciprocal-cross cows (AxB and BxA) and their 434 calves born in 1995-1997 were used to evaluate the effect of forage environment on reproductive and preweaning performance. Cows were managed on 16 ha pastures of either common bermudagrass (BG), endophyte-infected tall fescue (E+), or E+ in the fall and spring and BG in the the summer (ROT) with all breed types represented in each pasture. Stocking rates were approximately 1.25 hd/ha for BG and E+ and an average of 1.25 hd/ha for ROT (approximately 2.5 hd/ha on BG in summer and 2.5 hd/ha on E+ in fall and spring). Eight Polled Hereford bulls were used each breeding season from 1994 to 1996 with a total of 13 different bulls used in the study. Calves were born from late February through May, weighed at birth, and tagged. Bull calves were castrated at birth by banding. Calves were weaned at an average age of 205 d when full weights and hip heights were taken. Creep-feeding was not practiced. Maternal heterosis in 205-d weight was larger on E+ than BG (32.0 vs 20.4 kg, P<.10) with maternal heterosis on ROT (29.2 kg) not significantly different from the other two forages. Maternal heterosis in weaning hip height was similar for E+ and ROT (4.7 and 4.3 cm) and both exceeded (P<.01) BG (1.4 cm). Heterosis in calving percentage was larger (P<.05) on E+ (29.6%) compared to BG and ROT (9.5 and 2.6%). Similarly, heterosis in 205-d weight per cow exposed was larger (P<.01) on E+ (114.3 kg) than BG or ROT (36.4 and 39.7 kg). Empirical reasons for these interactions might be suggested by the larger effect of E+ on AA and their calves compared to the other cow breed groups and their calves for calf performance and the larger effect of E+ on purebred cows compared to crossbreds for reproductive performance. These data suggest a higher level of stability in calf performance, comparing BG and E+, for the average of calves from crossbred cows compared to the average of calves from purebred cows. Similarly, these data suggest a higher level of stability in cow reproductive performance across forages in crossbred cows compared to purebred cows.

Key Words: Genotype x environment, Beef cattle, Forages

62   Analysis of litter size and piglet mortality using a multivariate model with direct and maternal effects. M. S. Lund*[1], P. Luttinen[2], L. Rydhmer[3], M. Henryon[1], and J. Jensen[1], [1]*Danish Institute of Animal Sciences,* [2]*Finnish Animal Breeding Association,* [3]*Swedish University of Agricultural Sciences.*

The objective of this study is to estimate (co)variances for direct and maternal genetic effects in the litter size of pigs and mortality of piglets. Only single-trait analyses have been reported in the literature for these traits, though they are likely to be genetically correlated. Therefore, to obtain a thorough understanding of the components involved in the number of piglets weaned, multi-trait analyses will be carried out which includes the total number of piglets born, mortality of piglets until birth, and mortality of piglets from birth until three weeks of age. The analysis will be performed on large purebred populations from Finnish herds, with complete pedigree information. The dataset consists of records on 116 792 Landrace litters and 82 471 Yorkshire litters with sires from AI-stations. The model will fit direct and maternal genetic effects for each of the traits in the analysis.

Key Words: Litter size, Piglet mortality

63   Crossbreeding parameter estimates for growth and litter traits in commercial rabbits. M. F. Medellin and S. D. Lukefahr*, *Texas A&M University-Kingsville.*

Postweaning fryer and litter production traits were measured in 1,111 weanling rabbits from 185 litters born in 1997 in sub-tropical, semi-arid south Texas. Genetic groups evaluated were Altex (A; a new commercial sire breed) and New Zealand White (NZW; a traditional commercial breed) purebreds and AxNZW and NZWxA reciprocal crossbreds. Traits were individual weaning (28-d; WW) and market (70-d; MW) weights and ADG. Litter traits were litter size weaned (LSW), 28 to 70 d total feed intake (LFI), feed efficiency (LFE), and survival rate (SR), and within-litter uniformity for MW (CV). The least-squares model consisted of fixed effects of sire breed, dam breed, season, and two- and three-way interactions, and random effects of sire/sire breed, dam/dam breed, litter/sire breed x dam breed (only for individual growth traits), and residual error. In favor of A sires, breed additive estimates were 37.3±20 (P<.10) and 140±37 g (P<.001) and 2.5±.6 g/d (P<.001) for WW, MW, and ADG, respectively. The maternal breed effect (obtained from NZW minus A performance of dams) did not influence WW (49.4±34 g), but tended to affect (P<.10) MW and ADG (112±63 g and 1.59±.9 g/d). Individual heterosis was not important for WW (15.4±19

g), but was significant for MW and ADG (81±34 g and 1.59±.5 g/d). Crossbreeding parameters were not significant for all litter traits investigated. However, when LFI and LFE were adjusted linearly for LSW (added to the above model), heterosis exhibited in crossbred litters significantly increased LFI by 2,470 g, while the breed additive contribution of A sires improved LFE by .26 units. Litter size at weaning was similar for A and NZW does (mean LSW was 6.1±.3 kits). Season affected (P<.05) all traits except CV. There was no relationship between breed-type of fryer and season of weaning for SR (P>.05; overall postweaning mortality was only 3.2%). A doe breed x season interaction was deteted for MW (P<.05). Fryers reared by A compared to NZW does were heavier by 176 g (P<.05) in the summer, whereas no differences existed between doe breeds in the other seasons. Experimental results recommend crossing of A bucks to NZW does to improve breeding efficiency in the meat rabbit industry.

Key Words: Rabbits, Breeds, Heterosis

64   Comparison of carcass traits of *Bos taurus x Bos taurus*, *Bos indicus x Bos indicus* and *Bos taurus x Bos indicus*). A. P. Márquez*[1], C. C. Vásquez[2], A. C. Correa[1], H. C. Hernández[3], and H. G. González[1], [1]*Universidad Autónoma de Baja California, Instituto de Ciencias Agrícolas*, [2]*Universidad Industrial de Santander, Colombia*, [3]*Universidad Autónoma de Baja California Sur*.

Evaluations of 511 carcasses of steers and heifers progeny from crosses involving Charolais, Brahman, Brangus, Hereford and Angus inheritance are persented. Traits evaluated included final weight, percentage of carcass yield chill, yield grade, dressing percentage and marbling score. Separate analyses for each trait was analyzed by using SAS. The analytical model included fixed main effects of sire breed, sex, slaughter group, dam breed and interaction of sire breed x dam. Random nested components of sires within sire breed and dams within dam breed and residual. A series of linear contrasts was used to test averages between specific breed combinations. Charolais crosses were the heaviest (P<.05)(average of all Charolais crosses = 508.33 kg)for final weight compared with progeny of other sire breed. Sex effects were highly significant (P<.01) for all the traits. Sire breed effects were significant for final weight, yield grade and dressing percentage. Sires nested as a random components within sire breed were significant for final weight, cold carcass percentage and yield grade. Dam breed effects were highly significant (P<.01) for all traits. Dam breed effects nested within dam breed were significant (P<.01) for cold carcass percentage, yield grade and dressing percentage. Sire x dam interaction was highly significant (P<.01) for final weight, cold carcass percentage and marbling score.

Key Words: Beef cattle, Carcass traits, Breed crosses

65   Breed, muscle quality and sensory characterisics of pigs classified as high or low for glycolytic potential of the loin muscle. R. S. Emnett*, S. J. Moeller, D. L. Meeker, K. M. Irvin, and R. N. Goodwin[2], [1]*The Ohio State University*, [2]*National Pork Producers Council*.

The effect of Glycolytic Potential (GP) on pork quality traits was analyzed for a population of 576 longissimus dorsi samples collected from pigs entered in the 1998 National Barrow Show Progeny Test. Berkshire (N=184), Chester White (N=99), Duroc (N=77), Hampshire (N=22), Landrace (N=55), Poland China (N=24), Spot (N=15), Yorkshire (N=69), Hampshire crossbred (N=16), Poland x Duroc F1 crossbred (N=8), and Tamworth x Hampshire crossbred (N=7) were represented in the test. Animals were classified as high glycolytic potential (N=26) or low glycolytic potential (N=550) based on a GP threshold of 160 μmoles lactate equivalents per gram for the population bimodal distribution. Muscle quality and sensory traits were analyzed in a mixed model analysis of SAS with fixed effects of day off test, breed and GP status and a random sire(breed) effect. Partial correlation coefficients were calculated among quality traits using the MANOVA statement in SAS. Objective muscle quality traits measured included loin pH (pH), water holding capacity (WHC) measured as the weight (mg) of exudate absorbed on a filter paper, Instron tenderness (INS), percent cooking loss (CL), and Minolta color (MIN). Sensory scores evaluated included tenderness (TEN) and juiciness (JUC). The least squares means for high and low GP pigs were 182.0 and 112.5 μmoles/g, respectively. High GP pigs had significantly lower pH (5.38 vs 5.56), WHC (.054 vs .038) and greater CL (23.6 vs 19.2) than low GP pigs. No statistical differences were found between low and high GP pigs for INS, MIN, JUC or TEN.

Breed was a significant source of variation for all traits evaluated. Berkshire and Chester White breeds exhibited significantly lower GP values than all other breeds. Residual correlations between GP and pH, INS, WHC, CL, and MIN were -.54, .12, .22, .25, and .29, respectively. The results of this study agree with previous research indicating that high GP values are associated with poorer WHC, lower pH and higher CL. The breed differences in GP warrant future studies to determine the relationship of GP with muscle quality and sensory traits.

Key Words: Swine, Muscle Quality, Glycolytic Potential

66   Estimation of genetic parameters for growth traits in a dog guide population. S. K. Helmink*[1], S. L. Rodriguez-Zas[1], R. D. Shanks[1], and E. A. Leighton[2], [1]*University of Illinois, Urbana*, [2]*The Seeing Eye, Inc., Morristown, NJ*.

An optimum-sized dog guide weighs 18 to 32 kilograms and stands 53 to 64 centimeters at the withers when mature body size is attained. Heritabilities and genetic correlations were estimated for birth weight, 42-day weight, mature weight, and mature height for 2334 German Shepherd Dogs (GSD) and 2028 Labrador Retrievers (LR) raised by The Seeing Eye, Inc., Morristown, NJ from 1979 to 1997. Data included 5006 observations for GSD from 114 dams and 34 sires, and 4123 observations for LR from 90 dams and 30 sires. Derivative free REML software was used to estimate (co)variance components with an animal model incorporating all pedigree information available and fixed effects for sex and birth year. Maternal effect and covariate of age when measurement was taken were also considered. Heritabilities ranged from 0.16 ± 0.07 to 0.51 ± 0.11 for GSD and 0.31 ± 0.11 to 0.44 ± 0.08 for LR. The maternal component was higher than the additive component for heritability of birth weight. Heritability of mature weight was estimated as 0.49 ± 0.07 for GSD and 0.44 ± 0.08 for LR. Mature height heritability was estimated as 0.31 ± 0.08 for GSD and 0.44 ± 0.08 for LR. Mature height was most highly correlated with mature weight. Selection for lighter dogs at maturity will yield a decrease in height at maturity, and selection for taller dogs at maturity will yield an increase in mature weight. The estimated genetic parameters will aid in the development of breeding strategies to increase the probability of dogs attaining optimum mature size.

Key Words: Body Weight, Height, Heritability

67   Differences in fresh and cooked ham muscles due to breed and sex. R. N. Goodwin*[1], R. K. Miller[2], and E. P. Berg[3], [1]*National Pork Producers Council*, [2]*Texas A & M University*, [3]*University of Missouri*.

Purebred barrows and gilts (787) representing the pure breeds of Berkshire, Chester White, Duroc, Hampshire, Landrace, Poland China, Spot, and Yorkshire were evaluated. These pigs represented 103 sire families. Pigs were entries in the 1996-1997 National Barrow Show Sire Progeny Tests and slaughtered at the Quality Pork Processors commercial packing plant in Austin, MN. One ham per carcass was collected from the plant fabrication line, packaged individually, and transported to the Texas A&M University Meat Lab at College Station, TX. Hams were separated into skin, bone, seam fat, subcutaneous fat, OUTSIDE ham (biceps femoris and semitendinosus), KNUCKLE (quadriceps group), INSIDE (semimembranosus), and other lean. Measures of ultimate ph (RPH), drip loss (DRIP, %), Minolta reflectance (RREFL), and Hunter color (RHUNT, L*) were taken from the fresh INSIDE, KNUCKLE, and OUTSIDE. The INSIDE, KNUCKLE, and OUTSIDE were injected up to 20% of green weight using a brine containing water, salt, sodium tripolyphosphate, dextrose, sodium erythorbate, and sodium nitrite. Ham muscles were tumbled for one hour after injection and allowed 12 hours at 4°C to equilibrate. Ham muscles were cooked to an internal temperature of 71°C. Measures of ph (CPH), Minolta reflectance (CREFL), Hunter color (CHUNT, L*), cooking yield (COOKYLD,%), and slicing yield (SLICEYLD,%) were taken on cooked muscles. Fresh ham measures were evaluated with a mixed linear model including fixed effects of BREED, SEX, BREED*SEX and slaughter date. Random effects were SIRE within BREED and DAM within BREED. Cooked ham measures were evaluated using the fresh ham model with the additional effect of brine injection amount. A REML algorithm was used to estimate sire variances. Heritabilities were calculated as four times the sire variance divides by total variance. BREED differences were found for

all measures (P<.05). Heritabilities ranged from 0 (OUTSIDE DRIP) to .28 (INSIDE RHUNT).

Key Words: Swine, Genetics, Pork Quality

68   The genetic relationship of ovine milk score with range lamb weaning weight. G. D. Snowder*[1], A. D. Knight[1], C. M. Bromley[2], and L. D. Van Vleck[3], [1]*USDA, ARS, U.S. Sheep Experiment Station,* [2]*University of Nebraska, Lincoln,* [3]*USDA, ARS, MARC, Lincoln.*

Range ewes are commonly evaluated for milking ability by producers as to the ewe's ability to rear lamb(s) under range conditions. The U.S. Sheep Experiment Station has been subjectively scoring a ewe's milking ability (low, average, high)within 24 hrs of lambing for many years. The objective of this study was to determine factors influencing milk score and estimate genetic parameters between milk score and litter weight weaned. Lambing records of Columbia (n=1731), Polypay (n=1129), Rambouillet (n=1704), and Targhee (n=1638) individual ewes were evaluated. Only 1 to 10% of first parity ewes were scored as high milking ability. However, 29 to 40% of second or greater parity ewes were evaluated as high milking ability. Some positive association may exist between body size (kg) and milk score especially at third parity or later in all breeds. Ewes with high milk scores gave birth to significantly heavier lambs in all breeds while ewes with low milk scores were associated with significantly higher lamb death losses at birth. Heritability of milk score and the genetic correlation of milk score with litter weight weaned were determined by MTDFREML analyses within each breed. Heritability estimates were moderate and similar among breeds (Columbia, .21; Polypay, .26; Rambouillet, .21; Targhee, .23). The genetic correlations between milk score and litter weight weaned were also moderate and within a general range (Columbia, .51; Polypay, .44; Rambouillet, .46; Targhee, .38). Conclusions include first parity milking performance may not be a good indicator of future potential milking ability, milk score may be a good selection trait for improving maternal ability, and it appears useful under commercial range conditions weaning at older ages (120 d).

Key Words: Ewe, Milk, Heritability

69   Genetic comparison of top Holstein bulls and their progeny in Hungary. A. Janosa*[1], B. Baranyai[2], and J. Dohy[1], [1]*Godollo University of Agricultural Sciences,* [2]*Agricultural Biotechnology Center, Godollo.*

Progeny-tested Hungarian Holstein-friesian sires have been examined. The Hungarian Total Production Index (TPI)of 44 sires were compared to their 282 sons' TPI (i.e. 6.4 sons/sire)and to 16,435 granddaughters' milk fat and protein production performance. The goal of the present work was to determine if there were correlations between (1) the sires' TPI and their sons' TPI and also (2)granddaughters' fat and protein production performance. The Hungarian Total Performance Index was counted as follows: TPI=6*PTA Fat(kg)+14*PTA Protein (kg)+80*PTA Final Score+70*PTA Udder Score. Rank correlation between the indices was calculated by the method of Spearman. After the analysis for rank-correlation (r), a weak correlation was found between the sires' TPI and the sons' average TPI (r=.424); the sires' TPI and granddaughters' fat (r=.332) and protein (r=.341) production performance. It can be concluded that however modern the selection of the best sires is (BLUP), the weak correlations between TPI of sires and the fat and protein production performance of their granddaughters show that progeny-testing of sires' sons is indispensable. The application of TPI does not improve production directly, but prevents the constitutional degradation of the animals. Our other results of correlation between sires' TPI and granddaughters' type final sore, udder score and feet composit made with similar method, also reinforce this conclusion. The correlations found are strong or middle strong and they are .651,.568 and .579, respectively.

Key Words: Genetic Comparison, Production Index, Progeny-testing

70   Consequencaes of selection on mothering ability and vitality on underlying mortality traits in pigs. E. F. Knol*, *Institute for Pig Genetics, The Netherlands.*

In The Dalland genetic improvement program selection against piglet mortality is based on EBV's for mothering ability and piglet vitality.

In two data sets the consequences of this approach were checked. Data 1 consists of around 10,000 litters of commercial offspring with a full pedigree. Correlations of pedigree index of mothering ability with live- and still- born and with the occurrence of aggression, overlaying and splay legs were non-significant, while correlations with no. weaned were 0.04 (P= 0.0001) and mothering ability 0.03 (P=0.0002). Pedigree index for piglet vitality correlated in the expected directions with still- born -0.03 (P=0.0017), no. weaned 0.04 (P=0.0002), mothering ability 0.04 (P=0.0001), overlaying -0.03 (P=0.0016) and the occurrence of splay legs -0.03 (P=0.0068). Correlations with live born and aggression were non-significant. Gestation length in pigs is highly heritable and correlated with aggression -0.03 (P=0.0001), overlaying -0.04 (P=0.0001) and splay legs -0.07 (P=0.0001). In data 2 some 25,000 litters of pure line sows were analysed, registration of piglet traits is more precise and includes birth weight. Heritability estimates for mothering ability, aggression, overlaying and occurrence of splay legs are resp. 0.07, 0.08, 0.04 and 0.08. Permanent environment estimates resp. 0.05, 0.31, 0.05 and 0.09. Genetic correlations (stde) of mothering ability with aggression, overlaying and splay legs are resp. -0.13 (0.22), -0.33 (0.25) and -0.54 (0.18). It is concluded that selection on mothering ability and piglet vitality will not necessarily reduce aggression, but will reduce piglet mortality in general and more specific overlaying and the occurrence of splay legs in both pure lines and the commercial hybrid.

Key Words: Piglet Mortality, Aggression, Splay Legs

71   Comparison of carcass traits from calves by Angus, Charolais, Salers, Piedmontese, Tarentaise and Hereford sires. D. C. Anderson*[1], D. D. Kress[2], D. L. Boss[1], K. C. Davis[2], and D. W. Bailey[1], [1]*Northern Agricultural Research Center, Havre, MT,* [2]*Montana State University, Bozeman, MT.*

Carcass traits were evaluated from 158 crossbred steers out of Hereford, Tarentaise and Tarentaise-Hereford cross dams mated to Angus (AN), Charolais (CH), Salers (SA), Piedmontese (PD) and Tarentaise-Hereford (TH) sires for 2 yr. Calves were weaned Oct. 1 and placed on feed Nov. 15. Steers were serial slaughtered by time on feed with 1/2 each breed group fed 180-210 d and 1/2 fed 210-240 d. Ration included barley grain, corn silage, chopped hay and protein supplement. Main effects were year, sire breed (SB), sire/sire breed, and age of dam with slaughter age as a covariate. Sire/sire breed was used as error term for SB. ADG on feed was influenced by SB (P<.01) with AN and CH greatest and PD lowest. Carcass traits evaluated were hot carcass weight (HCW), yield grade (YG), ribeye area (RIB), marbling score (MARB), kidney pelvic heart fat (KPH) and 12th rib fat thickness (FAT). Warner-Bratzler shear force (WBS) data were collected for 1 yr on a 2.54 cm thick steak taken at the 12th rib and aged 14 d. Least squares means for SB were HCW (P<.05), 290, 300, 270, 282, 288 kg; YG (P<.01), 2.5, 1.9, 1.1, 1.9, 2.5; REA(P<.01), 76.0, 81.0, 88.2, 78.8, 73.0 cm^2; MARB (P<.01), 426, 400, 353, 365, 417; KPH (P<.01), 2.1, 1.9, 1.7, 1.9, 2.1%; FAT (P<.01), 0.90, 0.58, 0.43, 0.61, 0.82 cm for AN, CH, PD, SA and TH, respectively. WBS values were similar (P=.55) for SB. PD sires had lightest HCW, largest REA, least MARB and FAT. CH sires had heaviest HCW and AN sires had highest MARB and most FAT. All breeds when compared to AN needed more days on feed and heavier HCW to increase MARB and to achieve a USDA choice quality grade.

Key Words: Beef Cattle, Crossbred, Carcass Traits

72   Partial DNA sequence and polymorphism for porcine anti-müllerian hormone receptor. P. A. Dyas*, E. V. Amargo, and B. A. Didion, .

The objective of this project was to identify DNA sequence for the porcine anti-müllerian hormone receptor (AMHR) gene and evaluate this gene for any polymorphisms within different genetic lines of swine. Polymerase Chain Reaction (PCR) primers were designed based on a conserved exon sequence in the AMHR gene from the human and rat. These primers were used to amplify a fragment from porcine genomic DNA. This fragment was cloned, sequenced and found to be 213 bp in length. The entire sequence was submitted for a BLAST search to identify homology. The results found this sequence to have 86% and 83% homology with human and rat AMHR sequence, respectively. This 213 bp fragment was labeled with digoxigenin (Roche Molecular Biochemicals) and used as a probe in non-radioactive southern blots. Eight micrograms of porcine genomic DNA was digested with a restriction

enzyme and electrophoresed on a 1% agarose gel. Six different restriction enzymes were evaluated for polymorphisms with the AMHR probe. Allelic variation was identified using the restriction enzyme *Hind* III. Two animals from each of seven different genetic lines were evaluated for allelic variation. Two alleles were detected using the AMHR probe in three of the seven genetic lines. Allele A was approximately 10 kilobases in size, while allele B was approximately 7 kilobases in size. Next, a single sire, two dams and the resulting two litters of offspring were evaluated for this polymorphism in one genetic line. The same two alleles described above exhibited Mendelian inheritance. Further research is required to identify the chromosomal location of the porcine AMHR gene.

Key Words: Porcine, Anti-müllerian hormone receptor, Polymorphism

73   Allelic frequencies of the porcine H-FABP gene in two genetic lines. E. V. Amargo*, P. A. Dyas, and B. A. Didion, *DeKalb Swine Breeders, Inc., DeKalb, IL.*

The porcine heart fatty acid-binding protein (H-FABP) gene has been sequenced and localized to swine chromosome 6 and may have an association with production traits such as intramuscular fat and backfat (Gerbens et al., 1997; 1998). The objective of this project was to determine allelic frequencies for three PCR-RFLPs of the H-FABP locus in two genetic lines of pigs. The PCR-RFLPs were detected in random selected Pietrain (N=220) and Duroc (N=69) genetic lines using two primer sets for H-FABP (FAB1 and FAB3). The FAB1 primer set yielded an 816 base pair (bp) PCR product. This product was digested with *Hae*III and *Msp*I in two separate restriction enzyme reactions. The FAB3 primer set yielded a 376 bp PCR product that was restriction enzyme digested with *Hinf*I. Each H-FABP polymorphism exhibited two alleles. The digestion products were electrophoresed on a 3% agarose gel for *Hae*III and *Hinf*I. The digestion products of the *Msp*I site were electrophoresed on a 2% agarose gel. The *Hae*III alleles comprised a 684 bp product (allele D) and a 406/278 bp product (allele d). The *Msp*I alleles comprised a 814 bp product (allele a) and a 703/111 bp product (allele A). The *Hinf*I alleles comprised a 256 bp product (allele h) and a 197/59 bp product (allele H). The table below shows the allelic frequencies for the Pietrain and Duroc lines. The data depicts heterozygosity existing for the H-FABP gene in the two genetic lines. However, the Pietrain line appears to be approaching fixation for allele A of the *Msp*I site. Research is ongoing to evaluate whether the allelic frequencies associate with percent intramuscular fat and backfat for these lines.

| Line | *Msp*I (%) | | *Hae*III (%) | | *Hinf*I (%) | |
	Alleles A	a	D	d	H	h
Pietrain	99.3	0.7	43.2	56.8	76.5	23.5
Duroc	72.4	27.6	65.9	34.1	77.9	22.1

Key Words: Porcine, Intramuscular fat, PCR-RFLP

74   Preliminary evaluation of pituitary responsiveness to GnRH as a tool to predict reproductive traits in bulls. M. G. Thomas*[1], J. A. Winder[2], C. C. Rasor[1], and D. M. Hallford[1], [1]*New Mexico State University, Las Cruces, NM,* [2]*Samuel Roberts Noble Foundation, Ardmore, OK.*

Development of physiological methodologies that can be incorporated into current sire evaluation techniques could increase the accuracy of sire selection. In this study, Forty-five Noble Line Composite bulls (1/3 Angus, 1/3 Brahman, 1/3 Gelbvieh) from 10 sires and reared in two locations were used to evaluate the use of pituitary responsiveness to GnRH as a tool to predict reproductive traits. Bulls averaging 232 ± 3.5 d of age received a 60 μg i.v. injection of hGnRH to stimulate pituitary secretion of LH. Blood was collected from each bull prior to GnRH injection and thereafter at 30-min intervals for 90 min. Reproductive traits such as scrotal circumference were measured every 28 d and age for scrotal circumference to equal 32 cm (AGE32) were determined during a 112-d performance test. Pituitary responsiveness to GnRH was evaluated for use in predicting reproductive traits using generalized least-squares procedures. In the initial model, sire(location) was used to predict reproductive traits with pituitary response to GnRH used as co-variants. A tendency (P < .10) was observed for sire(location) to be a significant source of variation within the model when predicting AGE32 (307 ± 5.7 d, $r^2 = .35$). The model did not appear to be effective for predicting scrotal circumference ($r^2 < .3$) even though a correlation was

detected between the LH response at 60 min ($10.2 \pm .4$ ng/ml) and scrotal circumference at d 56 of the test ($30.5 \pm .5$ cm; r = .31, P < .04). Sire(location) appeared to be a significant (P < .05) source of variation when the data were used to predict serum concentration of LH above baseline 30 min after GnRH injection ($9.4 \pm .6$ ng/ml, $r^2 = .38$). These data provide evidence to suggest that pituitary responsiveness to GnRH may be useful in predicting reproductive traits in bulls and that this response could be influenced by a sire.

Key Words: bulls, GnRH, sire

75   Reproductive performance of beef cows with divergent genetic merit for milk production. D. S. Buchanan*, O. Cobanoglu, R. P. Wettemann, J. Minick, and S. Rupert, *Oklahoma Agricultural Experiment Station, Stillwater, OK.*

Milk production is an important component of calf weaning weight and contributes to efficiency of production in cow-calf enterprises. It is obtained at a cost to body condition which may affect cow reproduction. The objective of this study was to evaluate the extent to which differences in genetic merit for milk production affects reproductive efficiency in beef cattle. Crossbred cows sired by high and low Milk EPD sires from Angus and Hereford (mean Milk EPD (kg) for High Angus (HA), Low Angus (LA), High Hereford (HH) and Low Hereford (LH) were 8.7, -6.1, 7.4, and -3.9, respectively) were compared in spring and fall calving seasons for calving interval, calving date and days to luteal activity. Interval and date were evaluated over a seven year period with 1669 opportunities to calve in cows ranging in age at calving from two to eight years. Cows that failed to calve during a calving season were switched to the other season. Consecutive failures to calve caused the cow to be removed from the herd. Days to luteal activity (determined as days after calving until two consecutive weekly progesterone concentrations exceeded 1ng/ml) was evaluated on 227 cows (ages four to eight years) during a single year. The least squares model included breed, milk EPD level, year, season, sex of calf, cow age and two factor interactions. Least squares means for HA, LA, HH and LH for calving interval (with observed significance level for group differences) were: 418.5, 416.4, 436.6 and 416.7 days, respectively (P>.2). Similarly, for calving date (days following the initiation of the calving season) the means were 32.2, 27.9, 26.9 and 29.5 days, respectively (P>.2). In the same manner, means for days to luteal activity were 56.2, 57.5, 57.6 and 55.5 days, respectively (P>.2) These results provide little evidence that genetic differences in milk production contribute to a loss in reproductive efficiency in this environment (native range, body condition at calving app. 5.5 on a 1-9 scale). Cattle producers should be able to use Milk EPDs to affect calf performance without major concerns about the subsequent effect on reproduction.

Key Words: Beef cattle, Milk production, Reproduction

76   Allelic frequencies for a leptin Sau3AI RFLP in biologically diverse breeds of cattle in the southern United States and Mexico. C. C. Rasor*[1], M. G. Thomas[1], H. C. Salazar[2], R. M. Enns[2], H. M. Zhang[2], R. L. Ax[2], G. L. Williams[3], R. D. Randel[3], R. L. Stanko[3], and J. Rios[4], [1]*New Mexico State University, Las Cruces, NM,* [2]*University of Arizona, Tucson, AZ,* [3]*Texas Agricultural Experiment Stations, Beeville, Kingsville and Overton, TX,* [4]*University of Chihuahua, Chihuahua, Mexico.*

Leptin is a hormone that influences appetite and increases with adiposity in rodents and humans. In 1997, Pomp and coworkers (J. Anim. Sci. 75:1427) identified a RFLP within PCR amplification products of the bovine leptin gene using the restriction enzyme Sau3AI. Three genotypes (i.e., AA, AB, BB) were reported in unrelated animals of various breeds. High frequencies of the A allele were found in Bos taurus breeds; however, this allele was absent in the Brahman cattle that were evaluated (n=4). These data led us to hypothesize that RFLPs within the leptin gene may be indicators of metabolic or feed efficiency differences observed in biologically diverse breeds of cattle. Frequencies of the Sau3AI RFLP within PCR products of the leptin gene were then determined in eight populations of beef cattle located in the southern United States and northern Mexico. Frequencies of the A allele were .88 in Angus (n = 25), .93 in Brahman (n = 7), .76 in Brangus (n = 44), 1.0 in Criollo (n = 11), .97 in F$_1$ Braford (n = 18), 1.0 in Mashona (n = 6), .94 in Santa Cruz (n = 33), and .96 in Santa Gertrudis (n = 25). Frequencies for the AA, AB, and BB genotypes across these breeds of cattle were .82, .16, and .02, respectively. The Brahman, Criollo, and Mashona cattle

evaluated were unrelated. Angus and Brangus cattle were progeny from 4 and 3 sires, respectively. Santa Gertrudis and Santa Cruz cattle were each the progeny of 10 sires. These Sau3AI RFLP data do not support the hypothesis that RFLPs within the leptin gene may be indicators of metabolic or feed efficiency differences observed in biologically diverse breeds of cattle.

Key Words: cattle, leptin, Sau3AI

77   Estimation of variance components for teat number in swine using REML and Gibbs sampler. C. Lee* and C. D. Wang, *Hallym University, Chuncheon, Korea.*

Variance components were estimated for teat number in a swine population (N=16322). The data containted a variety of breeds: Landrace (L, N=9898), Yorkshire (Y, N=1748), crossbred of Landrace and Yorkshire (LY, N=1924), crossbred of Landrace, Yorkshire, and Chinese Indigenous Min (LYM, N=2685), and Min pig (N=67). Analytical model included breed and sex as fixed effects and additive genetic effect as random effect. The restricted maximum likelihood (REML) and Gibbs sampling were used for parameter estimation. The results indicated that REML estimates of genetic and environmental variances were 1.03 and .54. The heritability was .66. The maximum likelihood (ML) estimates of breed effects were 13.82 (L), 14.42 (Y), 14.50 (LY), 14.52 (LYM), and 14.61 (M). Using Gibbs sampling, the posterior mean estimate (1.06) of expected genetic variances was larger than that with REML, but that (.51) of the environmental variance was smaller. However, the posterior mean estimates for breed and sex effects did not differ from those using ML. Bayesian analyses were also performed with flat prior for variance. The posterior mean estimates for variance components as well as for fixed effects were not different from those with (RE)ML. While flat prior is theoretically improper for variance components, empirically it can be closely corresponding to REML estimates. Thus a prior close to the flat prior is recommended for variance components in Bayesian analyses.

Key Words: Teat Number, Genetic Parameters, Bayesian inference

78   Effects of recipient breed on birth and weaning weight and wool follicle numbers of Merino lambs born by embryo transfer. T. Wuliji*[1], K. G. Dodds [2], R. N. Andrews[2], J. Aspinal[2], and T. Harison[2], [1]*E (Kika) de la Garza Institute For Goat Research, Langston University, Langston, OK 73050,* [2]*AgResearch, Private Bag 50034, Mosgiel, New Zealand.*

One hundred and eighty three embryos were collected from 29 donor Merino ewes and transferred as either a single or twins into Merino (MR), Coopworth (CR), and Romney (RR) recipient dams. A total of 130 lambs were weaned from these implants. A control group (MN) of 24 naturally conceived single and twin lambs were included for progeny comparisons. Data were analyzed by GLM procedures. Birth weight was 4.2, 4.4, 4.4, and 4.0 kg (SED .2) for MN, MR, CR, and RR, while weaning weight was 25.6, 30.4, 27.6, and 28.9 kg (SED 1.1) respectively. Follicle fiber area was measured 232, 243, 256, and 253 m^2 (SED 12) for MN, MR, CR and RR at birth, and 218, 203, 216, and 207 m^2 (SED 16) at weaning, respectively. Follicle fiber diameter at birth was 16.7, 17.2, 17.7, and 17.6 m (SED .4) for MN, MR, CR, and RR, while fiber diameter of wool samples at birth was similar for all groups (16.5 SED .3 m). The range in wool fiber diameter was less at weaning (19.8 to 21.7%) than at birth (24.7 to 26%). Fiber curvature of MN at birth was 107, which was greater (P <.01) than for other groups (95 for MR, 96 for CR, and 96 for RR, respectively; SED 3.2). Follicle density was 121, 122, 118 and 114 (SED 10) per mm^2 for MN, MR, CR and RR groups at birth, and 107, 114, 116, and 109 (SED 8) per mm^2 at weaning, respectively; both variables were similar among treatments. Follicle fiber diameter at weaning were 16.5, 15.9, 16.3, and 16.1 m (SED .6) for MN, MR, CR, and RR, respectively, while corresponding wool fiber diameter at weaning was 16.3, 16.1, 16.0, and 16.0 m (SED .4) at weaning. Lambs of RR and CR were significantly heavier (P <.05) at weaning than those of Merino (recipients or naturally bred) dams. These result suggest that crossbred dams improve weaning weight of lambs born to embryo transfers but do not effect wool follicle characteristics of Merinos.

Key Words: Merino, Embryo transfer, Follicle density

79   Live weight, reproductive performance, and wool characteristics in mixed age Romney ewes selected for a single trait of fleece weight. T. Wuliji*[1], K. G. Dodds[2], R. N. Andrews[2], P. R. Turner[2], and R. Wheeler[2], [1]*E (Kika) de la Garza Institute For Goat Research, Langston University, Langston, OK 73050,* [2]*AgResearch, Private Bag 50034, Mosgiel, New Zealand.*

Data were collected from 3525 mixed age Romney ewes over 11 years of production, either fleece weight-selected (HF) or control (RC). Data were statistically analyzed by least-squares analysis of variance. The model included year, flock and age of ewe, with older ewe classes (6 and above) combined. The HF ewes were (P < .001) heavier than RC for autumn, winter, and spring weights. Greasy fleece weight and yield, clean fleece weight and fiber diameter were 4.91 kg (SE .09), 79.2% (SE .3), 3.62 kg (SE .04), and 40.5 m (SE .2) for HF compared with 4.18 kg (SE .10), 78.8% (SE .4), 3.05 kg (SE .06), and 39.7 m (SE .3) for RC ewes. These differences were highly significant (P < .001) except for yield. There was no difference in wool brightness (Y:61.3 vs 61.6; SED .2), but yellowness (Y-Z: 5.4 vs 4.5; SED .2) was greater (P <.001) for HF ewes. Significant (P < .01) differences existed between flocks in ovulation rate (1.6 vs 1.5; SED .03), number of lambs born per ewe joined (1.8 vs 1.7; SED .02), number of multiple births per ewe lambed (73 vs 67; SED .02), and number of lambs weaned per lamb born (1.15 vs 1.12; SED .01). These results indicate that a selection for fleece weight as a single trait enhances fleece weight, live weight, ovulation rate, fiber diameter, and fleece yellowness.

Key Words: Romney, Wool , Ovulation

80   Feedlot and carcass performance of Angus-, Brangus-, Gelbvieh-, and Gelbray-sired steers. S. M. DeRouen*[1], T. D. Bidner[2], and W. E. Wyatt[3], [1]*Louisiana State University Agricultural Center, Homer,* [2]*Baton Rouge,* [3]*Jeanerette.*

Straightbred- and Brahman composite-sired progeny were evaluated for feedlot performance and carcass traits. Angus (A), Brangus (BA), Gelbvieh (G), and Gelbray (GB) bulls were randomly mated to first-cross Brahman-Hereford cows to produce spring- and fall-born steer calves over two yr. Percent Brahman inheritance was 25% in A- (n=30) and G- (n=23) sired steers and 44% in BA- (n=39) and GB- (n=25) sired steers. Following weaning and a stockering program, steers were shipped to a commercial feedlot and evaluated for feedlot and carcass performance. Steers were group fed and slaughtered at an average fat thickness (FT) of 10 mm. Analysis included sire breed and season as fixed effects and random effects of year, year x sire breed, and sire (sire breed) using PROC MIXED of SAS. Sire breed did not influence (P > .25) feedlot gain (FADG), slaughter weight (SWT), hot carcass weight (CWT), or Warner-Bratzler shear force (SF). Sire breed affected (P < .05) longissimus muscle area (REA), FT, marbling score (MS), and yield grade (YG). Overall least squares means for FADG, SWT, CWT, REA, FT, MS, YG, and SF were 1.61 kg, 553 kg, 353 kg, 82 cm^2, 10.3 mm, 484 (slight +), 2.80, and 4.94 kg, respectively. Angus-sired steers had smaller (P < .05) REA and higher (P < .01) FT, MS, and YG than G-sired steers. Brangus-sired steers had higher (P < .03) MS compared to GB-sired steers. Steers with 25% Brahman inheritance had larger (P < .01) REA than steers with 44% Brahman breeding. Though not significant (P = .25), SF for A- and BA-sired steers were numerically lower (.44 kg) compared to G- and GB-sired steers. These data suggest that superior carcass quality was achieved with the use of Angus sires and improved carcass cutability resulted with 25% Brahman inheritance as well as with the use of Gelbvieh sires.

Key Words: Brahman, Feedlot, Carcass

81   Estimation of litter environmental and maternal effects for performance test traits of Large White swine. Z. B. Johnson*[1], J. J. Chewning[2], and R. A. Nugent, III[2], [1]*University of Arkansas, Fayetteville,* [2]*The Pork Group, Rogers, AR.*

The objective of this study was to investigate the importance of litter environmental effects, maternal genetic effects and the covariance between additive genetic effects of the animal and maternal genetic effects for performance test traits for a population of purebred Large White swine. Boars were individually penned at approximately 100 d of age and fed a corn-soybean meal diet that was 1.14% lysine, 19% protein and 3,334 kcal/kg ME for approximately 77 d. Boars were weighed at the beginning and end of the test and feed intake recorded. Backfat

(BF; n = 7,716) and loin eye area (LEA; n = 7,712) were measured over the 12th rib at the end of the test using B-Mode ultrasound equipment. Daily feed intake (DFI), feed:gain ratio (FG) (n = 7,542), and ADG (n = 7,722) were calculated. Data were available for years 1990 to 1997. Four models were examined using DFREML procedures. Model 1 included only the additive genetic effect of the animal (**d**); Model 2 included **d** and the common litter environmental effect; Model 3 included **d**, the maternal genetic value (**m**), assumed to be uncorrelated with **d**, and the common environmental effect; and Model 4 was the same as Model 3 but with **d** and **m** assumed to be correlated. Ratios of likelihoods were used to compare models. Common litter environmental effects were important (P < .01) for all traits measured and explained from 13 to 27% of the phenotypic variation. The maternal genetic value was important (P < .05) for LEA, but had little effect on the estimation of heritability. The correlation between **m** and **d** was a significant source of variation (P < .05) for BF with an estimated correlation of -.59. In summary, the common environmental litter effect was important for all traits in this study and should probably be included in any estimation of genetic parameters; however, both maternal effects and the correlation between maternal and direct effects could be ignored for ADG, DFI, and FG.

Key Words: Pigs, Maternal Effects, Litter Effects

82   Comparison of performance of pigs from three breed terminal and rotational crossbreeding systems: Growth and survival rates. K. Nadarajah*, D. L. Kuhlers, S. B. Jungst, M. R. Duffle, and J. A. Little, *Auburn University, Auburn, AL*.

Growth performance and survival rates of pigs from a terminal and rotational crossbreeding system involving Duroc (DD), Landrace (LL) and Yorkshire (YY) breeds were evaluated at the Lower Coastal Experimental Station, Camden, AL. Terminal crossbred pigs were sired by five DD boars selected from the top 20% of the Terminal Sire Index (TSI). Rotational crossbred pigs were sired by ten boars (DD=4, LL=3 and YY=3) selected from the top 20% of the Maternal Line Index (MLI). Matings involved 151 dams that produced a total of 3876 pigs of four crossbred types namely, DD_{TSI} xYL (1858), DD_{MLI} x YLD (624), LL_{MLI} x DYL (657) and YY_{MLI} x LDY (737) that were compared for weights at birth, 21 and 56 d of age, average daily gain from 56 d of age to marketing (ADG), days to reach 105 kg, ultrasonic backfat at 10th rib (only in barrows) and survival rates at each of the respective weight periods. The linear model used to analyze the growth and survival traits accounted for fixed effects of contemporary group, parity, sex, crossbred types and random effects of sire and dam within crossbred types, and residual error. Pig weights at birth, 21 and 56 d of age, ADG and days to reach 105 kg did not differ (P>.10) among crossbred types. No significant differences (P>.10) were found across crossbred types in barrows for ultrasonic backfat thickness at 10th rib recorded at 105 kg weight. The terminal and rotational crossbreeding system had no significant effect on progeny survival rates at birth, birth to 21 d and from 21 to 56 d of age (P>.10). However, survival rate of pigs from 56 d of age to105 kg in the DD_{MLI} x YLD crossbred types was significantly different (P<.10) from the crosses of MLI boars mated to DYL and LDY dams. Sex of pig had a significant effect (P<.01) on all growth traits (except ADG) and on survival rates. Male pigs were slightly heavier at birth and 21d of age and reached 105 kg weight about seven d earlier than gilts across all crossbred types. Pigs from MLI-sired rotational crossbreeding system performed as well as the TSI-sired pigs from terminal crossbreeding system for growth traits. Lack of significant differences among the mating systems was unexpected considering the selection criteria used to select boars.

Key Words: Pigs, Growth, Terminal and rotational crossbreeding system

83   Milk production of crossbred daughters of high and low milk EPD Angus and Hereford bulls. J. A. Minick*, D. S. Buchanan, and S. D. Rupert, *Oklahoma Agricultural Experiment Station, Stillwater*.

Milk production is a major factor in the weaning weight of calves which, in turn, affects profitability of cow-calf enterprises. The objective of this study was to determine how well milk EPD of Angus and Hereford sires predicted milk production of crossbred daughters and subsequent calf performance. Bulls were chosen from each breed (n=41) to represent high or low milk EPDs. Mean EPDs in kg for high Angus (HA), low Angus (LA), high Hereford (HH), and low Hereford (LH) were +8.7,

-6.1, +7.4, and -3.9. Cows (n=273) calved in spring or fall from 1992-97 for a total of 660 records. Twenty-four hour milk production of the cows was estimated by two weigh-suckle-weigh measurements at monthly intervals. Cow weight and body condition score (BCS, 1-9) were obtained at weaning. The least squares model included breed, milk EPD level, sire of cow within breed and milk EPD level, year, season, cow age, calf sire, sex, and all two- and three-way interactions. Means were obtained for monthly milk production, birth and 205 day weight, and final cow weight and BCS. The least squares means for 24 hour milk production, in kg, for HA, LA, HH, and LH with p values for high versus low, across breeds, were: period 1) 6.88, 5.87, 6.59, and 5.70 (p<.01); period 2) 7.20, 6.12, 6.92, and 5.74 (p<.01); period 3) 6.12, 5.11, 5.07, and 4.25 (p=.01); period 4) 6.07, 4.92, 4.87, and 4.78 (p=.01); period 5) 4.80, 3.97, 4.15, and 3.75 (p=.01); period 6) 4.70, 3.36, 3.18, and 2.96 (p<.01); period 7) 3.72, 2.53, 3.02, and 2.97 (p=0.05). Similarly, least squares means for birth weight were 37.07, 37.85, 38.33, and 38.78 (p=.31); for 205 day weight were 237.26, 218.23, 222.17, and 214.12 (p<.01); for final cow weight were 482.40, 505.39, 509.49, and 511.65 (p=.11); and for final cow BCS were 4.90, 5.25, 5.09, and 5.20 (p<.01). Daughters of high milk EPD sires produced more milk and weaned heavier calves than those of low milk EPD sires. However, it is at the expense of body condition. Producers can use milk EPDs with confidence to influence calf weight.

Key Words: Beef Cattle, Milk EPD, Growth

84   Evaluation of carcass traits of Duroc pigs from a line selected on an index of ultrasound backfat thickness and predicted feed conversion. D. L. Kuhlers*, K. Nadarajah, S. B. Jungst, B. L. Anderson, and B. E. Gamble, *Auburn University, AL*.

Production of lean meat at minimum feed cost is the goal of swine producers. However, feed intake (FI) and feed conversion ratio (FCR) performance data and EPDs usually are not readily available. Desirable genetic correlations exist between FCR with growth rate and backfat thickness. In the present study,a line of Duroc pigs was selected (S) for 6 generations on an index of EBVs for decreased backfat thickness (BF) and improved predicted FCR. A contemporary randomly selected control (C) line was maintained. The 1,574 pigs, sired by 80 boars and out of 194 dams were performance tested for 168-day weight (W) and real-time (Aloka 500V) 10th-rib BF adjusted to 105 kg. The EBVs were obtained from a multiple trait mixed animal model using industry accepted genetic parameters. Each generation (except the base), one barrow per litter from both lines were individually fed to obtain FI and FCR data. Differences between the lines (S - C) for the live animal traits of BF, FCR, and W in the 6th generation were -.71 cm, -.23, and 5.4 kg, respectively. All barrows from the base through the 5th generation were slaughtered to obtain carcass length (LEN), 10th rib backfat thickness (BF10), loin eye area (LEA), percentage trimmed lean cuts (LEAN), and subjective color (COLOR; 1 = pale, 5 = dark) and marbling (MARB; 1 = practically devoid, 5 = moderately abundant) scores. A total of 204 carcasses were evaluated. Data were analyzed using the Mixed procedure of SAS with a model that included the fixed effects of line-generation (LG) and a covariate on hot carcass weight, and the random effect of sires within LG. Differences in LEN between the lines (S - C) were -.1, -.3, and 2.6 cm in generations 3, 4, and 5, respectively. For LEA, the (S - C) line differences were 3.6, 3.6, and 4.7 cm^2, for BF10, (S - C) line differences were -1.25, -1.13, and -1.24 cm, and for LEAN, (S - C) line differences were 3.4, 3.2, and 5.5% in generations 3, 4, and 5, respectively. The (S - C) line differences for the subjective meat quality traits of COLOR were .05, .00, and -.11, and for MARB, (S - C) line differences were -.48, -.98, and -.35, in generations 3, 4, and 5, respectively. Index selection for lean efficiency resulted in desirable changes in carcass LEA, LEAN, and BF10, but undesirable changes in COLOR and MARB.

Key Words: Pigs, Selection, Carcass Composition

85   Use of milk EPDs to predict differences in milk production of range beef cows. S. D. Rupert*, D. S. Buchanan, and J. A. Minick, *Oklahoma Agricultural Experiment Station, Stillwater, OK*.

Milk production is an important variable affecting calf weaning weight and overall success of any cow-calf enterprise. This study was designed to evaluate the effect of milk EPDs of Angus and Hereford sires on milk production of crossbred daughters. Bulls (n=35) were chosen from each

breed to represent high or low milk EPDs. Mean EPDs in kg for high Angus (HA), low Angus (LA), high Hereford (HH), and low Hereford (LH) were +8.7, -6.1, +7.4, and -3.9 respectively. The daughters were between 5 and 9 years old during this study. Milk production of cows (n=105) was evaluated via the weigh-suckle-weigh (WSW) method. A sample of these cows (n=48) were milked mechanically (MM) during the same lactation. Both techniques were used to generate 24 h milk production estimates. Least squares means were generated for the four Breed x Level interactions and the two Levels for each of seven WSW and four MM procedures that were equally spaced throughout the lactation. Least squares means, in kg, from MM for HA, LA, HH, and LH with p values for high versus low were: period 1) 5.76, 4.36, 6.01, and 3.94 (p<.01); period 2) 3.72, 3.22, 3.91, and 3.01 (p<.05); period 3) 3.97, 3.35, 4.19, and 2.46 (p<.01); period 4) 1.27, 1.18, 1.69, and 0.63 (p<.05). Likewise, least squares means, in kg, from WSW for HA, LA, HH, and LH with p values for high versus low were: period 1) 3.70, 3.49, 3.66, and 3.09 (p=.13); period 2) 2.96, 1.97, 2.48, and 1.66 (p<.01); period 3) 3.16, 2.15, 2.55, and 2.66 (p=.08); period 4) 2.41, 1.71, 1.95, and 1.98 (p=.36); period 5) 2.24, 1.76, 1.78, and 1.29 (p=.09); period 6) 1.78, 1.41, 2.65, and 0.92 (p=.01); period 7) 1.89, 2.0, 0.74, and 1.21 (p=.44). In addition, WSW and MM totals were highly correlated (r=.82). These results demonstrate that high milk EPD bulls sired daughters that produced more milk. The high correlation between WSW and MM should increase the confidence of that conclusion. Milk EPDs can be used with confidence to influence milk production.

Key Words: Beef Cattle, Milk EPD, Milk Production

86   Sire variation for carcass traits of purebred Brahman steers. T. Smith*[1], D. E. Franke[1], T. D. Bidner[1], G. Whipple-VanPatter[2], and H. D. Chapman[1], [1]*Louisiana State University Agricultural Center, Baton Rouge, LA*, [2]*Nebraska Central Community College, Hastings, NE.*

Purebred Brahman steers (n=169) sired by 25 Gray and 7 Red Brahman bulls were evaluated for postweaning growth and carcass traits. Spring-born paternal half-sib male calves were purchased from private producers at weaning, backgrounded, and grazed on ryegrass for 150 d. Following grazing, the steers were shipped to a commercial feedlot in south Texas for feeding. Steers were slaughtered in groups of about 45 head when they reached an approximate average endpoint weight of 530 kg and 1 cm backfat. All carcasses were subjected to high voltage electrical stimulation during slaughter. After a 24 hr chill, carcasses were ribbed, data collected and a longissimus muscle sample taken for calpastatin assay (CALP). Traits available for study included slaughter weight (SWT), hot carcass weight (HCW), ribeye area (REA), backfat measured at the 12th rib (BF), and marbling (MB). Two 2.54 cm steaks were removed from the large end of the strip loin and randomly selected for aging in vacuum bags for seven and 14 d. Steaks were then cooked to an internal temperature of $70^{o}C$ and core samples measuring 1.27 cm were taken for shear force determination (SF7 and SF14). A mixed model containing color and slaughter age as fixed variables and sire:color as a random variable was used to analyze the data. BLUP estimates of sire breeding value were obtained for all traits. Overall least squares means for SWT, HCW, REA, BF, MB, CALP, SF7, and SF14 were 528 ± 3 kg, 315 ± 2 kg, 84 ± .6 cm^2, .81 ± .02 cm, 363 ± 5, 5.1 ± .08, 4.8 ± .09 kg, and 3.9 ± .07 kg respectively. Gray Brahman steers had heavier hot carcass weight, greater backfat, more marbling, less calpastatin, and were more tender at 14 d of aging when compared to Red Brahman steers (P < .05). For Gray Brahman sires, BLUP for EBV ranged from -142.5 to 116.9 kg for SWT, -40.9 to 51.3 kg for HCW, -6.7 to 10.3 for MB, -.2 to .3 cm for BF, -8.1 to 6.3 sq cm for REA, -.6 to .9 for CALP, -.3 to .3 kg for SF7 and -.2 to .1 kg for SF14. For Red Brahman sires, BLUP for EBV ranged from -49.9 to 38.1 kg for SWT, -25.9 to 31.8 kg for HCW, -6.0 to 6.3 for MB, -.2 to .2 cm for BF, -7.6 to 9.6 sq cm for REA, -1.2 to 0.9 for CALP, -.2 to .2 kg for SF7, and -.1 to .1 kg for SF14. These results suggest useful differences among Brahman sires for several carcass traits.

Key Words: Cattle, Brahman, Carcass Traits, Estimated Breeding Value

87   Genetic polymorphism of milk protein in Chinese black and white dairy cattle. J. Luo*, H. Qiu, S. H. Wang, and J. W. Li, *School of Animal Science and Veterinary Medicine, Northwestern Agricultural University, China.*

This study was to investigate the characteristics of genetic markers of principal milk proteins of Chinese Black and White Dairy Cattle, a main milk-producing dairy breed in China. Morning milk samples of 747 cows (farm 1, n=328; farm 2, n=419) were collected from two farms in Shaanxi province, China. Milk protein variants at α_{s1}-casein (CN), β-CN, κ-CN, and β-lactoglobulin (LG) loci were identified using isoelectric focusing electrophoresis. Three phenotypes of α_{s1}-CN, κ-CN, and β-LG and six phenotypes of β-CN were detected. The gene frequency of two herds was similar ($P > .05$), therefore pooled data were used for calculation. The allelic frequency at each milk protein locus was as follows: α_{s1}-CN B, 0.85, α_{s1}-CN C, 0.15; β-CN A^1, 0.40, β-CN A^2, 0.52, β-CN B, 0.08; κ-CN A, 0.61, κ-CN B, 0.39; β-LG A, 0.43, β-LG B, 0.57. The dominant allele of locus mentioned above was B, A^2, A and B respectively. Linkage relation of milk protein loci were analyzed using the Chi-square test and the sequential probability test with the data of dam-daughter pairs. There were significant linkages among three casein loci ($P < .05$). A genetic linkage existed between α_{s1}-CN and β-CN, and α_{s1} -CN and κ-CN ($P < .01$), but there was no linkage between β-LG and κ-CN and the casein complex ($P > .05$). The results of this study should be useful in marker assistant selection for any association with milk protein properties, however, the selection of specific milk protein genotype may be affected by linkage relationships among milk protein loci.

Key Words: Chinese Black and White dairy cattle, Milk Protein, Polymorphism

88   Development of a heterogeneous mixed linear model with maternal genetic effects for multiple trait case. E.-C. Lin*[1] and P. J. Berger[2], [1]*Pig Research Institute Taiwan, Chunan, Miaoli, Taiwan, R.O.C.*, [2]*Iowa State University, Ames, Iowa.*

A heterogeneous mixed linear model for multiple traits was developed for a model with fixed effects, direct genetic random effects, uncorrelated random effects and residual. There are two assumptions about the genetic correlation in this model: one is perfect correlation (equal to 1) between heterogeneous groups within trait; the other is treating the correlation between heterogeneous groups across traits as a function of genetic variances and covariances in each heterogeneous group within and across traits. The heterogeneous mixed linear model is implemented by adjusting the direct genetic effects and corresponding incidence matrices with matrices of eigenvalues and eigenvectors of the genetic (co)variance matrix. Following the same assumptions and implementation, maternal genetic effects can be considered as another trait in the direct genetic (co)variance matrix. The same assumptions as described above for the genetic correlation are also satisfied in a model with both direct and maternal genetic effects. The genetic (co)variance matrices of direct (G_a) and maternal (G_m) genetic effects need to be combined as one (G_{am}) when the mixed linear model equations are implemented. Generating eigenvalues and eigenvectors of the G_{am} matrix is the same as a model without maternal genetic effect, but with twice the number of rows and columns. Traits affected by maternal genetic effects can be evaluated together by the model when heterogeneous (co)variances exist, such as in international genetic evaluation and genetic evaluation for progeny of AI sires raised across herds. The number of (co)variances that need to be known are reduced greatly due to these assumptions about the genetic correlation.

Key Words: Heterogeneous (co)variance, Mixed linear model, Maternal genetic effect

89   Comparison of the reliability of genetic evaluations from an organized progeny test and a field level performance recording program. N. Caron* and R. A. Kemp, *Lethbridge Research Centre.*

Calf performance records collected by two different recording programs were used to compare the reliability of their genetic evaluations (EPD). Records on 3,393 crossbred calves sired by 74 sires were available from Conception to Consumer (CtoC), an organized progeny test program, while records on 154,411 calves sired by 6,872 sires were used from the Charolais Herd Analysis and Records Management (CHARM), a field

level recording program. All sires were purebred Charolais. Multiple-trait evaluations were run independently using a sire model for the CtoC records and an animal model with the CHARM data. Traits evaluated were birth weight (BW), weaning weight (WW) and postweaning gain (PG). Edits, adjustment factors and genetic parameters were similar to the ones used in the North American (NA) evaluation. From birth to yearling, there was a decline of 17.5% in the number of records on CtoC in comparison to 45.0% on CHARM. Only 71.5% of sires on CHARM had PG records submitted on their progeny in comparison to all sires on CtoC. Correlations between sire EPDs from CtoC or CHARM with NA were satisfactory ranging from .72 to .85. Lower correlations between sire EPDs from CtoC and CHARM were obtained: .62 for BW, .40 for WW and .46 for PG. This situation was explained by the low number of progeny records for some sires on CHARM. An organized progeny test such as CtoC allows to obtain fairly accurate EPDs with a minimum of records while a field recording program like CHARM allows to test a large number of sires in an inexpensive way. An organized progeny test can be especially helpful for traits difficult to collect such as carcass and feed intake traits.

Key Words: Beef cattle, Genetic evaluation, Reliability

90   Effects associated with the *Bos indicus* growth hormone receptor haplotype in *Bos taurus* cattle. C. S. Hale*, W. O. Herring, G. S. Johnson, H. Shibuya, M. C. Lucy, D. B. Lubahn, and D. H. Keisler, *University of Missouri, Columbia, Missouri.*

We previously reported a length polymorphism in a TG-repeat microsatellite 90 base pairs upstream from the start site in the bovine growth hormone receptor gene. An 11-TG-repeat allele is enriched in *Bos indicus* (Zebu) cattle, but rare in the *Bos taurus* (Taurine) breeds in which 16 to 20-TG-repeat alleles predominate. Tightly linked to this polymorphism are other sequence differences such as a 1.2 kb retroposon 0.5 kb upstream from the start site in the Taurine haplotype which is absent in the Zebu haplotype, as well as single base substitutions in exons 5, 6, 7, and 10. The purpose of this study was to compare growth and carcass traits between Angus steers that were homozygous for the Taurine growth hormone receptor haplotype (n = 42) to their half-siblings that had one copy of the Zebu haplotype (n = 33). Animals were genotyped with respect to the TG-repeat using a microsatellite assay. A series of single trait analyses were then performed on 75 steer progeny of four purebred Angus sires that contained one growth hormone receptor haplotype commonly found in Taurine cattle and one haplotype commonly found in Zebu cattle. Contrasts between the Taurine and Zebu haplotypes were estimated using MTDFREML. The model included fixed effects of contemporary group, age of dam, haplotype within sire, and a random animal effect. No interaction was detected between sire and haplotype so this term was replaced with haplotype. Contrasts (Taurine - Zebu) were considered significant (P < .05) if the absolute value of the contrast was at least twice the standard error. Contrasts were significant for weaning weight (18 ± 6 kg), carcass weight (13 ± 6.2 kg), and marbling score (-.4 ± .2), while no significant differences were detected for birth weight (-.5 ± .8 kg), fat thickness (.01 ± .1 cm), or ribeye area (.3 ± 1.7 cm^2). This polymorphism may have potential for use in a marker assisted selection program.

Key Words: Growth Hormone Receptor, Cattle, Microsatellite

91   Mixed model estimates of genetic effects for beef cattle birth and weaning traits. D. E. Franke*, *Louisiana State University Agricultural Center.*

Considerable variation exists among cattle breeds for traits of economic importance. Breed differences are important genetic resources that can be used to exploit complimentarity and heterosis. Data from two-, three-, and four-breed rotational crossbreeding systems involving Angus (A), Brahman (B), Charolais (C) and Hereford (H) breeds and straightbred controls over four generations were used to estimate breed additive and dominant genetic effects. Traits were birth weight (BWT), daily gain from birth to weaning (ADG), weaning weight adjusted to 205 d (WWT), calf age at weaning (WAGE) and weaning weight per cow exposed (WWTCE). A linear mixed regression model was used to partition genetic effects. Brahman, C and H direct and maternal additive effects were computed as deviations from A. For BWT, the direct additive effects of B, C and H were 5.8 ± 1.3, 9.8 ± 1.0 and 2.9 ± 1.0 kg greater than A, and the maternal additive effect of B was 7.1 ± 1.2 kg less than A. Direct dominant effects of A-B, C-B and H-B combinations were

larger than for non-B combinations. For ADG, the direct additive effect of C (.095 ± .020 kg/d) and the maternal additive effects of B (.084 ± .023 kg/d), C (.065 ± .018 kg/d) and H (-.087 ± .017 kg/d) were different from A. Direct dominant effects for combinations including B for ADG were larger than for non-B combinations. Charolais and H direct additive effects for WWT (29.3 ± 4.6 and 9.6 ± 4.5 kg, respectively) were larger than A whereas the maternal additive effect of H was less than A (-18.6 + 3.8 kg). Direct dominant genetic effects for WWT were larger for breed combinations including B. Genetic effects for WWTCE were large and variable, and had large SE. For these breeds, results confirm the relative advantage of C for growth, the relative disadvantage of H for maternal ability and the larger dominant effects for breed combinations including B for growth traits.

Key Words: Beef Cattle, Preweaning Traits, Genetic Effects

92   Verification of a quantitative trait locus for dairy form in two families of Holsteins. T. S. Sonstegard*[1], C. P. Van Tassell[1], M. S. Ashwell[1], W. M. Garrett[1], and S. M. Kappes[2], [1]*ARS-USDA Beltsville Agricultural Research Center, Beltsville, MD*, [2]*ARS-USDA Meat Animal Research Center, Clay Center, NE.*

Preliminary analysis of variance for quantitative trait loci affecting conformation traits using the grandaughter design and eight large US Holstein grandsire families revealed a strong association in two families between the predicted transmitting abilities for dairy form and marker genotypes for bovine chromosome 27 (BTA27). Results from Family 8 (79 sons) indicated an association (P = 0.000021) with a microsatellite marker located near the telomere of bovine chromosome 27 (BTA27). An association (P = 0.00001) was also detected in Family 2 (165 sons) with a microsatellite marker located approximately 20 cM from the centromere of BTA27. Interval analysis performed with additional BTA27 marker genotypes generated from Family 8 yielded a genome wide significant test score for dairy form QTL near the telomere of BTA27. Interval analysis of Family 2 is in progress. Genes found in the genomic fragments of conserved synteny between human chromosomes 4 and 8 and BTA27 are being used to develop additional informative markers to refine the QTL interval and identify potential candidate genes for dairy form. Even though the phenotypic scores for dairy form are based upon femininity, conditioning and dairyness; we hypothesize that this QTL is associated with fat metabolism. This hypothesis is supported by identification of similarly located QTL found in other cattle populations for marbling, milk fat yield, and milk fat percentage.

Key Words: quantitative trait loci, mapping, cattle

93   Repeatability estimates of objective measurements on the rear legs of dairy cows. P. O. Boisot*, S. Rodriguez-Zas, and R. D. Shanks, *University of Illinois, Urbana-Champaign, IL.*

Feet and legs contribute to the longevity and profitability of dairy cows. Heritability of subjective measures of feet and legs are low, but selection should not ignore feet and legs because the low heritability estimates may be a function of inaccuracy of subjective linear scores. The objective of our research was to estimate the repeatability of different objective measurements on the rear legs of dairy cows in order to develop a method that could potentially replace subjective linear scores. Between September and November 1998, fourteen measurements, among dewclaw, hip, hock, pinbone, thurl and ground, were taken on 102 cows from the University of Illinois dairy farm. Measurements were combined to define triangles and therefore angles among points of interest. Three evaluators participated in the experiment and on a given day two sets of measurement were taken by two evaluators. Seventy-three of the 102 cows were measured twice at a 1 to 4 week interval. The data collection resulted in 352 observations. Cows were separated into two groups based on breed size : 74 big cows and 28 small cows. Size, evaluator, and time were fixed effects and cow, interactions of cow by evaluator and cow by time were random effects included in the model. Repeatabilities were computed from the ANOVA table obtained by the glm procedure in SAS using the formula : repeatability=variance between cows /(variance between cows + mean square error). The linear model explained over 80% of the variation for each variable. Repeatability estimates of the measurements ranged from 0.64 to 0.90. The highest estimates were obtained for measurements between hip, pinbone, hock or thurl with the ground and the lowest estimates involved either the hock or thurl. Repeatability estimates of angles were much lower ranging from 0.20 to

0.50. The variation in natural standing position of the cow hampered the accuracy of the objective measurements. Low estimates of repeatability suggest that this method is not sufficiently reliable to replace subjective linear scores for feet and legs.

94   Multivariate Bayesian analysis of Gaussian, right censored Gaussian, ordered categorical, and binary traits using Gibbs sampling. I. R. Korsgaard[1], M. S. Lund*[1], D. Sorensen[1], D. Gianola[2], P. Madsen[1], and J. Jensen[1], [1]*Danish Institute of Agricultural Sciences,* [2]*University of Wisconsin-Madison.*

A fully Bayesian analysis using Gibbs sampling and data augmentation in a multivariate model of Gaussian, right censored and grouped Gaussian traits is outlined. The grouped Gaussian traits are either ordered categorical traits (with more than two categories) or binary traits, where the grouping is determined via thresholds on the underlying Gaussian scale, the liability scale. Allowances are made for unequal models, unknown covariance matrices and missing data. Having outlined the theory, strategies for implementation are reviewed. These include joint sampling of the location parameters; efficient sampling from the fully conditional posterior distribution of augmented data, a multivariate truncated normal distribution; and sampling from the conditional inverse Wishart distribution, the fully conditional posterior distribution of the residual covariance matrix between traits.

95   Maternal and direct genetic relationships between weaning weight and traits derived from the Brody growth curve in Angus cattle. M. Kaps*, W. O. Herring, and W. R. Lamberson, *University of Missouri-Columbia, Columbia, MO.*

Direct and maternal genetic and environmental variances and covariances and associated genetic parameters were estimated for weaning weight, and growth and maturing traits derived from the Brody growth curve. Data consisted of field records of weight measurements of 3,044 Angus cows, and 29,943 weaning weight records of both sexes. Growth traits included weights, and growth rates at 365- and 550-d, respectively. Maturing traits included the age of animals when they reach 65% of mature weight, and relative growth rates, and degrees of maturity at 365- and 550-d, respectively. Variance and covariance components were estimated by REML from a set of two-trait animal models including weaning weight paired with a growth or maturing trait. Weaning and cow contemporary groups were defined as fixed effects. Random effects for weaning weight included direct genetic, maternal genetic, and permanent environmental effects. For growth and maturing traits only direct genetic effects were defined as random effects. Heritability estimates for growth traits ranged from .46 to .52, and for maturing traits they ranged from .31 to .34. Direct genetic and maternal genetic correlation estimates were -.05 and .55 between weaning weight and degrees of maturity at 365- and 550-d, respectively. Direct genetic correlation estimates ranged from .04 to .06, and maternal-direct genetic correlation estimates ranged from -.50 to -.56 for weaning weight with the age when animals reached 65% of mature weight and relative growth rates. Since maternal genetic weaning weight reflects an animal's milk producing ability, these estimates indicate that higher genetic capacity for milk production was related to higher body mass and degrees of maturity between 365- and 550-d of age, but was negatively related to absolute and relative growth rates in that life stage.

96   Genetic parameter estimation of growth and lactation curve components in Polled Hereford cattle. J. B. Glaze, Jr.*[1] and R. R. Schalles[2], [1]*University of Vermont Extension, White River Junction, VT,* [2]*Kansas State University, Manhattan, KS.*

Genetic parameters for growth and lactation curve components were estimated from weight and milk production records of Polled Hereford cows born from 1967 to 1979. These data were the result of a project at Kansas State University, in which selection was based on individual feed conversion. Cows that had complete monthly weight records from age five to ten, were used to estimate mature weight. Average weight over the five year period was considered to be mature weight. Monthly

cow weights were also used to fit a growth curve. The three parameter function, $W_t = A + B(1 - e^{-kt})$, where W_t = weight at time t, A = weight at time zero, B = gain from time zero to infinity, K = function of the rate of growth, and t = time, provided a means to describe the growth and development of the cattle in this study. During the final three years of the study, 205-day milk production was measured using the weigh-suckle-weigh technique. Milk production data were used to fit the lactation curve $Y_n = n/(ae^{kn})$, where n = week of lactation, Y = 24-hour milk yield, e = base of the natural logarithm, and a and k = parameters that define the shape of the curve. A multiple-trait, derivative-free, restricted maximum likelihood (MTDFREML) procedure was used to analyze the data generated in this study. A full animal model was used to calculate the genetic and phenotypic (co)variances. In the analyses of mature weight, age of cow was included as a fixed effect. Year of milking and age at milking were the fixed effects used during the analyses of milk production. The heritabilities of the lactation curve components K and A were found to be .15 and .40, respectively. The genetic correlation between these lactation curve components was -.78. Growth curve components A, B, and K had heritabilities of .35, .72, and .46, respectively, suggesting that selection for weight, gain, and rate of maturity can be effective. The genetic correlation between growth curve components A and B ($r_g = .42$) was positive, which is similar to reported genetic correlations between birth weight and mature weight. The genetic correlations between growth curve parameters A and K ($r_g = -.34$) and B and K ($r_g = -.74$) were negative. The negative association between B and K suggest that animals maturing fastest have less weight at maturity.

97   Estimation of genetic parameters for mature weight in Hereford cattle. J. M. Rumph*[1], R. M. Koch[1], K. E. Gregory[2], L. V. Cundiff[2], and L. D. Van Vleck[3], [1]*University of Nebraska, Lincoln,* [2,3]*USDA-ARS, USMARC,* [2]*Clay Center,* [3]*Lincoln, NE.*

Genetic parameters for mature weight in Hereford cattle were calculated using 8285 records from 2517 cows in a control line and three lines selected for weaning weight, yearling weight, and an index of yearling weight and muscle score over 22 years. Data included cow age (Ag), year (Yr), line (L), pregnancy status (bred vs. open, Pg), birth and method of rearing code of the parity (BMR), and calf disposal code (DSP). Weights were taken each year on three to nine year old cows at three times: brand clipping (generally prior to calving, BC), before breeding (BB), and palpation for pregnancy checking (PP). Heritabilities were estimated with REML using a univariate animal model with Ag x Yr x L, Pg x L, BMR x L, and DSP x L as fixed effects and direct genetic, maternal genetic, permanent environmental, and residual as random effects. The analyses for BC and BB weights also included the interval between calving date and weigh date as a linear and quadratic covariate. Estimates of direct h^2 (and SE) were .48 (.04), .46 (.04), and .43 (.05), of maternal h^2 were .02 (.02), .02 (.02), and .00 (.03), and of fraction of permanent environmental variance (c^2) were .24 (.03), .29 (.03), and .33 (.04) for BC, BB, and PP weights respectively when covariance between direct and maternal effects was forced to be zero. When covariance between direct and maternal effects was in the model, direct h^2 were .61 (.08), .59 (.07), and .54 (.09), maternal h^2 were .05 (.03), .05 (.03), and .04 (.04), and c^2 were .17 (.05), .21 (.05), and .27 (.06) for the same weights. Correlations between direct and maternal genetic effects in the latter model were -.46 (.16), -.47 (.15), and -.48 (.21). Direct h^2 is large enough to consider mature weight in breeding programs to optimize economic response to selection. Surprisingly, maternal genetic effects seem to be negatively correlated with direct genetic effects for mature weight although variance due to maternal effects is not large.

98   Estimates of genetic parameters and genetic trends for reproductive traits in Botucatu rabbits selected for litter and growth performance traits. A. S. A. M. T. Moura*, A. R. C. Costa, and R. Polastre, *Faculdade de Medicina Veterinária e Zootecnia, UNESP, Botucatu SP, Brazil.*

Genetic parameters and genetic trends were estimated for number of services per parturition (NS), and parturition interval (PI) in rabbits of a local strain in Botucatu, Southeast Brazil. Individual selection according to a multiple-trait index was practiced over a 2.6-yr period.

Two litter (number weaned, and litter weaning weight), and two individual performance traits (30-d weaning weight, and 70-d weight) were included in the index. Contemporary breeding stock were approximately 120 does and 15 bucks. Parturition-mating interval was 10 to 15 d. Mating pairs were randomly formed and mating between close relatives was allowed. Ventral palpation was performed 10 d after mating to determine pregnancy. Doe culling criteria included three consecutive conception failures. A square root transformation of NS was adopted. Data on 2,162 parturitions and 1,630 PI produced by 551 does were fitted to an animal model to estimate variance components and breeding values for NS and PI. The bivariate model included the random effects of animal and permanent environment, the fixed effects of parity and parturition date, and the covariate of doe inbreeding coefficient. Overall means of NS and PI were $1.123 \pm .005$ services and $49.5 \pm .4$ d, respectively. Doe inbreeding coefficient averaged $.059 \pm .001$, ranging from zero to .33. Estimates of direct heritability and permanent environment effect for NS and PI were .03 and .03, and .02 and .04, respectively. The estimated genetic correlation between the two traits was .73. Estimates of direct genetic trends per year for NS and PI were $-.0037 \pm .0003$ services (P < .001) and $-.200 \pm .030$ d (P < .01), respectively. Both reproduction traits showed discrete but favorable genetic change with selection for litter and individual performance traits.

Key Words: Genetic trends, Rabbits, Reproduction

99　Genetic and environmental weaning weight parameter estimates across and within Hereford populations in three countries.
J. K. Bertrand*, D. de Mattos, and I. Misztal, *University of Georgia, Athens.*

Original data consisting of 487,661, 102,986 and 2,322,722 weaning wt records from the Hereford Associations of Canada (CA), Uruguay (UY) and the US were available for analysis to obtain genetic and environmental parameters within and across the three populations. Ten samples containing between 12,000 and 57,000 records were obtained by randomly selecting herds with greater than 500 records. An animal model that contained maternal effects and an EM-REML algorithm was used to estimate (co)variances. Pooled estimated phenotypic variances were 617.0, 630.0 and 579.9 kg^2 for CA, UY and US, respectively. Pooled direct genetic, maternal genetic, permanent environment and error variances, expressed as a percentage of the phenotypic variance, were 20, 16, 21 and 49% for CA, 23, 18, 16 and 53% for UY and 24, 16, 16 and 52% for US. Pooled direct-maternal covariances were negative and were 8, 10 and 6% of the phenotypic variance for CA, UY and US, respectively. To investigate the possibility of genotype by environment interactions across countries, pair-wise data sets (CA-UY, CA-US, UY-US) were created by randomly sampling herds that had greater than 500 records and that also had progeny or grandprogeny from sires used across all three countries. For comparison purposes, regions within the US were defined, Upper Plains (UP), Cornbelt (CB), South (S) and Gulf Coast (GC) and pair-wise analyses were also conducted (UP-CB vs S-GC, UP vs CB, S vs GC). A multiple-trait animal model that considered weaning wt a different trait in each environment was fit to the data in each pair-wise analysis, utilizing an EM-REML algorithm. Direct and maternal (in parentheses) estimated genetic correlations for CA-UY, CA-US, US-UY, UP-CB vs S-GC, UP vs CB and S vs GC were .88 (.84), .86 (.82), .90 (.85),.88 (.87), .88 (.84), .87 (.85), respectively. Results of these analyses strongly suggest that genetic and environmental (co)variances are such that these three populations could be considered as one single population for the purposes of genetic evaluation.

Key Words: Across Country Genetic Parameter Estimates, Beef Weaning Wt, Hereford

100　Heritabilities and genetic correlations for male scrotal circumference and female reproductive and growth traits, in Canchim cattle.
M. M. Alencar*[1], A. M. Silva[2], A. R. Freitas[1], R. T. Barbosa[1], and L. A. Correa[1], [1]*EMBRAPA-Centro de Pesquisa de Pecuária do Sudeste/Sao Carlos, SP/Brazil,* [2]*Graduate student/UNESP, Jaboticabal, SP/Brazil (Bolsista da FAPESP).*

The objective of this study was to estimate heritabilities of and genetic correlations among male scrotal circumference (SC12; 857 observations) at 12 months of age, and female body weights at first (BWFC; 927 observations) and second (BWSC; 769 observations) calvings, age at first (AFC; 1466 observations) and second (ASC; 1136 observations) calvings,

adult weight (AW; 956 observations), and mature weight (A; 486 observations) and maturation rate (k; 486 observations) obtained using the Von Bertalanffy model, for Canchim (5/8 Charolais + 3/8 Zebu) cattle. The restricted maximum likelihood method with an animal model that included the fixed effects of contemporary groups (year-season of birth for SC12, AFC, ASC, A and k, and year-season of calving for BWFC, BWSC and AW) and the random effects of animals, was used to estimate the variance and covariance components. The heritability estimates, obtained by univariate analyses, were equal to: 0.30 (SC12), 0.38 (parameter A), 0.35 (parameter k), 0.12 (AFC), 0.33 (BWFC), 0.04 (ASC), 0.39 (BWSC), and 0.38 (AW). The genetic and phenotipic correlations between the parameters A and k were equal to -0.74 and -0.75, respectively. The genetic correlations, obtained by bivariate analyses, among SC12 and the female traits were: -0.24 (parameter A), 0.27 (parameter k), -0.47 (AFC), 0.09 (BWFC), -0.67 (ASC), 0.07 (BWSC), and -0.17 (AW). These results indicate that male scrotal circumference, and female weights (BWFC, BWSC and AW) and growth curve parameters A and k have enough additive genetic variation to respond to mass selection. Selection to increase SC12 should result in desirable correlated responses in AFC, ASC and k, without any considerable change in female adult body weights. Thus, SC12 is a good selection criterion to increase reproductive efficiency of the herd studied.

Key Words: Beef cattle, Growth and reproductive traits, Gentic parameters

101　Interactions between genotype, environment and disease affect breeding against susceptibility for a production disease.
K. H. de Greef* and L. L. G. Janss, *ID-DLO Lelystad NL.*

There is concern that the increase in growth potential of broilers increases susceptibility and incidence of ascites (a metabolic disease related to a too high oxygen demand). Opportunities for breeding against ascites were studied in 2000 cold housed broilers by assessing genetic parameters of many ascites and production related traits. The most striking and relevant result in this was the sign of the observed genetic relation between body weight and ascites. It was contradictory (-.31) to the generally assumed positive relation. Below, this contradiction is unraveled and the importance of recognising such underlying mechanisms for breeding against production diseases is stressed.

The observed negative r_g is to be considered particular for the disease inducing (cold) environment. It can be explained through three interferencing genetic, environmental and GxE effects: - ascites susceptibility is only expressed in a challenging environment (simple G*E) - faster growing animals have a higher ascites susceptibility (genetic effect) - when ascites actually occurs, body weight is depressed (environmental effect triggerd by a genetic liability) So the animals that were expected to be the heaviest ones ended below average due to ascites, resulting in the reversed genetic correlation.

This explanation was substantiated in two ways. First, regression of ascites on actual weights resulted in a negative regression, whereas regression of ascites on the breeding values (based on mid-parent values for growth in a 'normal' environment) showed a positive relation. Secondly, analysing the non-diseased part of the population resulted in the expected positive r_g between ascites and body weight (.21).

For the specific case, it can be stated that for an effective breeding program aiming at reducing ascites, there is not a unique testing environment that produces all correct genetic parameters. An important generalised implication is that r_g's between interrelated traits may be very dependent on the environment. Unraveling the interferencing (simple) operating mechanisms may prevent breeders from being unsuccessful caused by using irrelevant genetic parameters.

Key Words: Breeding, Disease, Genotype - environment interaction

102　Effect of sire by year interaction on estimates of genetic parameters from a selection experiment with Hereford cattle.
L. D. Van Vleck*[1], J. Dodenhoff[2], and R. M. Koch[2], [1]*USDA-ARS, USMARC, Lincoln, NE,* [2]*University of Nebraska, Lincoln, NE.*

Estimates of genetic correlation between direct and maternal effects for early weights of beef cattle often are negative. Several reasons have been proposed. Studies of field records have shown that including sire by year interaction and grandmaternal effects improve the model and change the estimate of the direct-maternal genetic covariance. This

analysis involved 9,968 progeny records from a long-term selection program (1960-1985) in Hereford cattle. Data from three selection lines and a control line were combined. Traits were birth (BW) and weaning (WW) weights, pre-weaning gain (WG), post-weaning gain (YG), and muscle score (MS). The most complete models included fixed effects of sex-line, sex-year, and age of dam-line and random direct, maternal, and grandmaternal genetic, maternal and grandmaternal permanent environmental and either sire by year-sex or sire by year interaction effects. For BW, grandmaternal and sire interaction effects were not important. For WG and WW, including grandmaternal effects was important and increased maternal heritability with no change in direct-maternal (d-m) correlation. Sire by year interaction accounted for .01 of variance and had little effect on estimates of genetic parameters. For YG, grandmaternal model reduced the magnitude of negative d-m correlation although maternal heritability was only .03. Further addition of sire interaction effects resulted in slightly positive d-m correlation. The best model included grandmaternal and sire by year by sex interaction effects. For MS, a maternal effects model was significantly better than a direct effects model (small negative d-m correlation). Sire by sex-year accounted for .01 of variance and did not affect other parameter estimates. Grandmaternal and sire interaction effects were not important. These data did not show any effect of sire by year interaction on estimates of direct-maternal genetic correlation or maternal heritability for weaning weight or pre-weaning gain.

Key Words: Beef Cattle, Growth, Selection

103   Effects of sporidesmin on mouse lines divergently selected for response to toxins in endophyte-infected fescue. W. D. Hohenboken*[1], J. L. Robertson[1], D. J. Blodgett[1], C. A. Morris[2], and N. R. Towers[2], [1]*Virginia Polytechnic Institute and State University*, [2]*AgResearch, Ruakura Animal Research Centre, Hamilton, New Zealand.*

For eight generations, mouse lines were selected for smaller (Resistant = R) or larger (Susceptible = S) growth reduction from endophyte-infected fescue seed (EIFS) in the diet. After five generations of relaxed selection, this experiment was conducted to determine whether R and S lines differed in response to the mycotoxin, sporidesmin (Spd). At 8 wk of age, R and S mice which had never consumed EIFS were randomly assigned (six or seven per line x sex x dose subclass) to receive DMSO carrier or 10, 20, 30 or 40 mg/kg Spd by oral gavage. Livers and kidneys were collected for histological examination at death or euthanasia 13 d post-treatment. At all ages, S mice were significantly heavier than R mice. Mice that succumbed to 40 mg/kg Spd died sooner than mice dying from 30 mg/kg (62 vs. 124 h; P = .02), but there was no line or line x dose interaction effect. Within those mice, liver weight as a proportion of body weight was not influenced by line, dose or their interaction. The R mice were more resistant to Spd than S mice; LD50 values differed by a factor of 1.35 (23.6 versus 31.8 mg/kg for S and R mice, respectively; P < .05). Treatment with Spd caused dose related liver and kidney lesions in both lines. Infarcts of hepatic lobules and fibrosing cholangitis in livers of mice dosed at 30 and 40 mg/kg were less severe in R than in S mice. In both lines, foci of acute tubular necrosis and tubular basophilia (indicative of tubular regeneration) were seen in the kidneys of mice receiving 30 and 40 mg/kg Spd, with no clear-cut protection against these lesions in the R line. In mice, bi-directional selection for weight gain response to EIFS resulted in a favorable correlated change in resistance to a chemically unrelated toxin. It may be possible to select within livestock populations for broad-spectrum resistance to toxins.

Key Words: Mice, Genetic resistance, Toxins

104   Breeding objectives for niche markets and production efficiency. A. M. Edwards* and J. W. Wilton, *University of Guelph.*

Twenty-five breeding objectives corresponding to twenty-four niche markets and production efficiency were derived for both a large and medium frame beef population in integrated production systems. Objectives were compared to determine whether cattle within a population or herd should be bred to match a particular niche market or production efficiency. Niche markets were identified for two optimum carcass weights, two carcass weight pricing structures, three optimum marbling levels, and two ribeye area pricing structures. Correlations between two breeding objectives were calculated as $r_{T_iT_j} = a'_i Ca_j / [(a'_i Ca_i)(a'_j Ca_j)]^{1/2}$

where a_i is a vector of economic values corresponding to breeding objective T_i in the medium frame herd, a_j is a vector of economic values corresponding to objective T_j in the large frame herd, and C represents the variance-covariance matrix of objective traits. Correlations between breeding objectives for medium frame niche markets and the large frame production efficiency objective were 0.99. Correlations between production efficiency in the medium frame herd and large frame niche markets ranged from 0.88 to 0.97. Correlated response of the objective traits in the medium frame herd included an increase in all carcass traits accompanied by an increase in herd feed costs, resulting in an average change in profit of $11.00 per head. Objective trait responses in the large frame herd included a minimal increase in carcass traits and a decrease in all herd costs with the exception of feedlot feed costs, resulting in an average change in profit per head of $12.50. Correlations between objectives implied that breeding for efficiency in a large frame herd was similar to breeding for niche markets in a medium frame herd. Changes in profit and objective trait responses implied that breeding toward production efficiency in a large frame herd may result in more rapid changes in profit than breeding for niche markets in a medium frame population. Therefore, to maximize change in profit in integrated production systems, large frame populations should be bred for production efficiency and medium frame herds for niche markets.

Key Words: Breeding objective, Selection, Beef

105   Selection of bulls for cryopreservation of semen for the conservation of Kerry Cattle. R. K. Splan*[1] and E. P. Cunningham[2], [1]*University of Nebraska, Lincoln,* [2]*Trinity College, Dublin 2, Ireland.*

The objective of this study was to examine levels of inbreeding of the Irish Kerry Cattle population over time, and to devise a strategy to select bulls as semen storage candidates for future use in conservation of the breed. Kerry Cattle are an endangered, dual-purpose breed, and one of the last remaining indigenous breeds in Ireland. The Irish population now consists of less than 700 breeding females and 50 males currently available for either live cover or artificial insemination. Pedigree records on 17,114 individuals registered with the Irish Kerry Cattle Herd Book from 1890 to 1998 were used to estimate current and historical levels of inbreeding. The current level of inbreeding in the breed is about 14% . After review of several methods of measuring genetic diversity among individuals, a strategy to select bulls for cryopreservation of semen was developed. Average genetic relationship between each bull and all other members of the breeding population will be calculated and bulls with minimal values proposed as semen storage candidates. To generate a list of proposed matings to produce potential bull calves with maximal genetic diversity, specific matings between all individual bulls and cows in the breeding population will be ranked on average genetic relationship between their resulting potential progeny and a random sample of contemporary breeding animals. Implementation of these methods will aid in maximizing genetic diversity of the threatened Irish Kerry Cattle population.

Key Words: Inbreeding, Genetic Diversity, Breed Conservation

106   Effects of including rear leg defects on finishing trait EBV's of Yorkshire gilts. J. J. Chewning* and C. N. Fitzgerald, *Pork Group, Tyson Foods Inc, Rogers AR.*

The purpose of this study was to investigate the effects of accounting for rear leg defects (RLD) on genetic parameters and EBV's in a closed population of Yorkshire gilts. All gilts born on three farms from 1992 to 1998 were individually identified at birth and weighed at 100 d of age (W100, n=36,505). Fifty nine percent (n=21,548) were tested for an additional 77 d and data collected were gain on test (GAIN), ultrasonic backfat thickness (P2) and RLD score. Gilts were selected for 77 d testing using a combination of maternal and grow finish indices. Gilts were given 1.2 M^2 per head and *ad libitum* access to a 1.14% Lysine, 19% CP and 3344 ME/KG corn-soy diet. Gilts were visually scored for being sickle-hocked, cow-hocked and post-legged using a scale of 0 to 3 (0=absent through 3=non-functional). Scores were summed and one was added to avoid zeros. Frequencies of RLD scores were 6069, 6359, 5858, 2515, 604, 129 and 14 for scores 1 to 7, respectively and none scored 8-10. Phenotypic weights at the end of the test were similar for all RLD scores, whereas P2's were 16.4, 16.4 16.2 15.7 15.2, 13.6 and 14.9 mm for RLD scores 1 to 7, respectively. Genetic parameters were estimated using a multiple trait animal model (38161 animals in A^{-1})

using MTDFREML with and without inclusion of RLD score as a trait. Heritabilities were .37, .37, .53 and .21 for W100, GAIN, P2 and RLD score, respectively. Genetic correlations were moderate between W100, GAIN and P2 (.37 to .45), low between W100 and GAIN and RLD score (.07 and .04), and -.25 between P2 and RLD score. Spearman correlation coefficients between P2 EBV's calculated with and without RLD scores were .92, .86, .86, .84, .83, .82 and .84 for gilts with RLD scores of 1 to 7, respectively. These data suggest inclusion of RLD score into selection programs may allow better estimation of P2 EBV's, particularly for gilts with higher RLD scores.

Key Words: Swine, Leg Defects, BLUP

107   Carcass expected progeny differences using real-time ultrasound measures from yearling Angus bulls. D. E. Wilson*, G. H. Rouse, C. L. Hays, V. R. Amin, and A. Hassen, *Iowa State University, Ames, IA/USA.*

The objectives of this research were to determine genetic parameter estimates for real-time ultrasound (RTU) measured composition traits on yearling Angus bulls and to compare sire expected progeny differences (EPD) based upon RTU measured traits to those based upon carcass measured traits of steer progeny. The RTU measures in this study were from 4,222 yearling bulls. The bulls came from 88 contemporary groups as defined by herd and scan date. There were 497 sires represented in the data. RTU images were collected by technicians participating in a two-year research project at Iowa State University (ISU) and funded by the American Angus Association (AAA). ISU image-interpretation technicians made all RTU measurements at the ISU centralized ultrasound processing laboratory from images received from field RTU technicians. The measures included rump fat thickness (RFAT), 12-13th rib fat thickness (FAT), ribeye area (REA), and percentage intramuscular fat (%IMF). Measures were adjusted to a 365-d age end point. Genetic parameter estimates were made using restricted maximum likelihood procedures. The genetic prediction model was a multiple-trait sire model with sire and maternal grandsire additive genetic relationships. Carcass EPD used for comparison came from the 1998 Fall AAA Sire Evaluation Report. The h^2 estimates for RFAT, FAT, REA and %IMF were .52, .44, .39 and .42, respectively. Genetic correlation estimates for RFAT-FAT, FAT-%IMF, REA-%IMF and REA-FAT were .82, .17, -.12, and .23, respectively. Of the 497 sires with RTU-based EPD, 193 also had carcass-based EPD. Comparisons were made between EPD from the two sources of data using sire rank correlations. In general, as RTU-based EPD accuracy levels increased, rank correlations increased between RTU-EPD and the carcass-EPD. For RTU-EPD accuracy levels of .8 and higher, the rank correlations were .83, .91 and .84 for Marbling Score-%IMF, REA, and 12-13th rib fat thickness. There was no minimum accuracy assigned to the carcass EPD used in these rank correlations. These results would indicate that breeders could use EPD based upon RTU measures from yearling bulls to predict the same genetic differences observed from steer progeny carcass measures.

Key Words: Beef cattle, Composition, Ultrasound

108   Evaluation of maternal performance for crossbred cows sired by Tuli, Senepol, Brahman, Angus or Hereford sires. J. F. Baker*, R. C. Vann, and L. Varnadoe, *University of Georgia Coastal Plain Station, Tifton, GA, USA.*

Birth (n=388) and weaning (n=358) records for calves from seven types of crossbred cows were used to evaluate maternal performance of the dams. The cow breed types were: 1/2 Brahman (Bn) 1/2 British (Bt) (BnBt) , 1/2 Senepol (Sn) 1/2 Bt (SnBt), 1/2 Tuli (Tu) 1/2 Bt (TuBt), 3/4 Bt 1/4 Bn(BC) , 1/2 Sn 1/4 Bn 1/4 Bt (SBB), 1/2 Tu 1/4 Bn 1/4 Bt (TBB), and Bt cross. British was either Polled Hereford or Angus. Heifers were mated to either Hereford, Angus or Limousin bulls to calve at 2 yr of age with calves born in January through early March. Weights of calves at birth, in late March, and at weaning, cannon bone length at birth, hip height at weaning and ADG from March to weaning were analyzed to evaluate maternal performance for the seven types of dam. Data were analyzed with a model that included fixed effects of cow breed type, cow age, sire breed of calf, year, and calf sex. Weaning weight and height models included age at weaning as a covariate, March weight used age in March as a covariate, and the birth traits used Julian day as a covariate. Cow breed type was a significant source of variation for all six traits evaluated. Calves from BnBt cows were heavier ($P < .01$) in March (83 ± 2 kg) and at weaning (240 ± 4 kg) than calves from SnBt

(70 ± 4, 212 ± 8 kg) and TuBt (70 ± 3, 211 ± 5 kg) dams. In March the calves from BC and SBB dams were similar but heavier ($P < .05$) than calves from TBB dams (78 ± 2, 79± 3, 70 ± 3 kg, respectively) but at weaning SBB calves were heavier ($P < .05$) than calves from BC and TBB dams (235 ± 8, 214 ± 4, 215 ± 5 kg, respectively). In summary, important differences were measured for maternal performance for birth and weaning traits in cow types adapted to the hot, humid Southern U.S.

Key Words: Breeds, Weaning weight, Maternal performance

109   Responses in ovulation rate and litter size to two-stage selection in swine. A. Ruíz-Flores*[1], J. P. Cassady[1], and R. K. Johnson[1], [1]*University of Nebraska, Lincoln.*

The objectives were to estimate genetic parameters for ovulation rate (OR) and fully formed pigs (FF), and to quantify responses to 2-stage selection. Three lines were used. Line IOL was derived from a line previously selected for an index to increase OR and embryonic survival. It had greater OR (4.22 ova) and FF (1.94 pigs) at generation 0 than line C, its control line. Line COL originated from line C. Lines IOL and COL underwent 8 generations of 2-stage selection. In stage 1 all gilts from the 50% of the litters with greatest FF were retained and OR was measured in them. Approximately 50% of these gilts were selected for OR in stage 2. The gilts selected for OR were mated to boars selected from the upper one third of the litters for FF and the two-stage selection was repeated in their progeny. Line C was maintained with random selection. Each line had 40-45 litters by 15 sires per generation. Ovulation rate was measured by laparotomy 11 days after second estrus. The hypothesis was that after selection for OR, FF was a measure of uterine capacity (UC) as selected gilts were expected to have OR that exceeded UC. Phenotypic data on first parity gilts for OR (n=1742) and FF (n=974) were analyzed. The MTDFREML program with an animal model including random effect of animal and fixed effect of generation was used. Differences between lines within generation were calculated using linear contrasts of EBV for OR and FF. Heritability estimates were .42 and .18 for OR and FF, respectively, and the genetic correlation was .51. At generation 8 differences in EBV for OR and FF between IOL and C were 6.10 ova and 4.10 pigs; differences between COL and C were 2.24 ova and 2.23 pigs; and differences between IOL and COL were 3.92 ova and 1.88 pigs. The 2-stage selection procedure was effective in improving OR and UC. All the increase in OR was realized as an increase in FF in line COL. Number of fully formed pigs increased more than OR in line IOL presumably because UC was limiting litter size in generation 0.

Key Words: Litter Size, Pigs, Two-stage Selection

110   Effects of selection for below average birth weight and high yearling weight or for high yearling weight on characteristics of Line 1 Hereford females. M. D. MacNeil* and J. J. Urick, *USDA Agricultural Research Service, Miles City, MT.*

Simultaneous selection for low birth weight and high yearling weight has been advocated to improve efficiency of beef production. Two sublines of Line 1 Hereford cattle were established by selection either for below average birth weight and high yearling weight (YB) or for high yearling weight alone (YW). Direct effects on birth weight and yearling weight diverged between sublines with approximately four generations of selection. The objective of this study was to estimate genetic trends for traits of the cows. A three parameter growth curve [W = A(1 - B*exp(-K*age))] was fitted to age(d)-weight (W) data from cows surviving past 4.5 years of age (n=738). The resulting parameter estimates were analyzed simultaneously with birth weight and yearling weight using multiple trait restricted maximum likelihood methods. To estimate maternal additive effects on gain from birth to weaning (MILK) the two-trait model previously used to analyze birth weight and yearling weight was transformed to the equivalent three-trait model with birth weight, gain from birth to weaning and gain from weaning to yearling as dependent variables. Heritability estimates were: 0.32, 0.27, 0.10, and 0.20 for A, B, K, and MILK, respectively. Genetic correlations with direct effects on birth weight were: 0.34, -0.11, and 0.55, with direct effects on yearling weight were: 0.65, -0.17, and 0.11 for A, B, and K, respectively. Genetic trends (per generation)for YB and YW were: A (kg)8.0 ± .2 and 10.1 ± .2; B (x1000) -1.34 ± .07 and -1.16 ± .07; K (x1000) -14.3 ± .1 and 4.3 ± .1; and MILK (kg) 1.25 ± .05 and 1.89 ± .05, respectively. Beef cows resulting from simultaneous selection for below average birth

weight and increased yearling weight had different growth curves and reduced genetic trend in maternal gain from birth to weaning relative to cows resulting from selection for increased yearling weight.

Key Words: Selection, Growth curve, Beef cattle

111   Evaluation of Simmental sires for daughters' length of productive life. B. E. Cunningham*[1], R. L. Quaas[2], and E. J. Pollak[2], [1]*American Simmental Association, Bozeman, MT,* [2]*Cornell University, Ithaca, NY.*

An analysis of length of productive life (LPL) was conducted using 25,512 Simmental cows from 22 herds representing 1,647 Simmental sires. LPL was the number of days from first calving to the day the cow disappeared from the herd. Records were censored if the cow changed herds or produced a calf in 1998. The data were analyzed using the Survival Kit V3.0 (Ducrocq and Sölkner, 1994; Ducrocq and Sölkner, 1998) for proportional hazard models. The baseline hazard function was assumed to follow a Weibull distribution. Management groups (M) were formed using herd·season·year subclasses. Four models were evaluated to describe LPL. Model 1 had Year (Y), Percent Simmental (PS), M, and Sire (S). Model 2 used Y, PS, M, S, and calving ease score (CE) of the cow's first calf. Model 3 had Y, PS, M, S, and the cow's predicted producing ability (PPA) for calf weaning weight. Model 4 used all effects. The S and M effects were random with normal and log-gamma distributions, respectively. The estimated σ^2_S were .035, .017, .036, and .016 for models 1, 2, 3,and 4, respectively. The γ_M estimates were 3.10, 3.01, 2.86, and 2.74 for models 1, 2, 3, and 4, respectively. Using the predicted S hazard values, simple correlations were .99 between models 1 and 2, .90 between models 1 and 3, and .89 between models 1 and 4. The use of CE scores reduced the variation among sires but had little effect upon sire rank. The use of PPA did not reduce variation among sires but caused some changes in sire rank.

Key Words: Beef Cattle, Genetic Evaluation, Survival Analysis

112   Comparison of threshold and linear models for calving difficulty in beef cattle. R. Ramirez-Valverde*, I. Misztal, and J. K. Bertrand, *University of Georgia, Athens, Georgia.*

The purpose of this study was to compare several sire-maternal grandsire (SM) and animal (AM) models for calving difficulty (CD). The models were: univariate threshold (T) and linear (L) models for CD, and bivariate threshold-linear (TL) and linear-linear (LL) models for CD and birth weight (BW). Data obtained from the American Gelbvieh Association included 84,420 first-parity records with both CD and BW available. Additionally 95,038 pedigree records were available. CD scores were distributed as 73.4% in the first category (no assistance), 18.7% in second, 6.3% in third, and 1.6% in fourth. Effects included in AM were fixed sex-age of dam, random herd-year-season, and random animal direct and maternal. Effects included in SM were fixed sex-age of dam, random herd-year-season, and random sire and maternal grandsire. Genetic parameters and thresholds were obtained from an earlier study. Data splitting techniques were used to compare the predictive ability of the models defined through correlation between estimated breeding values (BV) from two samples, with one half of CD records discarded randomly in the first sample and the remained CD records discarded in the second sample. Reported correlations are average of two replicates for direct effects of 6,954 sires only. For SM, the correlations were .45, .46, .86, and .90 for L, T, LL and LT, respectively. For AM, the correlations were .50, .57, .86, and .91, respectively. In all cases, the correlations for T were better than for L and for LT were higher or equal than LL. Differences in correlations between the linear and threshold models were larger with AM than with SM. The correlations for the bivariate models were much higher than for the univariate models, and differences in correlations between SM and AM were larger for univariate than for multivariate models. Animal threshold-linear model is the model of choice for genetic evaluation of calving difficulty.

Key Words: Threshold model, calving difficulty, beef cattle

113   Analysis of herd life in a four-breed diallel in beef cattle. V. E. Vega-Murillo*[1], S. D. Kachman[1], L. V. Cundiff[2], and L. D. Van Vleck[3], [1]*University of Nebraska, Lincoln ,* [2,3]*USDA, ARS, USMARC ,* [2]*Clay Center,* [3]*Lincoln, NE.*

Survival analysis was used to investigate herd life of 537 females produced in 1973 and 1974 in a four breed diallel design including Red Poll (RP), Brown Swiss (BS), Hereford (H) and Angus (A) breeds. Data were collected at the U.S. Meat Animal Research Center, and included records of cows from 57 sires (15 H, 16 A, 15 RP, and 11 BS). A Weibull regression model was used to explain the effect of the breed combination on herd life measured by the number of days from the beginning of the first breeding season of the cow to her termination from the herd. Model included fixed effects of breed combination, and year of birth of the cow, with sire within breed of sire as a random effect. Significance of the explanatory variables was tested using a likelihood ratio test. The effect of breed combination was significant (P < .05). The change in log likelihood associated with the year of birth was small compared with that of other effects. The estimate for the scale parameter was 0.81 ± 0.04, indicating a baseline hazard function which decreases over time. Solutions for fixed effects indicated a higher probability of being culled for purebred than for crossbred cows (P < .01). Heterosis was favorable for F1 Angus-Brown Swiss and F1 Hereford-Brown Swiss crosses (P < .01 and P < .05, respectively). The risk ratios for the breed combinations were 1.2, 1.5, 0.8, 0.9, 0.6, 1.6, 0.7, 0.5, 0.9, 0.5, 1.2, 0.9, 0.8, 0.9, 0.7, and 1.0 for RP, RPxBS, RPxH, RpxA, BSxRP, BS, BSxH, BSxA, HxRP, HxBS, H, HxA, AxRP, AxBS, AxH, and A, respectively. Brown Swiss crosses were superior to A and H breeds. The significant breed group differences in herd life indicate that purebred cows have a higher risk of leaving the herd than crossbred cows.

Key Words: Survival Analysis, Heterosis, Risk Ratios

114   Iterative bootstrap bias correction of (co)variance components from a bivariate linear-threshold sire model. P. J. Gates*[1], K. Johansson[1], C. Moreno[2], and J. Jensen[3], [1]*Swedish Unversity of Agricultural Sciences, Uppsala, Sweden,* [2]*Universidad de Zaragosa, Zaragosa, Spain,* [3]*Danish Institute of Animal Science, Foulum, Denmark.*

The iterative bootstrap bias correction (Kuk, 1995) was applied to (co)variance component estimates from the mode of the joint posterior distribution of both location and dispersion parameters from a bivariate linear-threshold sire model. The data were generated as a Monte Carlo simulation with 30 replicates. Each replicate consisted of 6450 observations that were made in one of 60 contemporary groups. Each contemporary group contained offspring from 30 dams mated to 3 "herd sires" and 10 dams mated to 2 "reference sires". Thus, every "herd sire" had 30 progeny in only one contemporary group, whereas the "reference sires" could have progeny in between 1 and 10 contemporary groups. Three traits were simulated: a continuous trait 1 (h^2=.25) and binomial traits 2 (h^2=.10, 15% incidence) and 3(h^2, 5% incidence). The genetic and environmental correlations between all trait combinations were simulated to be .50 and .20, respectively. Combinations of trait 1 and trait 2, and trait 1 and trait 3 were analyzed with bivariate linear-threshold models that fitted effects of contemporary group and sire for both traits. All of the (co)variance component estimates from the joint mode were extremely biased. 150 rounds of iterative bootstrap bias correction were applied to the joint mode estimates of sire and residual (co)variances. Each bias correction round was based on only one bootstrap resample. Point estimates for each of the (co)variance components were taken to be their mean over the last 30 iterations and were used to calculate heritabilities, as well as genetic and environmental correlations for each replicate. Averaged over 30 replicates, the absolute bias for the heritabilities, as well as for the genetic and environmental correlations between trait 1 and 2 were small (<.02). The average biases for the genetic and environmental correlations between trait 1 and trait 3 were large, -.116 and .048, respectively. The results indicate that bias corrected (co)variance components from a linear-threshold model are essentially unbiased, as long as the incidence and heritability are not too low. This is unfortunate, since low incidences and heritabilities are a common source of bias when variance components are estimated with threshold models.

Key Words: Variance components, Threshold models, Bias

CONTEMPORARY ISSUES

115   Incidence of severe welfare problem in horses arriving at slaughter. T. Grandin*[1], K. McGee[1], and J. Lanier[1], *Colorado State University, Ft. Collins, CO USA.*

Sixty-three trailer loads of horses (1,008) arriving at two slaughter plants in Texas were observed in July and August of 1998 for incidence of welfare problems. Forty-two percent of the horses were transported on double-decks, 9% on straight single-deck semi-trailers and 49% on goosenecks. The average number of horses on each load was: double-decks 28, single-deck straight trailers 22, and goosenecks 11. The maximum number transported on each type of trailer was: double-decks 45, single-deck straight trailers 25, and goosenecks 22. Ninety-two percent of the horses arrived in good condition while 1.5% were not fit for travel. Seventy-eight horses (7.7%) had severe welfare problems. Sixty horses (6%) out of the 78 horses had conditions caused by owner neglect or abuse and 1.8% (18 horses) had transport and marketing injuries severe enough to be rated a severe welfare problem. Origin problems were significantly greater than transport problems (p<.001). Examples of origin welfare problems were: loaded with a broken leg, emaciated, foundered, race horses with bowed tendons, and horses that were too weak to be transported. Fighting was a major cause of injuries during transport and marketing. Thirteen percent of the carcasses had bruises caused by bites or kicks. Bites or kicks caused fifty-one percent of all carcass bruises. Loads from dealers who picked up horses from more than one auction had more external injuries and carcass bruises than direct loads (p<.001). The authors make the following recommendations: 1) Educate horse owners that they are responsible for horse welfare. 2) Segregate aggressive mares and geldings. 3) A lack of federally inspected slaughter facilities will increase the number of horses that will die from neglect, or are diverted to Mexico or to non-inspected facilities in the United States.

Key Words: Welfare, Slaughter, Transportation

116   Differences among olfactometry labs for ambient air measurement of pork production odors. C. L. Tengman*, D. J. Uthe, and R. N. Goodwin, *National Pork Producers Council.*

Public scrutiny and regulation of modern livestock production facilities is increasing. Many complaints associated with hog production facilities have been based upon odors. All livestock industries are currently facing regulations or potential regulations with regard to air quality and/or odor. The National Pork Board, through the National Pork Producers Council, developed the Odor Solutions Initiative (OSI) in 1997, a program dedicated to odor measurement and odor control research. A total of 20 farms in 5 states (MN, IA, MO, NC, UT) were part of two monitoring projects. Project one in MN, IA, MO, and NC in the fall of 1997 and project two in Utah in May, 1998. Ambient air temperatures ranges for the three mid-west states, NC, and UT were -0.5-13°C, 9-19°C, and 2-16°C. Olfactometry air samples were collected in 10-liter tedlar bags using 10-liter Supelco vacuum pumps for odor unit (OU) evaluation. The tedlar bags were filled by collecting air over 1 minute intervals every 8 minutes, or for 10 minutes continuously. Samples were taken at distances (DISTANCE) of 1.5m, 30m, and 76m from the manure storage for project one. Project two consisted of sampling locations (LOC) at the lagoon cover, lagoon berm, in the barn and others (Bliss hood, vent

tubes). All sample bags were shipped overnight for evaluation within 24 hours of collection. Four independent olfactometry labs (OL) evaluated bag samples for OU. A statistical model with fixed effects of FARM, OL, and DISTANCE from source was used to evaluate project one data. Odor unit differences were found among FARM, OL, and DISTANCE in project one (P<0.05). A statistical model with fixed effects of OL, LOC, LOC by OL interaction, and air temperature was used to evaluate project two data. Project two showed no OL or air temperature differences in OU (P>0.05). Odor unit differences and standard errors in project two are shown in the table.

Location	OU
Covered lagoon	$12976^a \pm 914$
In hog barn	$56^c \pm 873$
on lagoon berm	$187^c \pm 901$
Other sample	$3376^b \pm 619$

[a,b,c] Means with the same superscript are not statistically different (P < .05).

Key Words: odor, olfactometry, swine

117   Simulated greenhouse gas emissions from beef and dairy systems. H. W. Phetteplace*, D. E. Johnson, and A. F. Seidl, *Colorado State University, Fort Collins, CO.*

Inventory assessment and mitigation strategies for greenhouse gas (GHG) emissions from all sources including the livestock industry are expectations of the Kyoto protocol. Greenhouse gases of concern in animal agriculture are methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). A computer model was developed simulating beef (cow-calf, stocker, feeder) and dairy production systems at several US locations. Inputs include the animal's production stage, body weight, age, amount of milk or meat it produced and the amount and type of feed it consumed (including how the feed is processed and fed). Simulated herds were structured on a 100-head basis, into 15 to 25 classes, based on physiological or production stage. On a per unit product basis, the cow-calf segment produced 520 g of enteric CH_4/kg weaned weight, the stockers and feeders produced 270 and 80 g CH_4/kg body weight gain, respectively, and dairy cattle produced 20 g enteric CH_4/kg milk. Manure CH_4 was estimated to be 11 g/kg weaned weight for the cow-calf system, 6 and 1 g/kg weight gain for the stockers and feeders, respectively and 2 g/kg milk for dairy cattle. Nitrous oxide production was 31 g/kg weaned weight for cow-calf, 15 and 7 g/kg weight gain for stockers and feeders, respectively, and 4 g/kg milk for dairy cattle. Carbon dioxide emissions were estimated to be 403 g/kg weaned weight for cow-calf, 68 and 57 g/kg gain for stockers and feeders, respectively, and 32 g/kg milk for the dairy systems. The total global warming potential (GWP) was 21 kg/kg weaned weight for cow-calf herds in both Virginia and Wisconsin. Total GWP was 12 verses 8 kg/kg weight gain for stockers in Virginia and Wisconsin, respectively. The total GWP for feeder cattle was 3 versus 4 kg/kg weight gain for Iowa and Texas, respectively. The simulated dairy system produced a total GWP of 1 and 2 kg/kg milk for California and Wisconsin, respectively. Current GHG inventories and imposed mitigation strategies can be evaluated with this model.

Key Words: Greenhouse gases, Computer model, Ruminants

ENVIRONMENT AND BEHAVIOR

118   Influence of sow gestation diet on piglet behavior. K. A. Scott*[1], M. Shea-Moore[2], and J. Morrow-Tesch[3], [1]*Purdue University, West Lafayette,* [2]*USDA-ARS, West Lafayette,* [3]*USDA-ARS, Lubbock.*

Although cognition is generally believed to develop postnatally, recent research has demonstrated that learning in some species occurs prior to birth. Studies have demonstrated that stimuli presented in the fetal environment can influence future preferences and aversions. The purpose of this study was to preliminarily assess how dietary odors and flavors fed to gestating sows affect odor and feed preferences of piglets after birth. The volatile compounds in onion and garlic are thought to pass to the amniotic fluid of mammalian species and were thus used in the study. Using a randomized complete block design, sows were assigned to 1 of 3 treatment diets, garlic, onion, or control (n=4/treatment), for the last 2 weeks of gestation. Due to the volatile nature of the

odor compounds being used, it was necessary to confound treatment with location. At farrowing, 5 piglets from each litter were tested in a Y-maze for odor preferences prior to first nursing. Preference was quantified using behavioral analysis software. Sow diet did not significantly affect odor preference of piglets tested in the Y-maze. To test the long-term influence of prenatal exposure to odors and flavors, naïve piglets from each treatment were weaned into individual pens and presented with both onion and garlic feed for 4 days post-weaning. Daily feed consumption was measured and data were log transformed to control for heterogeneous variability. Data were analyzed using a mixed model analysis with weaning weight as a covariate. Piglets from sows fed an onion diet consumed significantly more garlic feed on day 3 (2.4 +/- 0.16 log grams garlic, 2.1 +/- 0.16 log grams onion, P= .05) and day 4 (2.5 +/- 0.14 log grams garlic, 1.9 +/- 0.14 log grams onion, P< .001). It appears that the sows' onion diet may have created an aversion

to onion feed, resulting in increased garlic feed intake. Although these results are preliminary, they do suggest that piglets are capable of perceiving and remembering olfactory and gustatory cues presented in their prenatal environment, affecting postnatal behavior. By adding volatile compounds to diets during gestation, it may be possible to increase feed consumption and reduce stress at weaning.

Key Words: Cognition, Behavior, Pig

119   Restricting feed intake of feedlot steers during summer. S. M. Holt*[1], T. L. Mader[2], J. B. Gaughan[1], R. T. Cowan[3], and A. T. Lisle[4], [1]*School of Veterinary Science and Animal Production, University of Queensland, Australia,* [2]*University of Nebraska, Concord, USA,* [3]*Australian Tropical Dairy Institute, University of Queensland, Australia,* [4]*School of Land and Food, University of Queensland, Australia.*

Eighty-four *Bos taurus* steers, initial BW 386 $\pm$ 3.7kg were used in a randomised complete block experiment (BW as block) to investigate the effects of level and duration of restricted feeding during summer on tympanic temperature and growth rate. Steers were randomly assigned to one of 12 pens (7 head/pen). Dietary treatments (Trt) consisted of 1) Corn Gluten Feed based (CGF) ration restricted to 75% of *ad-libitum* for 21d; 2) CGF ration restricted to 87.5% of *ad-libitum* for 21d; 3) CGF ration *ad-libitum*; 4) CGF ration restricted to 75% of *ad-libitum* for 42d; 5) CGF ration restricted to 87.5% of *ad-libitum* for 42d; 6) Dry Rolled Corn (DRC) based ration *ad-libitum* (control). Daily DMI for Trt 3 and 6 was predicted from NRC (1996) recommendations. Trt 1, 2, 4 and 5 were adjusted every 7 days accordingly from the predicted intakes. BW was obtained at the start of the study and then every 21d. Tympanic temperatures (T_t) of 2 to 3 steers per treatment were recorded throughout the study. Climatic data (ambient temperature and relative humidity) were recorded hourly and days were partitioned into 3 categories; 1)Thermoneutral (TNL) mean THI=73; 2)Moderate (MOD) mean THI=78.5 and 3)Hot (HOT) mean THI=82. T_t was lowest (P<.05) for Trt 2. Mean T_t for Trt 1 to 6 were 39.18 °C, 39.15°C, 39.33°C, 39.26°C, 39.20° C and 39.24°C, respectively. During TNL, T_t was lowest (P<.05) for Trt 6, while for MOD Trt1 was lowest (P<.05) and Trt 2 was lowest (P<.05)for HOT. Although there was no difference (P>.05) in ADG, steers fed Trt 5 obtained the highest ADG. There appears to be some benefits in restricted feeding of cattle during the summer such as lower T_t. However, the amount and duration of the restriction, along with composition of rations needs further investigation.°°°°°° *circ*

Key Words: Environmental Stress, Tympanic Temperature, Restricted Feeding

120   Effects of diet quality and milk flavor on post-weaning behavior of piglets. J. M. Gardner*, T. M. Widowski, and C. F. M. de Lange, *Department of Animal & Poultry Science, University of Guelph, Ontario, Canada.*

Early weaning of pigs can lead to an increase in belly-nosing and other oral-nasal (o-n) behavior patterns. Since these behavior patterns resemble massaging the udder and sucking, they may be associated with hunger or feeding. The objectives of this study were to determine any effect of the establishment of feeding or the presence of milk in the diet on o-n behavior (nosing, chewing or sucking other pigs) of pigs weaned at 14-18 days. During the first 2 weeks post-weaning, pigs were fed diets differing in quality and flavor. Six replicates of 8 pigs per replicate (n=192) were fed 1 of 4 diets: 1) high quality, high in milk products; 2) high quality, no milk products; 3) poor quality, no milk products; 4) diet 2 sprayed with milk replacer 5 times daily. After 2 weeks the pigs were fed a standard nursery diet. Feed intake was measured daily for week 1 and weekly for week 2. Behavior was recorded every 5 min during two 4h periods on days 2-7, 10, 14, 17, and 21 post-weaning. Diet quality but not the presence of milk influenced ADFI and ADG during week 1. ADFI (P≤.05) and ADG (P≤.05) of pigs on diet 3 were less than those of pigs on the other diets. During week 2, ADFI was the same for all diets (P≥.05). Although diet did affect ADFI and ADG during week 1, there were no effects on any behavior pattern recorded, including time spent at the feeder (P≥.10). Belly-nosing was low (0.99±0.07%) and was rarely observed before week 2. Overall, the pigs spent 4.23±0.17% of their time engaged in o-n behavior and 7.36±0.18% at the feeder. During week 1, o-n behavior appeared to be inversely related to the time spent at the feeder. On day 1, pigs spent 3.22±0.81% of time at

the feeder and 5.15±0.81% engaged in o-n behavior. From days 2-4, time at the feeder increased to over 7% while o-n behavior decreased to 3%. During week 2 both time at the feeder and o-n behavior increased for pigs on all diets. The establishment of feeding and the presence of milk in the diet had no effect on piglet-directed behavior during the first 3 weeks post-weaning.

Key Words: Pigs, Diet, Post-weaning behavior

121   Preliminary study of dairy cow response to ergotized barley during heat stress. H. Al-Tamimi*[1], D. Spiers[1], J. Spain[1], G. Rottinghaus[1], N. Hill[2], D. Chatman[1], J. Underwood[1], and M. Ellerseick[1], [1]*University of Missouri-Columbia,* [2]*University of Georgia.*

Limited information is available about the effect of dietary ergot on dairy cow performance during summer months. A field experiment was carried out to determine the combined effects of summer heat and ergotism on thermal status and performance of lactating Holstein cows (Average BW = 588 $\pm$ 28 kg). Animals in two treatment groups (n = 5 per group) ingested either a control diet (E-) or a diet containing barley seeds (E+) infected with the fungus Claviceps purpurea (10μg ergot/kg BW/day) for 10 d, preceded by a 5-d period of feeding on a control diet. Measurements included daily dry matter intake (DMI), milk production (morning and afternoon) and hourly air temperature (Ta). Thermal status was evaluated 4 times daily using measurements of respiration rate (RR), rump temperature (Tr), tail-skin temperature (Tt), and rectal temperature (Tre). Moreover, every other-day milk samples were analyzed for lysergic acid content using a developed ELISA procedure. Although RR, Tr, Tt and Tre were numerically higher in E+ compared to E-, the differences were insignificant (P > .05). Correlations between RR, Tr, Tt and Tre with Ta were significant (P = .0001) in both groups. None of the milk contained lysergic acid as a result of E+ treatment. Results of this study show that short-term heat stress of lactating dairy cows ingesting ergot at 10 μg/kg BW/day does not result in a significant shift in thermal status or productivity. Additional studies are needed to determine the ergot-induced thresholds for a shift in dairy cow performance.

Key Words: cattle, ergot, heat

122   Biological markers of cattle response to heat stress on endophyte-infected tall fescue. D. E. Spiers*[1], J. Lakritz[1], P. A. Eichen[1], G. E. Rottinghaus[1], H. Al-Tamimi[1], J. R. Dodam[1], and J. Underwood[1], [1]*University of Missouri.*

A summer field study was conducted to correlate changes in thermal status with biochemical indices of homeostasis for cattle grazing on endophyte-infected tall fescue (EIF), with the ultimate goal being the identification of markers for these stress conditions. Simmental heifers (n=12; average initial weight = 431 kg) were placed on EIF pastures (ergovaline level = ~200 ppb) and monitored from early June, when daily ambient temperature (Ta) fell below 10°C, through late July, when Ta rose above 35°C. All measurements were made 3 times per week, with daily determinations during morning (0800-0900h) and afternoon (1500-1600h) periods to cover the extremes in ambient conditions. Animals remained exposed to sun during sample periods to ensure collection of values representative of the field environment. Measurements of respiration rate (RR), rectal (Tre), and skin temperatures were made on resting animals under these conditions. In addition, there were determinations of standard ambient conditions, with blood and tissue samples collected to identify biochemical markers of animal strain. Average daily gain during this period was .48 kg. The best indicator of thermal strain was skin temperature, which was linearly related to Ta ($r^2 \geq$.70). A polynomial relationship existed between Ta and both RR and Tre, with $r^2 \geq$.59 and .48, respectively. A number of blood parameters exhibited significant (P≤.01) morning versus afternoon differences, and changes over time with the increase in heat stress and continuous exposure to EIF. These included red blood cell count, hematocrit, and serum levels of glucose, chloride, potassium, and bilirubin. Whole blood and liver-reduced glutathione (GSH) was highest during the first week of exposure, and returned to baseline thereafter. Blood levels of GSH in morning and afternoon samples were not significantly different (P≥.05). Further analyses are needed to determine which markers reliably identify animal sensitivity to heat stress and endophyte-infected tall fescue in the field environment.

Key Words: cattle, endophyte, heat stress

123   A chronic rat model of performance and thermoregulatory responses to endophyte-infected tall fescue diet. P. A. Eichen*, D. E. Spiers, G. Rottinghaus, and K. Fritsche, *University of Missouri - Columbia.*

Fescue toxicosis is a serious problem in cattle grazing endophyte-infected tall fescue (EIF). In previous studies, acute injection of rats with ergovaline, one of the toxins in EIF, showed body temperature changes similar to those seen in cattle fed EIF. Feeding EIF to rats allows development of a more accurate chronic model. Twelve 50 day-old, male rats were implanted with transmitters (Mini-Mitter, Sunriver, OR) to continuously monitor core body temperature (Tc) and activity. Rats were housed at thermoneutrality (TN; 21°C) and fed a diet containing endophyte-free fescue seed (EFF). After two weeks equilibration, rats were randomly assigned to either EIF or EFF diets and maintained at TN for one week. They were then exposed to heat stress (HS; 31°C) for 23 days, followed by one week recovery at TN (RTN). Body weight and feed intake were measured daily. Rats receiving EIF showed decreased feed intake (P$\leq$.0001) and weight gains (P$\leq$.0001) immediately upon introduction of EIF diet. During HS, EIF- and EFF-fed rats showed parallel decreases in feed intake (P$\leq$.002). Average daily Tc was similar for both groups during initial TN (ITN) period, but was higher for EIF- compared to EFF-fed rats during HS (P$\leq$.0001) and lower during RTN (P$\leq$.0001) periods. Daily maximum Tc was higher in EIF-fed rats during ITN and HS periods (P$\leq$.0007), but was not different from EFF-fed rats during RTN. Daily minimum Tc was lower in EIF- compared to EFF-fed rats during all three phases of treatment (P$\leq$.02). Average daily activity levels were not different during ITN and HS periods, but were lower for EIF- compared to EFF-fed rats during RTN (P$\leq$.02). The primary shifts in activity were a lower daily maximum level in EIF-fed rats during RTN and HS periods (P$\leq$.04), and a lower daily minimum level in EIF-fed rats during HS (P$\leq$.02). The rat model of chronic response to EIF contains many of the same responses noted in cattle, and at the same time allows for detailed analyses of shifts in thermoregulatory ability and activity.

Key Words: rats, fescue toxicosis, heat stress

124   Cattle hair whorl position and temperament in auction houses. J. L. Lanier*, T. Grandin, R. D. Green, D. Avery, and K. Mcgee, *Colorado State University, Ft. Collins, CO/USA.*

The relationship between hair whorl position and temperament was assessed for 1,636 beef type (Bos taurus, Bos indicus), dairy breeds and their crosses. A secondary objective was to quantify typical hair whorl location in cattle. Whorl classification was: lateral position (left, right, or middle) and height (high=above eye level, middle=at eye level, low=below eye level). A four point ring score was used to determine individual temperament. One equaled calm, and four equaled a highly excited animal. Animals with ring scores of 3 and 4 were further rated as whether they exhibited signs of fight or flight. Analysis on effect of breed, was only between Bos taurus beef (n=1233) and Holstein dairy cattle (n=350). Ten percent of cattle surveyed had no facial hair whorl. Animals with higher ring scores had higher whorl positions (P<.01). A single spiral hair whorl was found in 86% of the animals. Middle-middle whorl placement was found in 47% of the cattle. Cattle with low whorls were the most likely to have more whorls off of the centerline (P<.01). Abnormally shaped whorls were associated more often with low whorls (P<.01) and whorls located off of the centerline (P<.01). Female cattle had more abnormal whorls than male cattle (P=.01). Beef type animals had more abnormal whorls than Holsteins (P<.01) who were calmer than beef type cattle (P<.01) in the ring. Differences between ring score and gender (P<.01) and ring score and hair whorl height (P=.01) were found. Ring scores tend to be higher for females and animals with high hair whorls as compared to bulls and steers and cattle with low or middle hair whorls, respectively. Results of this study support research on the association between hair whorls and temperament. Facial hair whorls in cattle may be a useful management tool in assessing which animals may become fearful in novel environments such as feedlots, auctions and slaughter houses.

Key Words: Cattle, Hair whorl, Temperament

125   The welfare status of adult sows: A comparison of physiological and productive indicators in different housing conditions. G. A. Maria*[1] and M. C. Aceá[1], [1]*University of Zaragoza (Spain).*

Dry adult sows (n=96) were placed in three housing systems: an outdoor paddock (G1, n=33), indoor small group pens (G2, n=32), and neck tethered in partial stalls (G3, n=31) and were assessed using physiological and productive traits related to welfare status. Physiological traits included the plasma concentrations of cortisol (C) pig major acute phase protein (pig-MAP), haptoglobin (HAP), creatinine kinase (CK) and the polymorph:lymphocyte ratio (PM). Productive traits included age at first insemination (A), % of repeated inseminations (R), number of piglets born alive per sow per year (NA), number of piglet weaned per sow per year (NW) and a global cycle index (GC). Least squares analysis was used to evaluate the significance and magnitude of the fixed effect housing system (G1, G2 and G3) on productive and physiological traits. The NA for each group was 27.88 $\pm$ .90 (G1), 26.11 $\pm$ .85 (G2) and 26.06 $\pm$ .99 (G3) while NW was 22.08 $\pm$ .83 (G1), 23.65 $\pm$ .78 (G2) and 22.73 $\pm$ .87 (G3). No significant differences between groups were observed for the main productive traits, with the exception of A (G1:219 $\pm$3.6, G2:209 $\pm$3.4 and G3:208 $\pm$3.7) and R (G1:11.04 $\pm$2.3, G2:4.7 $\pm$2.2 and G3:8.4 $\pm$2.4). The housing system had a significant effect on all physiological traits analysed. C values (ng/ml) for each group were: 23 $\pm$2.5 (G1), 20 $\pm$2.4 (G2)and 33 $\pm$2.3 (G3). CK values (U/I) were: 2115 $\pm$615 (G1), 3137 $\pm$594 (G2) and 3286 $\pm$605 (G3). Mean plasma concentration (mg/ml) for HAP and pig-MAP for G1, G2 and G3, respectively, were: 1.99 $\pm$.09, 1.67 $\pm$.08 and 1.59 $\pm$1.7 (HAP), and 1.7 $\pm$.17, 1.29 $\pm$.16 and 1.31 $\pm$.16 (pig-MAP). The PM ratio for each group was 1.64 $\pm$.14 (G1), 1.54 $\pm$.13(G2) and 1.18 $\pm$.14 (G3). According to the results of C, CK and PM, the lowest welfare status was indoors but, following pig-MAP or HAP data, we find that welfare status was lower outdoors. On the other hand, according to the productive data, the three systems seem to provide good welfare situation. Correlation coefficients between productive and physiological welfare indicators were not significant.

Key Words: Pig, Welfare, Housing System

126   Behavioral and physiological responses to transportation stress in three genetic lines of pigs. C. S. Busse* and M. M. Shea-Moore, *USDA-ARS Livestock Behavior Research Unit.*

In pigs, there are genetic lines selected for rapid muscle growth (lean gain) that display elevated levels of fear and anxiety during handling. Producers are reporting handling problems with these pigs selected for lean gain. The objectives of this study were to determine if selected genetic lines of pigs respond differently to transportation stress. Using a randomized complete block design, market-weight pigs from three distinct genetic lines were used (high-lean-gain (HLG), n=14; moderate-lean-gain (MLG), n=11; low-lean-gain (LLG), n=12). Baseline salivary samples were collected for cortisol analysis two weeks prior to transportation. Pigs were mixed within each genetic line and loaded into one of three pens in a livestock trailer, with a maximum of 5 pigs/treatment/pen. Pigs were then transported for 2 h over a variety of road and speed conditions and videotaped for behavioral analysis during transport. This was repeated 3 times until all pigs from each genotype were tested. The frequency of aggressive behavior in different genetic lines of pigs was significantly different (X^2_s=6.063, $X^2_{.05(2)}$=5.991, P<.05). HLG pigs were more aggressive (17 occurrences) than LLG pigs (6 occurrences) (P<.05), although MLG pigs were no different from either LLG or HLG treatments. Salivary samples were collected post-transportation prior to unloading, and after unloading. The data were analyzed using a mixed model analysis and heterogeneous variances were corrected using a log transformation. As others have found, cortisol was significantly increased after transportation in all genotypes (P<.05). However, there were no differences among treatments. Physically moving pigs from the trailer to a holding pen in the abattoir significantly elevated (P<.0001) cortisol levels within all treatment groups. In conclusion, these results indicate that an animal's behavior, in addition to multiple physiological measurements is necessary to truly understand the whole animal response to transportation stress.

Key Words: Genotype, Aggression, Cortisol

127   The development of indices of welfare for beef cattle in feedlots. S. C. Wilson*[1], L. R. Fell[2], and D. P. Collins[2], [1]*Texas Tech University, Lubbock,* [2]*NSW Agriculture, N.S.W. Australia.*

This study was instigated to develop a set of welfare indices for beef cattle in the feedlot environment. Firstly, ethical frameworks for the study were examined then a model for assessing welfare was determined. In this model cattle were considered to have reduced welfare if they were under a significant state of distress which includes entering a pre-pathological state. This is characterized by physiological changes such as elevated hypothalamic-adrenal-axis (HPA) activity in conjunction with depressed immune function. Matched groups of cattle were placed in three environments: (1) pasture, (2) a feedlot with a stocking density of 12.0 m^2/head plus a firm dry feedlot pad and (3) a feedlot with a stocking density of 6.0 m^2/head and a wet and muddy feedlot pad. Two trials were conducted (N= 14/ treatment, 42 d duration). Behavioral observations (scan samples, 10 min intervals) were conducted on all treatments. Results showed that with regard to the HPA axis there was a higher (P <.05) relative adrenal mass in both feedlot groups (4.78 ± 0.15 and 4.76 ± 0.14 g/kg$_{bwt}$, mean ± SE for environments 2 and 3) compared to the pasture group (4.36 ± 0.11 g/kg$_{bwt}$). But out of 20 immune variables tested, only two: serum IgA, and the gamma delta T-lymphocyte WC1, showed decreased activity in the feedlot groups in comparison to the pasture group. It was concluded that although there may have been a potential disruption of epithelial/mucosal immunity this was still insufficient evidence to state that the total immune system was depressed and thus that pre-pathological states existed in the feedlot treatments. Behavioral observations were conducted primarily to ascertain if there are behavioral correlates to pre-pathological states. Ultimately this was not possible. However, the data provides information on pasture and feedlot cattle with regard to the following: frequencies and circadian patterns of agonistic and affiliative behaviors, spatial relationships, and time budgets and circadian patterns of lying, standing and feeding behaviors.

Key Words: Cattle, Pre-pathological States, Behavior

128   Altering feeding times for feedlot cattle reduced dust-generating behaviors. F. M. Mitloehner*[1], J. L. Morrow-Tesch[2], J. W. Dailey[2], and J. J. McGlone[1], [1]*Texas Tech University, Lubbock,* [2]*USDA-ARS, Lubbock, TX.*

The objective of this study was to reduce the dust generation in a commercial feedlot by understanding and managing dust-generating behaviors of feeder cattle. It was hypothesized, that through changes in feeding management practices, cattle activity patterns that result in high quantities of dust may be redirected towards feeding and ruminating behavior which generate significantly less dust. Treatments were either the (1) conventional feeding at sunrise, 10 AM and noon (CON) or (2) feeding at sunrise, noon, and just before sunset (ALT). A mobile behavior lab was used to observe and quantify behaviors (feeding, ruminating, locomotion, agonistic and bulling) of 1,123 crossbred steers in four pens at a commercial Texas feedlot. Dust data loggers (DustTrak, TSI, MN) measured particulate matter counts (particle size ≤2.5μm) each 15-min over the entire summer season (June-September 1998). Simultaneously, the ambient temperature, humidity, wind speed and direction, precipitation, air pressure and solar radiation were measured with a weather station (Gempler, Austria). Multiple linear stepwise regression analysis determined that weather parameters explained only 18% of the variation in dust levels (R^2 = 0.18, P<.001). High dust levels were observed around sunset. When cattle were ALT they were engaged in dust-generating behaviors 20.6% of the time compared to 69.0% in the control pens (P<.01). Unlike CON steers, steers fed at sunset ate, were waiting to eat or ruminated (8% vs. 32.6%, P<.01) during the sunset period. This change in behaviors had a positive effect on the dust levels. The EPA threshold for dust with a particle size ≤2.5μm is 0.065 mg/m^3. Over a period of 10 days, the 24-hr dust average in pens where cattle experienced ALT was 0.044 mg/m^3 vs. 0.61 mg/m^3 for CON. Changing the feeding regime of cattle to ALT redirected the cattle away from dust-generating behaviors thereby reducing aerial dust concentrations below EPA allowable limits.

Key Words: Cattle, Behavior, Dust

129   Effects of water misting and shade on heat stress in feedlot cattle. F. M. Mitloehner*[1], J. L. Morrow-Tesch[2], J. W. Dailey[2], and J. J. McGlone[1], [1]*Texas Tech University, Lubbock,* [2]*USDA-ARS, Lubbock.*

A total of 32 Charolais cross feeder cattle were used to assess the impact of heat stress on behavior, physiology, and production during late summer 1998. The objective was to determine the effects of the provision of shade and (or) water misting to minimize heat stress. For behavior measures the model was a split split plot. Treatments were: (1) shade and misting (SHMI), (2) only shade (SHAD), (3) only misting (MIST), and (4) no shading or misting (CONT). Two heifers were housed per pen. Maximum ambient temperature during late August was 32±4°C and humidity 62±8%. Behavior was continuously video recorded over 3d. Walking, standing, lying, feeding, drinking (main plot) and the location where these behaviors were performed (shaded or misted area) were measured and analyzed on a daily and hourly basis. Rectal temperatures, respiration rates as well as average daily gain were measured. Heifers in CONT spent more time lying down than the treated animals (SHMI=4.04±.24, SHAD=3.53±.24, MIST=3.68±.24, CONT= 4.98±.29, P<.01). Cattle in CONT (1.37±.37) spent less time (P<.01) standing than SHAD (3.15±.31) and MIST (2.68±.31) cattle. Standing behavior in SHMI (2.27±.31) was not different from SHAD or MIST. Misting lowered (P<.001) rectal temperature and misting and shade combined showed an additive effect of lowering respiratory rates in heifers (SHMI=30.0±3.3, SHAD=33.0±2.8, MIST=37.3±.3.2, CONT=46.7±3.3, P<.05). Average daily gains between the four treatments did not differ significantly. The guide for the care and use of agricultural animals in research and teaching identifies a requirement for cooling of beef cattle during heat. Our results indicate that cattle without shade or misting have a physiological stress response to heat (increased RR and rectal temperature) and alter their behavior as a result. MIST and SHAD appear to be equivalent solutions to reducing heat stress and their effects are largely additive.

Key Words: Cattle, Heat Stress, Shade

130   Shade-seeking behavior of cow-calf pairs in a moderate climate. T. M. Widowski*[1], [1]*Department of Animal & Poultry Science, University of Guelph, Ontario Canada.*

In moderate climates, there is some concern that the benefits of providing beef cattle shade on pasture may not outweigh the associated costs. Congregating in shade can result in manure accumulation and reduced pasture fertility. There is also a perception among some producers that providing shade may reduce the time that cattle spend grazing. The objectives of this study were to compare the activities and locations of cattle provided Shade (S) and No Shade (NS) in the climatic conditions of southern Ontario. Three beef cow-calf pairs were held on each of 12 fields (N=72). Each field was divided into 8 rotationally grazed paddocks with a central lane-way leading to a water trough. On half of the fields, a structure providing 80% shade was located in the lane-way. Cattle were observed during 6-h periods (distributed between 0800 and 1700 H) on each of 24 days from May-July 1998. At 10-min intervals, the numbers of cows and calves in shade, near the structure but not in shade, near the water trough, out on pasture (but not grazing) and grazing were recorded. During observation periods, means and (ranges) were 26.5°C (16.8-40.7°C) for air temperature, 59.2% (25.6-91.4%) for relative humidity, and 35.3°C (24.1-49.9°C) for black globe temperature. Overall, S cows spent (mean±SEM) 18.0±1.4% of time in shade. Cows without shade spent more time at the water trough (NS 19.8±1.6% vs S 13.2±1.0%, P≤.05) and more time on pasture (NS 36.8±1.3% vs S 23.0±1.3%, P≤.05). Time spent grazing was the same for both treatments (NS 43.2±1.0% vs S 42.6±1.0%, P≥.10). Calf behavior was similar to that of cows except that calves spent more time near the structure (10.1±1.0%) and less time grazing (16.8±0.9%). Black globe humidity index significantly affected time spent in shade (P≤.05) and time spent at the water trough (P≤.05). These data indicate that cattle without shade spend significantly more time congregating at the water trough on hot days. Although cattle with shade spend less time on pasture overall, this does not result in reduced grazing time.

Key Words: Shade, Cattle, Behavior

131 Reducing negative effects of weaning on behavior and growth in beef calves. J. E. Harris* and E. O. Price, .

One-hundred Angus/Hereford-cross calves were randomly assigned to five treatments to determine the effect of different weaning techniques on the behavior and subsequent growth of beef calves. These treatments were: 1) fenceline separation from dams - on pasture; 2) total separation from dams - on pasture; 3) total separation from dams - feedlot for one week - preconditioned to hay; 4) total separation from dams - feedlot for one week - not preconditioned to hay; 5) non-weaned controls - on pasture. Calves totally separated from dams on pasture were more active (walking) than calves in the other four treatments (P<0.05) and spent less time grazing than the other calves on pasture (P<0.05) in the three days following weaning. Totally separated calves on pasture vocalized at more than twice the rate of fenceline calves on the day of weaning. Fenceline calves were more active than non-weaned control calves (P<0.05) but did not differ in time spent grazing. For the first two days after weaning, calves in the fenceline treatment spent the majority of their time within 3 meters of the fence separating them from their dams. Thereafter, they were found at greater distances (P<0.001). Cumulative post-weaning weight gains for calves in the fenceline contact treatment were similar to weight gains of the non-weaned control calves for the first three weeks after weaning. Calves in the fenceline treatment exhibited greater cumulative weight gains than totally separated calves for four weeks after weaning (P<0.05). At the conclusion of the study (10 wks) the cumulative weight gain of the fenceline calves continued to be greater than that of the non-preconditioned feedlot calves (P<0.05). Other weaned treatments did not differ. It was concluded that providing fenceline contact between beef calves and cows at weaning reduces the negative effects of weaning on calf behavior and growth rate.

Key Words: Beef Calves, Weaning, Cattle Behavior

132 Aversion learning techniques to evaluate dairy cow handling practices. E. A. Pajor*[1], J. Rushen[2], and A. M. de Passillé[2], [1]*Department of Animal Sciences, Purdue University, West Lafayette, IN,* [2]*Agriculture and Agri-Food Canada, Lennoxville, Canada.*

Fear of humans is a major source of stress for cows and can have a negative effect on milk production. Much of the cows' fear is thought to result from certain forms of handling which are aversive. The objective of our research was to determine if an aversion corridor could be used to determine which handling practices dairy cattle find most aversive. In an aversion corridor experiment the animal must learn the relationship between walking down the corridor and the treatment received at the end of the corridor. If the treatment is aversive the animal is expected to take more time and require more force to reach the end of the corridor than if the treatment was neutral or positive. In the first experiment, 54 cows were randomly assigned to 4 different treatments (hit/shout, brushing, control, and food). Cows were walked down a corridor and treatments applied when they reached the end. Treatments (2 min in duration), were applied 12 times, 3 times a day over 4 d. The time and force required for cows to walk down the corridor were measured. Cows on the hit/shout treatment took more time and required more force to walk through the race than cows on the other treatments (all comparisons, P < 0.001). In addition, brushed cows took longer to move through the race then cows given food (P < 0.05). In a second corridor experiment, 60 cows were randomly assigned to 5 different treatments (electric prod, shouting, hitting, tail twist, and control). Treatments (1 min in duration), were applied 9 times, 3 times a day over 3 d. Cows on the shout and electric prod treatments took more time and required more force to walk down the corridor then cows on the control treatment (all comparisons, P< 0.05). Aversion learning techniques show promise as an effective method to determine what handling practices cows find most aversive.

Key Words: Cow, Handling, Learning

133 Sensitivity to sudden intermittent sounds and movements is related to excitability in cattle. J. L. Lanier*, T. Grandin, R. D. Green, D. Avery, and K. McGee, *Colorado State University.*

Casual observations indicated that some cattle are sensitive to sudden movement or intermittent sound. Six commercial livestock auctions in

two states and 1,636 cattle were observed, to assess the relationship between breed, gender, and temperament score, on the response to sudden intermittent visual, touch, and sound stimuli. A four point ring score was used to score each animal while it was in the ring. The scores used were 1. Stands still or walks, no head, tail or ear movement, head in non-alert position. 2. Walks, some head, tail or ear movement, alert head position. 3. Runs, displays aggression, erratic head, tail and ear movement, alert head position. 4. Hits fence, people or partitions. Animals were observed for flinches, startle responses or orientation towards sudden intermittent sounds, motions, and tactile stimulation such as being touched with a cane or plastic paddle. The cattle observed were mostly Bos taurus beef breeds, and Holstein dairy cattle. Holsteins were more sound sensitive (p=.02) and touch sensitive (p<.01) than beef cattle. Sensitivity to sudden intermittent stimuli increased as ring score (excitability) increased. Cattle with a ring score of one were the least sensitive to sudden intermittent movement and sound, while those with a ring score of four were the most sensitive (p<.01). This same relationship was observed for touch stimuli, but was not statistically significant. Motion sensitive cattle were more likely to score a temperament rating of three or four than non-sensitive cattle (p<.01). Steers and heifers were more motion sensitive than the older bulls and cows (p=.03). Beef cattle urinated (p<.01) and defecated (p<.01) more often in the ring than did dairy cattle. Reactivity to sudden intermittent stimuli may be an indicator of an excitable temperament.

Key Words: Cattle, Temperament, Start response

134 Effect of animal density and trough placement on drinking behavior and dehydration in slaughter horses. A. E. Gibbs*[1] and T. H. Friend[1], [1]*Texas A & M University, College Station, TX/USA.*

The effects of density of horses and trough placement on latency to drink and the amount of time spent drinking water on-board a semi-trailer were determined. Three experiments using 19, 20, and 24 slaughter-type horses, ranging in body condition scores from 2 to 6, were conducted in hot weather. The horses were deprived of access to feed and water for 4 h prior to and for 8 h during transportation. Transport in a commercial 16-m long, single-deck, open-topped semi-trailer commenced at 1200 h and lasted until 2000 h, followed by a 1 h watering period. In Exp. 1 and 2, the trailer was divided into four 2.4 x 3.6 m compartments into each of which two steel water troughs (25 x 90 cm)were hooked on the inside of the trailer during the watering period. Each compartment contained 4 to 6 horses. The troughs were placed along one side of the trailer in Exp. 1 and placed on opposite corners of each compartment in Exp. 2. In Exp. 3, the trailer was divided into two 2.4 x 7.2 m compartments each containing 12 horses. Two troughs were staggered on the opposite walls of each compartment (four troughs per compartment). Three of the 19 horses were blocked from drinking in Exp. 1, 5 of the 20 horses were blocked from drinking in Exp. 2, and all of the horses drank in Exp. 3. All horses that drank took their first drink within 15 min of water entering the troughs in Exp. 1 and 2 and within 25 min for Exp. 3. Total serum protein, Na, and Cl were not significantly different between Exp. 1 and 2 (P>.52) or between densities (P>.16). Total serum protein and electrolytes indicated that the horses that did drink were not dehydrated following the water period. The larger compartment (2.4 x 7.2 m) and group size (12 horses) used in Exp. 3 provided adequate maneuvering room so that all of the horses could get access to the water when the water troughs were placed on both sides of a compartment at the rate of 0.8 m of trough per 2.4 m of wall.

Key Words: Horse, Transportation, Dehydration

135 Effects of density on displacement, falls, injuries, and orientation during horse transportation. M. N. Collins*, F. D. Jousan, S. C. Chen, and T. H. Friend, *Texas A & M University, College Station, Texas/USA.*

Three groups of slaughter-type horses, totaling 30 mares and 29 geldings, were used to determine density effects on displacement (distance moved during a stop), falls, injuries, and orientation using a single-deck, open-topped commercial semi-trailer. Each horse was assigned to one of two treatments: high density (1.28 m[2] per horse with 14 horses) or low density (2.23 m[2] per horse with 8 horses). Both treatments occurred sequentially on the same day (treatment order was alternated each trial), using the middle 2.44 x 7.32 m compartment of a large semitractor trailer. The horses were transported for two laps around a 7.28

km course, averaging 25 min and 36 sec $\pm$ 89 sec. Each lap consisted of two $60°$ turns, four $90°$ turns, two $120°$ turns, one $180°$ turn, 6 hard brakes, and 6 rapid accelerations. Displacement, falls, and orientation were recorded for each horse using overhead video cameras. Average displacement between the two densities was not different (P=.47). The average number of horses that fell in the high density treatment (5.67) was greater than the low density treatment (1.33), P<.05. The average number of horses with injuries was greater in the high density (9) than the low density (2.3) treatment, P<.01. The average severity score for injuries for the high density horses was 1.77 and for the low density horses was .92. There was not a difference between the average percentage of time spent facing forward (15.74%) and facing backward (13.80%) for all horses, P=.38. The average percentage of time spent facing forwards and backwards did not differ between the high and low densities (P>.80). High stocking density did not affect time spent in various orientations but did increase the incidence of falls and injuries.

Key Words: Transportation, Horse, Density

136   Artificial selection for sexual performance in rams. C. J. Bench*, E. O. Price, M. R. Dally, and R. E. Borgwardt, *University of California, Davis*.

Ninety-two ram lambs born either to sires selected for high or low sexual performance were evaluated for their sexual behaviors at 8 mo of age when individually exposed in 5 x 5 m pens to four estrous ewes for 30 minutes in four weekly tests. Different ewes were used each week. Number of mounts and successful matings were recorded. Fourteen of 17 high performing ram lambs were sired by high-performing sires whereas 22 of 37 low performing ram lambs were sired by low-performing sires. These proportions were significantly different (P<0.01). Sons of high performing sires exhibited more ejaculations than sons of low performing sires in 30-min test sessions (mean +/- SE = 3.27 +/- 0.17 and 2.82 +/- 0.13, respectively; P<0.04). Likewise, sons of high performing sires exhibited more mounts without ejaculation than sons of low performing sires (15.44 +/- 1.7 and 10.42 +/- 0.95, respectively; P<0.02). Groups did not differ in efficiency (mounts per ejaculation). It was concluded that a significant response to artificial selection for sexual performance in rams can be attained in a single generation.

Key Words: Rams, Sexual performance, Selection

137   Evaluation of aggression, antler growth and testis function in yearling Fallow bucks with zeranol implants or GnRH immunization. S. M. Webb*[1], D. A. Neuendorff[1], A. W. Lewis[1], T. E. Adams[2], and R. D. Randel[1], [1]*Texas Agricultural Experiment Station, Overton*, [2]*University of California, Davis*.

The objective was to examine alternative methods to alter the behavior of yearling market Fallow bucks. Harvest season for the Fallow deer producer coincides with the Fall breeding season. The Fallow bucks become very aggressive during rut, causing considerable bruising, death, and injuries to each other, as well as posing a threat to handlers. Seventeen yearling fallow bucks (BW=26.93±5.2 kg) were randomly assigned to three treatment groups: control (C; n=6), immunized (I; n=6), and zeranol (Z; n=5). The I bucks received 1 mg of GnRH-KLH (keyhole limpet hemocyanin) emulsified in equal volumes of saline and Freund's complete adjuvant on d 1. A secondary (booster) immunization of 0.5 mg of emulsified GnRH-KLH was administered on d 175. The Z bucks were implanted with 12 mg zeranol on days 1, 112, and 224. Body weights were recorded and blood samples taken on d 1 and at 28 d intervals. Antler length and weight were recorded and hard antlers removed on Aug. 13 (d 204). Aggression was evaluated within treatment for head bunts, head pushes, fights, and avoidance during 10-minute video observation sessions. As previously reported, body weights and ADG were not affected (P>.10) by treatment and antler length and weight were reduced (P<.001) in Z. Plasma testosterone was lower during the early rut (P<.08), mid rut (P<.01) and higher at the end of the rut (P<.04) for the I group compared with C and Z. Plasma testosterone was affected by treatment (P<.05), day (P<.01), and a treatment by day interaction (P<.04). Aggression and plasma testosterone were correlated in the I group when looking at head bunts (P<.01;r^2=.99), head pushes (P<.03;r^2=.88), and fights (P<.04;r^2=.83), but were not correlated in C and Z. As previously reported, scrotal circumference (P<.02),testicle length and width measurements (P<.05) and paired testes volume (P<.01) were reduced in I compared with C and Z. The

use of zeranol suppressed antler development and early aggression, while GnRH immunization dramatically suppressed testicular development and aggression in 50% of the treated animals.

Key Words: GnRH Immunization, Zeranol, Fallow Deer

138   Segregated early weaning affects behavior and adrenal responses in pigs. Y. Yuan*, D. Charles, M. Tauchi, and A. J. Zanella, *Michigan State University, East Lasing, MI*.

Segregated early weaning (SEW) system which consists of early maternal separation and transportation of the newly weaned piglets to a separate site has been widely adopted in North America. Behavioral and adrenal responses were monitored in SEW and control pigs in two studies. Pigs were weaned between 9 and 13 d of age (SEW1, n=23), or kept with the sows (control, n=24). Behavior was observed on the weaning day (d 0), and on d 1, 2 and 3 post-weaning (PW). Urine samples were collected pre-weaning and on d 1, 3 and 5 PW. Pigs were weaned between 9 and 12 d of age (SEW2, n=24) or between 20 and 23 d of age (CW, n=23), and were videoed daily for a week PW, then weekly up to 8 weeks of age. Pigs were mixed and transported for 20 min at 10 weeks of age. Pre and post-transportation saliva samples were collected. The outcome and duration of fights were recorded for 3 d after mixing. Cortisol was measured using RIA. Data were analyzed using ANOVA and contingency table. Results are expressed as mean±SE. SEW1 pigs showed higher levels of vocalization (freq/min, P<0.01) than control pigs on d 0 (1.83±0.58 vs. 0±0.57) and 1 (7.44±0.58 vs. 0±0.57) PW. They spent less time lying on d 1 AM than control pigs (% of time, 20.46±5.50 vs. 53.96±5.38, P<0.01). Urinary cortisol/creatinine ratio (nmol/mmol) was higher (P<0.02) on d 1 (221.45±14.87 vs. 74.05±16.43) and 3 (102.43±14.87 vs. 71.62±12.73) PW in SEW1 pigs than in control animals. SEW2 pigs showed a higher frequency of belly-nosing (freq/hour, P<0.04) than CW pigs in both weeks 5 (2.37±0.23 vs.1.56±0.24) and 7 (1.91±0.23 vs. 1.23±0.24) of age. Transportation caused a 7-fold increase in salivary cortisol, but there were no differences between treatments. SEW2 pigs showed higher proportion of fights with no clear outcome (n=821, 44.57% vs. 32.18%, P<0.04) and tended to fight longer than CW pigs (sec, 34.17±4.98 vs. 22.98±6.44, P<0.08). The increased vocalization rate, performance of belly-nosing, and sustained high levels of urinary cortisol in SEW piglets demonstrates that the procedure is stressful. Our data also indicated that SEW compromise the ability of piglets to establish a stable social hierarchy later in life.

Key Words: Segregated Early Weaning, Behavior, Cortisol

139   Impact of environmental temperature on the neonatal pig's response to an endotoxin challenge. J. A. Carroll*[1], R. L. Matteri[1], C. J. Dyer[1], L. A. Beausang[2], and M. E. Zannelli[2], [1]*Agricultural Research Service - USDA, University of Missouri, Columbia 65211*, [2]*Endogen, Inc., Woburn, MA 01801*.

Our objective was to evaluate possible interactions between environmental temperature (ET) and the neonatal pig's ability to cope with an endotoxin challenge. Twenty-eight male pigs (24 hr old) were placed in environmentally controlled chambers maintained at $18°C$ or $34°C$ (n=14/ET). Rectal temperatures (RT) were measured at 15 min intervals for a 3-hr period following an i.p. injection of saline (Cont; n=7/ET) or lipopolysacchride (LPS; 150 ug/kg; n=7/ET). All pigs were humanely sacrificed following the 3-hr challenge period for tissue and blood collection. There was a TIME X ET X TRT interaction (P≤ .0001) for RT such that LPS pigs exposed to $18°C$ experienced a period of hypothermia while RT for LPS pigs at $34°C$ did not differ from that of Cont pigs at $34°C$. There was also an ET X TRT interaction (P= .014) for body weight (BWT) change such that LPS pigs maintained at $18°C$ lost the most BWT during the 3-hr period. At sacrifice, serum concentration of ACTH tended to be greater (P= .094) in pigs maintained at $18°C$, but was not affected by LPS treatment (P≥ .89). However, there was an ET X TRT interaction (P= .0013) for serum cortisol (CS) such that LPS pigs maintained at $18°C$ had a greater increase in serum CS at sacrifice as compared to LPS pigs at $34°C$. Serum concentration of prolactin (PRL) was reduced (P≤ .017) in pigs maintained at $18°C$ as compared to pigs maintained at $34°C$, however there was no effect (P≥ .14) of LPS on serum PRL. There tended (P≤ .098) to be an ET X TRT interaction such that LPS increased serum PRL at $18°C$ but had no effect on serum PRL at $34°C$. There was an ET X TRT interaction (P≤ .016) for serum tumor-necrosis factor alpha (TNF) such that LPS increased serum TNF at sacrifice in pigs maintained at $18°C$, but had no effect on serum TNF

in pigs maintained at 34°C. These results provide evidence that acute exposure to a cold ET can significantly compromise a neonatal pig's ability to cope with an endotoxin challenge, and suggest a possible role for PRL in the neonatal pig's immune response.

Key Words: Neonatal Pig, Tumor-Necrosis Factor Alpha, Environmental Temperature

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140   Behavior and environmental impact of outdoor gestating sows: effect of cold weather and grass burning. H. A. Rachuonyo*[1], J. L. Morrow-Tesch[2], J. G. Gentry[1], D. L. Anderson[1], S. C. Wilson[1], J. W. Dailey[2], H. T. Bird[1], and J. J. McGlone[1], [1]*Texas Tech University,* [2]*USDA-ARS, Lubbock, TX.*

The objectives of this study were to evaluate relationships among behavior of outdoor-kept PIC sows, changes in soil nutrients and percent ground cover and to determine if burning a pasture (Old World bluestem) prior to occupation has any effects on these relationships. Seven pregnant sows were assigned at random to one of four replicated paddocks (1 acre each) per treatment (control or burned). Behavior (rooting, wallowing, standing, lying down) of each sow was recorded at 10-minute intervals for a 24 h period (averaged for each hour) on a cold (mean of -5.3°C) and warmer (mean of 4.6°C) day. Soil samples were collected with a soil auger at a 0 to 15 cm depth on days 0 and 30 of the trial. Soil samples were extracted and assayed for nitrate by spectrophotometer. Ground cover was estimated visually on day 0, 30 and 60. Behavior measures were analyzed as a split-split plot over days and hours within days. Ground cover data and soil nitrate levels were analyzed as a split plot with two treatments, three areas (hub, middle and outside) within each paddock and two sample times (0 and 30 days). More sows (P<.05) spent time rooting on the cold than on the warmer day. On the warmer day, wallowing activity was greater (P<.05) than on cold. Other behaviors were not different between day nor between treatments. Ground cover decreased (P<.05) over time (0.1 - 0.27% per day) but was not different between burned and grass paddocks. Rooting hole numbers (0.18 per day) and sizes (55 cm^2 per day) increased (P<.05) with time but did not differ between treatments. Soil nitrate levels were lower (P<.05) for grass than burned paddocks but were not different among areas or over time. These results indicate how long it might take a given number of sows to alter ground cover, how sow behavior changes with weather conditions and that burning increases soil nitrate levels.

Key Words: Pig, Behavior, Soil

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141   Behavior and performance of lactating Newsham sows and piglets reared indoors or outdoors. A. K. Johnson*[1], J. L. Morrow-Tesch[2], S. C. Wilson[1], H. Rachuonyo[1], J. G. Gentry[1], and J. J. McGlone[1], [1]*Pork Industry Institute, Texas Tech University, Lubbock,* [2]*USDA-ARS, Lubbock, TX.*

A total of 125 lactating sows and their litters were used to determine the effects of intensive indoor and intensive outdoor production systems on sow and litter productivity and behavior. All sows were Newsham genotypes of contemporary age and fed a completely balanced corn-soy diet. Outdoor sows were heavier at farrowing (212.9±.75 and 204.7±.81kg) and lighter at weaning (164.7±3.4 and 171.1±2.15kg) than indoor sows (P<.05). Outdoor sows lost more (P<.05) weight during lactation than indoor sows (32.9±.8 and 28.3±.9kg). While weaning weight per piglet and numbers weaned per litter were similar between environments, outdoor sows weaned litters with a lighter (P<.05) total litter weaning weight than indoor sows (49.4±1.2 and 56.3±1.3kg). Behavior data were collected by live observation on 30 sows and litters, using a 5-min scan sample over a 4-h period in the afternoon (1400 to 1800 h). Outdoor lactating sows (n=16) were more (P<.01) active than indoor (n=14) lactating sows (30.6±3.6 and 11.5±4.0% of time observed). Outdoor sows spent less (P<.01) time drinking than indoor-housed sows (1.0±.5 and 4.9±.6% of time observed). Outdoor sows spent less (P<.05) time nursing than indoor sows (28.8±3.4 and 42.6±3.8% of time observed). The interval between nursing bouts was higher (P=.01) for outdoor sows than for indoor sows (42.6±1.9 and 32.8±2.2 min). The variation in nursing interval (nursing interval standard deviation) was greater (P<.05) for outdoor litters than for indoor litters (12.7±1.3 and 5.2±1.5 min). Piglets spent less time lying when housed outdoors than indoors (60.2±2.5 and 72.8±2.8%). Outdoor piglets also spent more (P<.01) time not in contact with the sow

than indoor piglets (63±3.7 and 39.2±4.1%). In conclusion, outdoor-kept Newsham sows lost more weight during lactation, weaned lighter litters, and both sow and piglets were more active and nursed in a less synchronized manner than indoor-housed sows.

Key Words: Pigs, Behavior, Housing-system

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142   Dust and microbe levels from indoor and outdoor pig units. J. L. Morrow-Tesch*[1], F. M. Mitloehner[2], J. W. Dailey[1], S. C. Wilson[2], and J. J. McGlone[2], [1]*USDA-ARS, Lubbock, TX,* [2]*Texas Tech University, Lubbock, TX.*

The EPA clean air act sets specific levels of acceptability for particulate matter (PM) in the air, at PM 2.5 μm that level is .065 mg/m^3. Objectives of this study were to measure dust levels and microbiological contaminants on dust from pig units. A wheat field and a building at Texas Tech University were controls. Treatment sites were an indoor and outdoor gestation unit, and an indoor and outdoor farrowing unit. Dust was measured for two 24 hr periods at each site using dust meters (Dust Trak, TSI, MN). Bacterial and fungal counts were determined by taking 5 min samples with a six-stage Anderson Sampler (Anderson, GA). Plates containing media favorable to either bacterial or fungal growth were incubated 48 hr and colonies were counted. The experiment was a repeated measure design. Dust levels were higher (P < .001) on d 2 except in the indoor farrowing unit. Dust levels at the gestation units also increased (P < .001) on d 2 but were similar (P > .05) between indoor and outdoor units (mean indoor .006 vs .049, and outdoor .004 vs .052, SE = .0007, mg/m^3 for d 1 and 2). The outdoor farrowing pasture had a higher (P < .001) number of fungal colonies compared to all other environments (mean = 122.6, SE = 6.19 total counts). Most fungi were at stages 3 through 6 corresponding to PM between 3.3 and .65 μm. Total bacterial counts did not differ (P > .05) among environments. During d 2 several sites (indoor farrowing, indoor and outdoor gestation) sampled approached the EPA limit (at PM 2.5 μm) for dust, including both the control sites. The outdoor farrowing pastures had the lowest dust levels for both days. Fungi are known allergens and have potential to be carried into the respiratory tract of both animals and humans on dust particles, especially at PM 4 μm or less. Our results indicate that methods of reducing particulate matter on certain days are needed in west Texas to enhance animal and worker health and well-being within indoor and outdoor pig production units.

Key Words: Swine, Well-being, Health

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143   Pork quality of hogs finished on slats and deep-bedding. J. G. Gentry*, M. F. Miller, and J. J. McGlone, *Texas Tech University, Lubbock, TX.*

Current swine production practices often have a negative impact on consumer perception. Pork products from hogs raised under a sustainable environment may be more desirable to consumers than products from hogs raised in confinement. A group of hogs finished on deep-bedding (n=1765 pigs from 11 truckloads) were compared to a group of hogs finished on slatted flooring (n=1053 pigs from 8 truckloads) for carcass characteristics and meat quality. From these two groups, forty pork loins were purchased and evaluated on the following measures: Warner-Bratzler shear force (WBS), sensory taste panel scores, percent fat and percent moisture. Taste panel scores ranged from 1-8 for all categories except off-flavor (1= least desirable and 8= most desirable). Off-flavor scores range from 1 to 5 (1= no off-flavor and 5= extreme off-flavor). Least-squares means for yard dead (number of head per truckload) were 0.87 for the slatted group and 0.002 for the deep-bedded group (P<.05). In addition, carcasses from the deep-bedded group had a trim loss (percentage trim events per truckload of pigs) of 5.8% compared to 14.9% for the group finished on slats. WBS values (kg) were 3.64 and 2.94 for the hogs finished on slats and deep-bedding, respectively (P<.001). Deep-bedded hogs had higher taste panel scores for tenderness, juiciness, flavor intensity and overall mouthfeel. No significant differences were found in percent fat, percent moisture, off-flavor and pork flavor. Pork from hogs finished on deep-bedding was more tender, more juicy and more flavorful. These preliminary results indicate that hogs finished on deep-bedding had an advantage in pork quality and had less trim loss. However, since these hogs were not slaughtered on the same day, a plant/day effect may exist. Further studies are needed to clarify and extend these findings.

Key Words: Pork Quality, Housing Systems, Animal Welfare

144   Geographic distribution and economic impact of equine infectious anemia in Louisiana. M. Murphey*[1], G. Kennedy[1], and W. Green[1], [1]*Louisiana Tech University.*

Equine infectious anemia (EIA) is a viral, contagious disease of horses, mules, and donkeys. Prevention or control of the disease is by testing, quarantine, and destruction of infected animals. Louisiana has historically reported a high incidence of infected animals. Data of infected animal was collected with cooperation from the Louisiana Department of Agriculture and Forestry from the Equine Infectious Anemia Test Program. Data collected included animals tested from January 1994 through June 1998. Location was verified for 673 of the 735 infected animals. In order to determine an estimated economic impact a detailed survey was sent to owners of infected animals between January 1, 1995 and June 30, 1998. The survey requested information related to the use of the animal, method of disposal and an estimated dollar value of each animal pre and post infection. Results indicated that a majority of the infected animals were horses (93%) and that infections tended to be geographic in nature with the highest incidences being in mares and geldings and along the coastal regions of Louisiana. It was further discovered that the estimated impact of EIA to the Louisiana Agriculture Industry was approximately 5.7 million dollars between January 1995 and June 1998.

Key Words: Equine, Louisiana, Economics

145   Survey of consumption and attitude for goat products. A. C. Murry*[1], S. Turner[1], M. Nelson[2], and S. Gelaye[2], [1]*The University of Georgia,* [2]*Fort Valley State University.*

The demand for goat products or goat services has increased over the last decade. The various products produced from goats, which include meat, milk and fiber are crucial to the growth of the goat industry. Investigation into the demand for these and other products is necessary in order to develop marketing strategies to expand demand. The purpose of this study was to investigate socioeconomic variables that can be used by marketers of various goat products to segment their markets. Demographic and socioeconomic variables were hypothesized to influence and explain goat product purchases and attitudes. The independent variables used in this study were age, gender, income, education, and race. The dependent variables used were consumption or use of any goat product, consumption or use of goat milk, and attitude toward goat products. A random telephone survey of Georgia residents was conducted in the fall of 1997 by the Survey Research Center at The University of Georgia. Of the 402 Georgia residents surveyed, 151 had consumed or used goat products, and of those 151, 63 had consumed or used goat milk. For goat product consumption, gender, education, and race were influential variables, however, only education was significant (P< 0.10). Caucasian women with higher education levels were more likely to have consumed or used goat products. For goat milk consumption, the only identifying segment variable was education, with higher education levels being a negative influence. Also, attitude towards using goat products was influenced by age, gender, and education levels, with positive attitude more likely for older women with higher education levels. The percentage of positive attitudes towards using goat products was 31.0%. Positive attitudes were more likely from lower income, more educated persons. Results indicate that goat products consumption in general were influenced only by education levels and positive attitudes towards goat products were more likely for older women with higher education levels.

Key Words: Goat Products, Attitudes, Consumption

146   Exposing and evaluating pork producers acceptance to distance education medias. S DeCamp*[1], B Richert[1], W Singleton[1], N Vines[1], and G Slipher[2], [1]*Purdue University, West Lafayette, IN,* [2]*Indiana Pork Producers Association, Indianapolis, IN.*

A booth was developed by Purdue University and the Indiana Pork Producers Association for the 1999 Indiana Pork Conference to introduce pork producers to a variety of distance educational medias. The booth provided producers a hands-on interaction with eight different media types on display, which included: CD-ROM (CD), self-study manuals (SSM), video (V), multi-media kits (MMK), video conferencing (VC), chat rooms (CHAT), e-mail (EM), and the World Wide Web (WWW). A survey was developed to help determine producer's previous use of distance education and what they will try as a result of further exposure to different distance educational medias. After producers explored the booth they had the opportunity to enter a drawing by completing the 11 question survey, 38 surveys were collected. Chi-square analysis and Cochran-Mantel-Haenszel statistics were used to determine associations and differences. The greatest amount of previous exposure was with video compared to the other medias (p<.05). After exposure, producers were willing to try a majority of the medias except CHAT and MMK (p<.06; p<.004, respectively). Producers previously exposed to one type of media are more likely to try different media (eg. previously used EM will try WWW; p<.01). Producers exposed to a media are more willing to continue to try that media in future situations (p<.04). Producers feel that their questions will be answered adequately by distance education (p<.001). However, live face-to-face with Purdue University Specialists was the preferred way to receive educational training over distance education (p<.001). Producers also indicated that distance education will be the future mode for information access (p<.001). These results display a justification for using distance education in extension programming and indicate that while distance education is not the preferred delivery method, it is an acceptable form of information transfer.

Key Words: Distance education, Pigs, Extension

147   Effective use of educational fair exhibits to increase the agricultural literacy of the general public. M. J. Wylie*[1], R. Schwinn[2], and D. A. Cashman[3], [1]*University of Wisconsin - Madison,* [2]*Maryland Cooperative Extension,* [3]*Maryland State Fair.*

The general public is becoming less and less familiar with agriculture. Fairs attract a large percentage of the general population and are excellent sites for educational exhibits. An interactive exhibit can not only increase agricultural literacy, it can also serve to educate the people staffing the exhibit as to the perceptions of the general public regarding animals and agriculture in general. Today's society is a sound byte world and traditional methods of catching people's attention and educating them are often no longer effective. The fair-going public is a moving audience that is being bombarded with advertisements and information throughout their fair experience. An educational exhibit needs to be focused, easy to view, have a clear message, and offer more detailed resources if the public desires them. Teacher packets are an excellent supplement and prove to be extremely popular. They can also be followed up with an evaluation instrument to determine if and how educational material was utilized. Themes can create a fresh exhibit each year to attract previous fair-goers. Attention-getting and educational exhibit materials will be displayed in this poster presentation. Examples from the New York State Fair and the Maryland State Fair will be used. If distributing information, it is important to provide quality educational information with proper credits. A balance between cute and straight information needs to exist. Hands-on experiences offer the most impact. Creating an effective educational exhibit takes some planning time, but the benefits are well worth the effort.

Key Words: Agricultural Literacy, Fair Education, Animal Exhibits

148   The Virginia cow-calf management course: teaching basic beef production to producers by a diverse combination of media. J. B. Hall*, B. R. McKinnon, S. P. Greiner, and W. D. Whittier, *Virginia Tech, Blacksburg, VA.*

Producers often lack the basic knowledge or skills to adopt traditional as well as new technologies. We developed the Virginia Cow-Calf Management Course that combined at-home learning with hands-on workshops. The objective of this course was to improve production practices of beginning to mid-level producers. The course was offered from October to March including 5 all-day workshops. Workshops were held simultaneously in 4 locations. Participants recieved written materials about 2 wk before each workshop and had access to materials via the internet. Producers could interact with one another and instructors through an on-line discussion group. Producers were surveyed at the beginning and end of the class to characterize initial knowledge and assess changes as a result of the course. Producers (n=191) from 35 VA counties and 3 other states enrolled. Participants averaged 46.7 ± 1.2 yr of age with 11.8 ± 1.3 yr cattle experience. Most producers (61%) had off-farm jobs. Average farm size was 150-200 acres with 50-99 cows. Initially,

only 35% of producers body condition scored (BCS) cows, and few (27%) grouped cattle by nutritional needs. Average calving season was 90-120 d with only 14% of the calves from AI. Breeding soundness exams were performed on 44% of operations. By the end of the course, some basic practices had improved. Most producers (85%) used BCS and improved herd nutrition (55.9%). Other improvements included use of EPD, renovated working facilities and enhanced reproductive management. Producer ratings (1=poor; 5=excellent) averaged 4.9, 4.8 and 4.7 for overall course, written materials and hands-on workshops, respectively. Questions and answers (n=71) were posted on-line with each read an average of 52 times. We conclude that this combination of at-home, hands-on and internet instruction is effective for improving production practices in cow-calf operations.

Key Words: Beef Cattle, Producer Education, Internet

149   Beef 509: A partnership educational program.

J. F. Grimes*, S. L. Boyles, T. B. Turner, and J. W. Yates, *The Ohio State University, Columbus, Ohio.*

Beef 509 was a three-day cooperative educational effort of Ohio State University Extension, The Ohio State University Department of Animal Sciences, and the Ohio Beef Council. This program was designed to provide participants with in-depth education on market cattle evaluation, grading, carcass fabrication, and industry issues. Funding for the Beef 509 program was provided by OSU Extension, the Ohio Beef Council and participant registration fees. The first session of Beef 509 was held in January 1997. To date, six sessions have been held with 171 individuals participating. Individuals participating in the program represented a wide variety of interests including cow-calf, stockers, feedlot, packing, restaurants, breed associations, veterinarians, education, and Extension. Instruction is provided through a combination of classroom lecture, the use of live animals, and hands-on training in carcass fabrication. Estimates on carcass measurements and values are made on live animals by each individual. Participants are then divided into teams to process the carcasses. Muscle, fat, and bone are weighed and priced to determine final carcass value. Comparing live animal estimates to actual carcass values has proven to be an effective teaching tool. Evaluations have been conducted at the conclusion of each of the six Beef 509 sessions. Participants have given the program an overall rating of 8.68 (out of a possible 10). 100 percent of the respondents indicated that they would recommend attending Beef 509 to other industry members. 88.1 percent of the survey respondents felt they would make different business decisions than they would have if they had not attended Beef 509. When asked if they learned new information about issues facing the cattle industry during Beef 509, 127 individuals responded yes, 27 stated somewhat, and 4 marked no. In terms of the length of the program, 10.7 percent of the surveys indicated the program was too short while 8.1 percent felt the program was too long. 96.2 percent of the responses felt that the days of the week for the program were satisfactory. Additional evaluations have been conducted to monitor any attitude or behavioral changes.

Key Words: Beef, Teaching, Carcass

150   Centralized ultrasound processing to evaluate beef cattle for carcass merit.

G. H. Rouse*[1], D. E. Wilson[1], C. L. Hays[1], V. R. Amin[1], A. T. Hassen[1], S. P. Greiner[2], and J. Crouch[3], [1]*Iowa State University, Ames, IA,* [2]*Virginia Tech, Blacksburg, VA,* [3]*American Angus Association, St. Joseph, MO.*

Advances in real-time ultrasound technology and accuracy of compositional and quality evaluation using this technology will give beef cattle breeders a faster and less expensive means to improve carcass merit. In 1998, Iowa State University (ISU) and the American Angus Association (AAA) began a two year research project to utilize centralized processing to transfer this technology to seedstock producers. The objectives of this project were 1) provide the seedstock industry with timely, accurate and unbiased measurements for fat thickness, ribeye area and % IMF (marbling), 2) assist breed associations in the accurate assembly of data required to generate adjustment factors and EPD for carcass merit from ultrasound measures, 3) provide education, training and operational assistance for ultrasound technicians working with breeders. During 1998, the Centralized Ultrasound Processing (CUP) laboratory processed images on 6,224 yearling bulls, 1,194 replacement heifers and 542 feedlot steers, using the following protocol: a) The breeder notifies the breed association of intentions to scan a contemporary group of animals, b) The

breed association sends the breeder a barn sheet including information on the contemporary group, c) The breeder selects a technician from an approved list, d) The technician scans the cattle and submits the images to CUP for processing, e) The processing results are forwarded to the breed association by CUP for adding adjustment factors and computing within contemporary group ratios, f) The breed association sends the final results to the breeder, g) The breed association also includes the data into their national database for future calculation of carcass EPD, h) Questions by the breeder after receiving the final results can be directed to the technician or back to CUP. Following the two year research project, this technology utilizing the CUP protocol will be transferred to a commercial entity. Currently, three breeds - Angus, Simmental and Limousin are participating in centralized processing.

Key Words: Ultrasound, Beef Cattle, Carcass

151   Development of models for prediction of percent intramuscular fat in live cattle.

A. Hassen*, D. E. Wilson, G. H. Rouse, C. L. Hays, and V. R. Amin, *Iowa State university, Ames, IA, USA.*

In the present study a total of 500 steers were used to develop models for prediction of percentage of intramuscular fat (%IMF) values in live beef cattle. Prior to slaughter, steers were scanned across the 12th and 13th rib using an Aloka 500V machine and Classic scanner 200. Four images were collected per individual steer using each machine. After slaughter, a cross-sectional slice of the longissimus dorsi muscle from the 12th rib facing was used for chemical extraction to determine actual %IMF. Texture analysis software was used by two technicians to define image parameters which included Fourier, histogram, and texture parameters. These parameters were used as independent variables in the development of %IMF prediction models. A total of four prediction models per machine were developed. These included, models developed without transformation of actual %IMF values (model-I), log transformation of actual %IMF (model-II), ridge regression (model-III) and principal components regression (model-IV). The results indicated that Fourier parameters played an important role in the prediction of %IMF ($P < .05$). Model R^2 and root mean square error (RMSE) of Aloka models I, II, III and IV were, .72, .84%; .72, .86%; .69, .91%; and .71, .86%; respectively. The corresponding R^2 and RMSE value of Classic models I, II, III, and IV were .68, .87%; .70, .85%; .64, .94%; and .65, .91%; respectively. All models were validated based on an independent data set from 71 feedlot steers. The overall mean bias, standard error of prediction, and rank correlation coefficient across the four Classic models were, .67%, .81%, and .91, respectively. For Aloka models the corresponding values were .42%, .84%, and .88, respectively. Both Aloka and Classic equipment can be used to accurately predict %IMF in live cattle. Further improvement in the accuracy of prediction could be achieved through increasing the development data set and the variation in %IMF of cattle used.

Key Words: Beef Cattle, Ultrasound, Intramuscular fat

152   Feedlot performance and carcass characteristics that affect feedlot net return.

S. R. McPeake*, T. R. Troxel, M. S. Gadberry, W. T. Wallace, and G. V. Davis, *University of Arkansas Cooperative Extension Service.*

The objective of this study was to determine the carcass and performance traits that affected feedlot net return. A total of 365 steers from the Arkansas Steer Feedout Program were used in this study. Stepwise regression analysis was conducted by year (1996 and 1997) with net return (NR) serving as a dependent variable. Average daily gain (ADG), dressing percent (DP) and quality grade (QG) were the top three indicators ($R^2 = .84$) of NR in the 1996 steers (n = 137), while feed cost of gain (FCG), (QG) and medicine cost (MC) were the top three indicators ($R^2 = .69$) of NR in the 1997 steers (n = 228). Least square means for ADG, DP, QG and NR from steers that ranked in the top 25% for NR in 1996 were 1.58 kg/day, 64.9%, 3.7 (4 = choice and 3 = select) and $194.88, respectively, while least squares means for steers that ranked in the bottom 25% for NR in 1996 were 1.10 kg/day, 63.6%, 2.9 (2 = standard) and $10.91, respectively. Least squares means for FCG, QG, MC and NR from steers that ranked in the top 25% for NR in 1997 were $1.05/kg, 3.5 , $2.19 and $61.06 , respectively, while least square means for steers in the bottom 25% for NR in 1997 were $1.53/kg, 2.2, $18.92 and $ -183.41 respectively. Choice steers had higher ($P < .05$) average NR (1996 and 1997) than steers that graded select, standard or were

dark cutters. Least square means for NR were $76.82, $28.85, $ -44.15 and $ -162.64 among choice, select, standard and dark cutter steers, respectively. Regardless of year, DP, QG and MC were important indicators of NR. Steers that fit the following breed criteria (no more than 25% Brahman, 50% or less Exotic and 50% or more English breeding) had smaller (P < .05) ribeye areas and had higher (P < .05) percent choice, ADG, backfat and yield grades than steers that did not fit the breed criteria. Steers that fit the breed criteria had higher numerical net returns than steers that did not fit the breed criteria, but the differences were not significant. Although breed type affected NR, individual feedlot performance and carcass characteristics were more important indicators of NR.

Key Words: Beef Cattle, Net Return, Carcass Data

153   Effects of calving season and weaning age on bioeconomic efficiency in range beef cattle. M. H. Makarechian*[1], Hang Pang[1], and J. A. Basarab[2], [1]*Department of AFNS, University of Alberta,* [2]*Alberta Agriculture, Food and Rural Development.*

A dynamic simulation model named "Alberta Beef Production Simulation System" which contains herd inventory,nutrient requirements, forage production and economic submodels was used to compare bioeconomic efficiency of spring and fall calvings and different weaning ages(220,200,180,160 and 140d). Comparisons were made assuming a mature cow weight of 550kg and a peak milk yield of 8.2kg/d. The first day of calving season was assumed as March 28 and September 8 for spring and fall calving respectively. Bioeconomic efficiency was measured as the net return per cow(total return-total cost). The total dry matter intake and feed cost per year were higher in the fall calving cows,as calves born in the fall were exposed to severe cold weather longer than spring born calves in Alberta,resulting in higher demand for maintenance energy. Bioeconomic efficiency improved as weaning age increased from 140 to 220d in both calving seasons. For weaning ages of 200d or less,spring calving was more efficient than fall calving. However,at weaning age of 220d,fall calving was more efficient, primarily due to the higher market prices of fall born calves. The results indicated that the interaction of calving season and weaning age was an important factor affecting bioeconomic efficiency of calf production in Alberta.

Key Words: Beef calf, Calving season, Weaning age

154   Trace mineral fortification of winter supplement is an effective means of addressing trace mineral deficiency in spring-calving beef cows. J. D. Arthington*[1] and L. R. Corah[2], [1]*University of Florida Range Cattle Research and Education Center, Ona,* [2]*Certified Angus Beef, Manhattan, KS.*

When balancing free-choice mineral, a uniform, daily consumption level is assumed. Due to many influencing factors, this desired intake level is rarely achieved on a continuous basis. The following evaluation was conducted with a Kansas commercial cattlemen experiencing difficulty with mineral consumption. An initial trace mineral evaluation was conducted via tissue mineral analyses of liver biopsy collections. The analysis revealed substantial copper deficiency (liver Cu < 50 ppm) in 7 of 12 animals tested. Action was taken to increase the amount of Cu sulfate included in the free-choice mineral to a final Cu concentration of 3.50%. Following 81 d of fortified-mineral supplementation, another trace mineral evaluation was conducted. Again, liver Cu concentrations were well below the adequate level in 9 of 11 animals tested (adequate defined as $\geq$ 75 ppm liver Cu). The reason for the continued deficiency was contributed to the failure of cows to consume adequate free-choice mineral. In attempt to better ensure mineral intake, Cu sulfate was added to the cow's daily supplement of alfalfa range cubes. Cows were offered 1.82 kg of range cubes containing .10% Cu sulfate. A final trace mineral evaluation was conducted after cows were offered Cu sulfate-fortified range cubes for 90 days prior to spring calving. These results revealed adequate copper stores in all 10 cows tested. Mean liver copper concentration $\pm$ stnd. dev., minimum, maximum, and median liver copper concentrations for the three sampling periods were 90.9 $\pm$ 84.3, 4.9, 263.0, and 34.2, 42.4 $\pm$ 31.7, 7.8, 112.0, and 31.0, and 314.7 $\pm$ 66.0, 236.0, 447.0, and 320.0, for initial, intermediate, and final samplings, respectively. The increase in liver copper concentration can be attributed to the daily consumption of Cu in the range cube. By removing the variability of free-choice mineral intake, adequate stores of tissue copper were achieved prior to the calving and breeding season, a time when quality trace mineral nutrition is most critical.

Key Words: Copper, Mineral, Cow

GROWTH AND DEVELOPMENT

155   Expression of peroxisome proliferator-activated receptor gamma (PPARγ) in porcine white blood cells (WBC). M. T. Leininger*, C. P. Portocarrero, and K. L. Houseknecht, *Purdue University, West Lafayette, IN.*

PPARγ is a key regulator of adipocyte differentiation and is involved in the transcriptional regulation of multiple adipocyte genes. Drugs which activate PPARγ have potent anti-diabetic effects. We previously cloned the porcine PPARγ gene and reported high level expression in adipose tissue. Recently, in vitro evidence suggests that PPARγ may regulate macrophage function. The aim of this work was to determine if PPARγ is expressed in porcine WBC, which isoform(s) are expressed, and the effect of an acute endotoxin challenge on PPARγ expression in porcine WBC. Mononuclear cells were isolated from control pigs, total cell lysates were prepared and analyzed by Western blotting using antisera which measures total PPARγ, but does not distinguish between the γ1 and γ2 isoforms (PAN- PPARγ; Affinity Bioreagents, Inc., Golden CO). Additionally, samples were analyzed using antisera specific to the γ2 isoform (Affinity Bioreagents). Total PPARγ was detected in WBC but at lower abundance than in adipose tissue. In contrast, there was no detectable γ2 signal in white blood cells compared to a robust signal in adipose tissue, indicating that the γ1 isoform predominates. To determine the effects of immune challenge on PPARγ expression, castrate male pigs (n=4) were fitted with jugular catheters and treated with saline (Control) and lipopolysaccharide (LPS: 25mg/kg BW). Following each injection, blood samples were collected hourly for 10 hr and white blood cells isolated. At 10 hr post-injection, an adipose tissue biopsy was obtained. PPARγ mRNA expression in adipose tissue was not altered by LPS treatment (P>0.05). However, PPARγ1 protein expression in WBC undergoes dynamic change with endotoxin challenge (repeated measures ANOVA, P<0.05). By 1 hr post-challenge, expres-

sion was increased 2-fold over basal, was maximal by 4 hr post LPS (3.22 $\pm$.8 fold) and was normalized to control by 8 hr post-challenge. These changes in PPARγ1 expression are consistent with reports that PPARγ expression is up-regulated during the conversion from monocyte to macrophage in response to immune challenge in vitro. This is the first evidence of dynamic changes in PPARγ expression in WBC in vivo in any species, and suggests that PPARγ may play an important role in the immune response in the pig.

Key Words: Adipose tissue, Inflammation, Immunity

156   Characterization of the porcine Lhx3 pituitary transcription factor. S. J. Rhodes*, J. Blanton Jr., J. L. Bridwell, A. L. McCutchan, B. C. Meier, and G. E. Parker, *Indiana University-Purdue University at Indianapolis, Indianapolis, IN.*

The anterior pituitary gland contains five cell types that are characterized by the trophic hormones that they secrete. Recent studies have identified transcription factors that regulate development of the gland in mice and humans. Pit-1 is a POU homeodomain factor that is required for the function of the somatotrope, lactotrope and thyrotrope cell lineages. Other regulatory proteins appear to control early pituitary development. These include the LIM homeodomain transcription factor Lhx3/P-Lim. Mice lacking Lhx3 do not develop the anterior and intermediate lobes of the pituitary, indicating that Lhx3 is essential for pituitary organogenesis. To understand the events that regulate pituitary development in swine with the goal of deciphering the pathways that regulate growth and reproductive fitness, we have cloned complementary DNA clones encoding porcine Lhx3 (pLhx3). The pLhx3 protein

sequence exhibits strong similarity to murine Lhx3 within the amino-terminal LIM domains and the DNA-binding homeodomain, but is less conserved outside these motifs. Northern analysis demonstrated that the pLhx3 gene produces a rare 2.2 kb transcript in the adult swine pituitary. Assay of gene expression during porcine embryogenesis revealed that the pLhx3 gene displays a biphasic expression pattern. Expression vectors for pLhx3 activated porcine alpha-glycoprotein promoter luciferase reporter genes in transfection assays. Recombinant pLhx3 protein specifically bound to a target site within the porcine alpha-glycoprotein gene promoter in gelshift assays. Porcine Lhx3 expression vectors induced transcription from prolactin enhancer/promoter reporter genes in synergy with Pit-1. pLhx3 protein specifically interacted with Pit-1 and the LIM domain-binding protein NLI in solution binding assays. Green fluorescent protein/confocal microscopy studies demonstrated that Lhx3 is a nuclear protein. Our results suggest general conservation of Lhx3 function. Supported by a grant from the NRICGP/USDA to S.R.

Key Words: Transcription, Pituitary, Trophic hormone

157 Chronic in vitro porcine leptin treatment alters porcine adipocyte metabolism. T. G. Ramsay[1] and X. Yan*[2], [1]USDA-ARS, Beltsville, MD , [2]Pennington Biomedical Research Center, Baton Rouge, LA.

Leptin has numerous metabolic effects on peripheral tissues. However, it is unclear as to whether many of these effects are due to direct actions of leptin or perhaps due to indirect actions through intermediary molecules. This study was performed to determine whether leptin has acute (direct) or chronic (indirect) effects on adipocyte metabolism. Primary cultures derived from neonatal porcine adipocyte tissue were used to perform this experiment. The stromal vascular cell fraction of the adipose tissue was isolated by collagenase digestion, filtration and subsequent centrifugation. These SV cells were seeded on 25 cm^2 tissue culture flasks and permitted to proliferate to confluency in 10% FBS in DMEM/F12 (50:50). Cultures were then induced to differentiate using 2% FBS + 10 mM IBMX + 1 uM Dexamethasone for 48 hours. This medium was then replaced with 5% pig serum + 1 uM insulin to permit the adipocytes to fill with lipid. After 7 days of lipid filling, adipocytes were washed free of this medium, incubated overnight in serum free medium and then replaced with test medium. Test medium contained 0-1000 ng/ml recombinant porcine leptin and 2% pig serum. Cultures were incubated with these leptin containing media for either 4 hours (acute) or 120 hours (chronic) exposure. At the end of incubation, cultures were harvested for analysis of glucose metabolism ± insulin (10 nM), LPL activity and lipolytic response to isoproteronol (1 uM). Acute leptin treatment had no effect on the evaluated metabolic parameters. Chronic leptin treatment reduced lipogenesis by 35% in the presence of insulin (n = 5; p<.01). Heparin releasable LPL activity was unaffected by leptin treatment in the absence or presence of insulin. Lipolysis was elevated by 23% when insulin was also included in the lipolytic medium (n = 5; P<.05). These data suggest that porcine leptin functions through indirect mechanisms to alter porcine adipocyte metabolism as chronic stimulation was necessary to identify an effect of porcine leptin. (This research was funded by a grant from USDA-NRI)

Key Words: Leptin, Adipocyte, Metabolism

158 Quantification of satellite cell populations using fluorescent immunocytochemistry. N. T. Mesires* and M. E. Doumit, Michigan State University, East Lansing.

Postnatal muscle hypertrophy is associated with increased muscle DNA content. To understand the mechanisms of muscle growth it is crucial to quantify populations of proliferating and differentiating satellite cells. Our objective was to develop an in vitro immunocytochemical staining method to quantify populations of proliferating and differentiating satellite cells in growing pigs. Satellite cells were isolated from a 46kg barrow and an 80kg barrow. Cells were seeded and allowed to attach to fibronectin coated coverslips for 48 hours. Cultures were washed of cellular debris with phosphate buffered saline (PBS) and stained with 5.1H11, an antibody against a cell surface protein expressed in myogenic cells. Following 5.1H11 staining, cultures were fixed in 1% formalin and absolute methanol (-20°C), blocked with 2% goat serum in PBS, and stained for myogenin, a marker of differentiation, using an anti-myogenin

antibody (F5D). Parallel cultures were also fixed and stained for proliferating cell nuclear antigen (PCNA) using an anti-PCNA (PC10) antibody. Detection of bound antibodies was accomplished using an anti-mouse IgG with fluorescein isothiocyanate conjugate. All cultures were counterstained with Hoechst 33258 for detection of total nuclei. Staining treatments for each barrow were done in triplicate and analyzed via fluorescent microscopy. Total nuclei, as well as 5.1H11, PCNA, and myogenin positive cells were counted from 25 random fields. Eighty five percent of cells isolated from the 46kg barrow were satellite cells (5.1H11 positive) while 81% of cells isolated from the 80kg barrow were satellite cells. Ninety one percent of the cells from the 46kg barrow were proliferating (PCNA positive) while 79% of cells from the 80kg barrow were PCNA positive. No myogenin positive cells were detected in either culture. These data indicate that a high percentage of cells in initial isolates are satellite cells, most of which are in a proliferative state. This method will be useful for determining the changes in satellite cell proliferative activity associated with different muscle growth rates.

Key Words: Satellite cell, Differentiation, Proliferation

159 Prolactin inhibition by bromocriptine decreases mammary gland development in pregnant gilts. C. Farmer*[1], D. Petitclerc[1], and M. Sorensen[2], [1]Agriculture and Agri-Food Canada, Lennoxville Research Centre, Canada, [2]Danish Institute of Agricultural Sciences, Foulum Research Centre, Denmark.

This project was undertaken to determine the extent of prolactin involvement in mammogenesis in gilts. Twenty-eight pregnant gilts were assigned as controls (CTL; n=15) or received 10 mg of bromocriptine orally thrice daily (bromo; n=13) from d 70 to 110 of gestation. Jugular blood samples were collected on d 70 of gestation before the onset of bromocriptine administration and every 8 days thereafter, and were assayed for prolactin, IGF-I and progesterone. Gilts were slaughtered on d 110 of gestation and fetuses were counted and weighed. One row of mammary glands was used for dissection of parenchymal and extra-parenchymal tissues, and for determination of DNA, RNA, dry matter, protein and fat contents. Tissue from the other row was used for measures of prolactin receptor number and affinity. Concentrations of prolactin were drastically reduced throughout the bromocriptine treatment period (P<.001) whereas there was no overall treatment effect on progesterone and IGF-I levels (P>.1). Total weight and extraparenchymal tissue weight of the mammary glands were unaffected by treatment (P≥.1) but weight of parenchymal tissue (1011 vs 581 g, SEM=110), total DNA (3.2 vs 1.7 g, SEM=.37) and total RNA (3.1 vs 1.5 g, SEM=.4) decreased (P<.01) with bromocriptine treatment. Percentages of fat (67.3 vs 77.2, SEM=2.5) and dry matter (39.9 vs 45.6, SEM=1.3) in parenchymal tissue increased with bromocriptine treatment (P<.01) while that of protein (33.5 vs 25.4, SEM=2.1) decreased (P<.01). Both number of prolactin receptors (204.5 vs 125.3 fmol/mg protein, SEM=14.1) and receptor affinity (.67 vs .39 ng/mL, SEM=.04) in parenchymal tissue decreased with bromocriptine treatment (P<.001). Average fetal weight was lower in gilts receiving bromocriptine when compared to control gilts (1.25 vs 1.13 g, SEM=.04, P=.05) while fetal number did not differ (P>.1). These results clearly demonstrate that prolactin is essential for normal mammary gland development and can affect fetal growth during the last third of gestation in gilts.

Key Words: Sows, Prolactin, Mammary Gland Development

160 Effect of prepubertal feeding regimen on reproductive performance of gilts. J. Klindt*, R. K. Christenson, and J. T. Yen, USDA-ARS U.S. Meat Animal Research Center, Clay Center, NE.

Efficient development of gilts such that they conceive early and continue to produce offspring is a primary objective of swine production. Herein, we investigated different prepubertal feeding regimens on reproductive performance of gilts. At 13 wk of age white crossbred gilts were penned individually and assigned to treatments: AL, ad libitum access to feed from 13 to 25 wk of age (n = 63); C, ad libitum access to feed from 13 wk of age until 100 kg BW and then 90% of ad libitum until 25 wk of age (n = 64); and R, 74% of ad libitum from 13 to 25 wk of age. Feed was formulated to primarily restrict energy intake. The study was replicated in two seasons. At 25 wk of age gilts were moved to group pens, fed ad libitum and estrous detection initiated and continued for 7 wk. Gilts were mated at first estrus and those recycling were remated. Post-mating gilts were fed 1.5 x maintenance in gestation stalls until

35 to 45 d of gestation. At that time gilts were moved to pens (5/pen) where they were fed at approximately 1.5 x maintenance until 105 to 110 d of gestation when they were slaughtered or moved to farrowing crates (term). Average feed consumed (kg) from 13 wk of age to removal or term by all gilts assigned was 445 ± 11 by AL, 477 ± 11 by C, and 404 ± 11 by R (P < .01). Percentage of gilts reaching term and age at term (d) were 64 and 317 ± 2 in AL, 81 and 321 ± 2 in C, and 69 and 317 ± 2 in R (P < .08 and P < .13, respectively). For all gilts pig production/gilt was $6.8 \pm .7$ in AL, $8.1 \pm .7$ in C, and $6.9 \pm .7$ in R (P < .24) and efficiency (pigs/kg feed) was $.0139 \pm .0014$ in AL, $.0163 \pm .0014$ in C, and $.0157 \pm .0014$ in R (P < .45). No. of pigs produced and efficiency in gilts reaching term were $10.5 \pm .5$ and $.0214 \pm .0011$ in Al, $9.7 \pm .4$ and $.0192 \pm .0009$ in C, and $9.7 \pm .5$ and $.0223 \pm .0011$ in R (P < .36 and P < .08, respectively). These results indicate restricted feeding of gilts during prepubertal development may increase the efficiency of swine production without negative impact on reproduction from mating to term.

Key Words: Gilts, Puberty, Growth

161   Postnatal growth of offspring in response to somatotropin treatment of sows during early gestation. G. Kuhn, C. Rehfeldt, and K. Ender*, *Research Institute for Biology of Farm Animals, Dummerstorf, Germany*.

This experiment was undertaken to determine the influence of somatotropin (pST)-treatment of pregnant sows on the development of offspring during postnatal growth. Seven gilts received daily i.m. injections of 6 mg pST from day 10 to 27 followed by decreasing doses down to 0 mg pST from day 28 to 37 after artificial insemination (pST-group). Seven sows received a placebo (control). Three neonates of the highest (HW), of the middle (MW), and of the lowest (LW) birth weight from each litter were dissected into meat, fat cover, bones, skin, and internal organs. Subsequently, several tissues were analyzed to determine the composition of water, protein, lipid, and ash. The remaining piglets of the litters were allocated to three birth weight classes by the help of frequency distribution (low, middle, high) and reared up to 182 days of age on average. After slaughter, carcass composition and meat quality of the pigs were examined. All data were statistically analyzed using proc GLM. At birth the LW- and MW-piglets from treated sows were somewhat heavier in comparison to the corresponding piglets from untreated sows (by 11 and 4 %, respectively; NS). The body composition of the piglets was slightly influenced by pST-treatment. The percentages of meat and internal organs were increased whereas the percentages of fat cover and bones were decreased. Water percentage in meat and in adipose tissue were reduced whereas protein percentage was elevated. The total protein percentage in LW-piglets from treated sows was 1.56 % higher (P< 0.05) compared to corresponding controls. Live weight development up to slaughter was not clearly affected by pST. However, there were indications of slower growth up to 14 days of age followed by growth compensation up to 28 days of age. Thereafter, the influence of pST on live weight development differed slightly between pigs from different birth weight classes. Total daily gain was the same for pST- and control pigs on average. Carcass quality of slaughtered pigs was not clearly affected by pST-treatment of their mothers. PST-pigs of lower birth weight tended to exhibit higher carcass meat percentage in comparison to corresponding controls.

Key Words: Somatotropin, Growth, Pig

162   Effects of weaning on somatotrophic gene expression and circulating levels of growth hormone (GH), insulin-like growth factor-1 (IGF-1), and IGF-2. R. L. Matteri*[1], C. J. Dyer[1], K. J. Touchette[2], J. A. Carroll[1], and G. L. Allee[2], [1]*Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO,* [2]*University of Missouri, Columbia, MO*.

Weaning the piglet results in a well-characterized reduction in growth, increase in GH secretion, and a reduction in circulating levels of IGF-1 and IGF-2. The objective of this study was to evaluate postweaning changes in the secretion of these hormones and the expression of genes involved with their production. At 14 d of age, piglets were either crossfostered to a sow (S, n = 8) or weaned onto phase 1 diets containing 0 (NP, n = 8) or 7% (SDP, n = 8) spray-dried plasma. Animals were sacrificed after 4 d for blood and tissue collection. Weight gain over this 4-d period was significantly greater in S, compared to NP and SDP groups (1.3 +/- .09, .11 +/- .06, and .07 +/- .04 kg, respectively; P

< .001). Respective gains over the last day of the study were .23 +/- .05, .05 +/- .03, and .29 +/- .04 kg (P < .001). Serum GH concentrations at sacrifice were higher in NP and SDP, compared to S piglets (P < .001). Conversely IGF-1 and IGF-2 concentrations were equivalently lower in NP and SDP, compared to S piglets (P < .001). The level of pituitary GH mRNA did not differ among groups (P = .3). Levels of IGF-1 and IGF-2 mRNA were equivalent among groups in liver, muscle (l. dorsi), and fat tissue; however, a tendency was noted for lower liver IGF-1 mRNA in S piglets (P = .09). Liver IGFBP-3 mRNA also was unaffected by treatments (P = .4). A strong tendency for lower liver GH receptor mRNA was noted in S piglets (P = .06); however, muscle GH receptor mRNA was equivalent among groups (P = .7). The results indicate that the abundances of specific mRNAs in the present tissues are not the immediate determining factors of circulating GH and IGF levels. The high rate of gain between d 3 and 4 in the SDP piglets is not accompanied by a normalization of GH or IGF secretion, suggesting a significant lag time between recoveries of postweaning gain and somatotrophic axis function.

Key Words: Piglet, Insulin-like Growth Factors, Growth

163   Effects of weaning on gene expression of neuroendocrine regulators of feed intake. C. J. Dyer*[1], K. J. Touchette[2], J. A. Carroll[1], G. L. Allee[2], and R. L. Matteri[1], [1]*Animal Physiology Unit, Agricultural Research Service, USDA, Columbia, MO,* [2]*University of Missouri, Columbia, MO*.

One of the greatest challenges in swine nutrition is to decrease the postweaning lag by stimulating feed intake and growth. Spray-dried plasma (SDP) is often added to phase 1 diets to attempt to stimulate appetite during this lag. The current study was designed to investigate changes in gene expression (messenger ribonucleic acid, mRNA) of neuroendocrine appetite regulators during weaning. Young pigs (14 d, 4.69±0.13kg) were either crossfostered to a sow (SOW, n=8), weaned and fed a phase 1 diet containing no SDP (NP, n=8), or weaned and fed a diet containing 7% SDP (SDP, n=8). Animals were sacrificed 4 d after weaning (or crossfostering) for tissue collection. Gene expression was compared between treatments using initial (pre-weaning) body weight as a covariate. Expression of neuropeptide Y (NPY), a potent stimulator of feed intake, was equivalently decreased (P=0.011) in SDP and NP pigs compared to SOW pigs. There were no treatment effects seen on adipose leptin, or hypothalamic leptin receptor, orexin (ORX), orexin receptor type 2 (Orec2), or insulin-like growth factor 1 (IGF-1) gene expression. Correlation analysis revealed significant (P≤0.001) correlations between initial body weight and hypothalamic ORX, Orec2, NPY, and IGF-1 expression (R=0.664, 0.759, 0.791, and 0.697, respectively) across treatments. Interestingly, no such pattern was observed for adipose leptin or hypothalamic leptin receptor expression. Expression of Orec2 mRNA was strongly correlated to ORX expression across treatments (R=0.690, P=0.0002). This study provides not only the first report of endogenous orexin mRNA expression in a livestock species, but gives new insight into the neurochemical impact of weaning.

Key Words: Piglet, Appetite, Weaning

164   Biological effects of dietary porcine plasma protein on growth performance, small intestinal mass and morphology, and plasma urea levels in early-weaned pigs. R. Jiang, X. Chang, B. Stoll, M. Fan, and D. G. Burrin*, *USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine*.

We quantified the effects of diets containing porcine plasma protein on growth, small intestinal mass, mucosal morphology and plasma urea of early-weaned pigs. Ninety-six pigs (14 d old; 4 kg body weight (BW)) were assigned in groups of 32 to three dietary treatments; (control diet-ad libitum (C), plasma protein diet-ad libitum (P), and plasma protein, pair-fed to C (PFP)). Pigs (N=8 per treatment) were killed after 2, 4, 8 or 16 d of feeding. Over 16 d, daily food intake and weight gain in the P group were 30% and 43%, respectively, greater (P < 0.05) than C pigs; weight gain was similar in C and PFP groups. Intestinal masses in all three groups were similar at 2, 4, and 8 d. By 16 d the jejunal (JEJ) and ileal (ILE) protein and DNA masses (mg/kg BW) in both the P and PFP groups were lower than in C (P<0.05). Dietary plasma protein did not affect either crypt depth or villus height in the JEJ. Among dietary groups, ratios of 4 h in vivo crypt labeling (%total cells) with BrdU in the JEJ were 23%, 39%, 35%, and 36% at 2, 4, 8, and 16 d, but were not

affected by dietary plasma protein. Plasma urea concentrations were decreased by 40% and 42% in P and in PFP group (P < 0.05) during the 16 d of dietary plasma protein treatment, respectively. Regardless of food intake, pigs receiving plasma protein had lower relative small intestinal protein and DNA masses. Decreased plasma urea concentrations suggest that dietary plasma may reduce amino acid catabolism.

Key Words: Protein, Urea, Porcine

165   Enhanced carcass composition in IGF-I transgenic barrows and gilts. V. G. Pursel*[1], A. D. Mitchell[1], K. D. Wells[1], R. J. Wall[1], M. E. Coleman[2], and R. J. Schwartz[3], [1]USDA, ARS, Beltsville, MD, [2]GeneMedicine, Inc., The Woodlands, TX, [3]Baylor College of Medicine, Houston, TX.

The objective of this research was to determine whether directing expression of IGF-I specifically to striated muscle would enhance lean muscle growth in barrows and gilts. Although growth hormone is considered the primary growth-promoting hormone in mammals, many of its effects are thought to be mediated by insulin-like growth factor-I (IGF-I). Transgenic pigs were produced with a fusion gene composed of avian skeletal α-actin regulatory sequences and the cDNA encoding IGF-I. A founder transgenic boar (hybrid dam line) was mated to seven non-transgenic gilts from two hybrid sire lines to produce G1 transgenic and sibling control progeny. After weaning, pigs were provided feed ad libitum until they reached 120 kg body weight. At 90 and 120 kg body weight 13 transgenic and 24 sibling control pigs were anesthetized and scanned by dual-energy x-ray absorptiometry (DXA) to estimate body composition. At 90 and 120 kg the transgenic pigs had more lean and less fat than sibling control pigs (P<.05 at each weight). The day after the last live DXA scan all pigs were killed, the right half of each carcass was scanned by DXA after one day of chilling, and the loin eye area and back fat measurements taken. In comparison to sibling controls, transgenic gilts and barrows, respecively, had a larger LEA (29.4 and 31.4%, P<.001), more carcass lean (10.1 and 11.4%, P<.01), less carcass fat (20.1 and 22.0%, P<.01), and less average backfat (15.1 and 30.0%, P<.01). Average daily gain was similar for transgenic and control pigs. Based on these results we conclude that enhancing IGF-I specifically in skeletal muscle had a positive effect on carcass composition of terminal cross market swine.

Key Words: Swine, Transgenic, IGF-I

166   Porcine (pST) somatotropin administration increases protein balance by promoting protein conservation in fasted swine. R. C. Vann*[1], H. V. Nguyen[1], J. M. Vargas[1], P. J. Reeds[1], N. C. Steele[2], and T. A. Davis[1], [1]USDA/ARS Children's Nutrition Center, Houston, TX, [2]USDA-ARS Growth Biology Laboratory, Beltsville, MD.

Fasting lowers protein synthesis and increases degradation, thus it is important to conserve protein when feed is not available. The objective of this study was to determine the effect of pST on whole body protein turnover in fasted, young swine. Previously, Vann et al. (1998) reported pST promotes growth by lowering both protein degradation and amino acid oxidation in young, fed swine. Groups of six pairfed, weight matched (15 kg), growing barrows were treated with pST ($150\mu g$/kg/d) or diluent for 7 d and fasted overnight. The animals were then maintained with a 4 h somatostatin and replacement insulin (20 ng/kg$^{.66}$/min) infusion. Insulin concentrations were $5\mu U$/ml and fasting glucose and amino acid levels were maintained by infusion. Wholebody protein turnover and leucine (Leu) oxidation were determined with primed, continuous infusion of [1-^{13}C] Leu and ^{14}C-bicarbonate. pST-treated pigs had increased protein synthesis (+17%; $P < .05$), and lower Leu oxidation (-47%; $P < .001$) resulting in an increased protein balance (47%; $P < .01$) compared to the control pigs. The results indicate that the effect of pST on fed state Leu oxidation survives fasting and that pST blocks the reduction in protein synthesis that occurs with fasting. We conclude that pST promotes maximum efficiency via minimizing protein loss in fasting, and maximizing protein gain in the fed state. Supported by USDA NRI 96-35206-3657

Key Words: Swine, pST, Insulin

167   Metabolic responses to short-term bST administration in milk-fed bull calves between birth and 100 days of age. J. M. Smith*[1], M. C. Diaz[1], M. E. Van Amburgh[1], M. C. Lucy[2], and D. E. Bauman[1], [1]Cornell University, [2]University of Missouri-Columbia.

Fifty-four Holstein bull calves underwent a single short-term bovine somatotropin (bST) challenge to evaluate the functional coordination of the somatotropic axis. Calves were injected with a reconstituted daily injectable bST formulation (Monsanto) at 120 μg/kg BW subcutaneously for three consecutive days and were slaughtered the day after the third injection. Calves were fed a 30% crude protein: 20% fat milk replacer (Milk Specialties) from birth to slaughter at either 65 kg, 85 kg, or 105 kg BW (18 calves at each weight). Calves were fed to achieve one of three target rates of gain, 500 g/d (TRT 1), 950 g/d (TRT 2), or 1400 g/d (TRT 3), to their respective slaughter points (6 calves per TRT to each slaughter weight). Calves reached 65 kg BW at an average of 42.5, 25.7, or 26.8 days of age after growing 610, 1060, or 1050 g/d, respectively. Calves weighing 85 kg at slaughter were 69.5, 40.0, or 35.3 days old, on average, having gained 625, 1100, or 1300 g/d, respectively. Calves slaughtered at 105 kg BW were 98.2, 65.3 or 51.7 days of age with ADG of 620, 960, or 1250 g/d, respectively. Least square means of plasma IGF-1 concentrations measured by RIA after glycyl-glycine extraction of samples collected immediately prior to challenge and 14 h after the third bST injection (post-challenge) are presented in the following table. Post-challenge IGF-1 concentrations were higher (p≤.009) than pre-challenge levels in all calves.

Liver tissue from each of these calves and from six calves slaughtered at one day of age was analyzed by ribonuclease protection assay (RPA) for mRNA specific for IGF-1 and the liver-specific growth hormone receptor, GHR1A. Low levels of IGF-1 mRNA were present in day-old calves and remained low in calves grown at the lowest rate of gain. IGF-1 and GHR1A mRNA increased in calves grown at the highest two rates of gain. GHR1A mRNA was present in day-old calves.

| BW (kg) | Time | IGF-1 (ng/ml) | | |
		TRT 1	TRT 2	TRT 3
65	pre	129	256	193
	post	276	481	545
85	pre	144	211	264
	post	269	498	532
105	pre	164	265	346
	post	334	518	506

Key Words: Somatotropic axis, Insulin-like growth factor-1, Calves

168   Responsiveness to growth hormone-releasing hormone (GHRH) challenge: A physiological predictor of average daily gain in beef bulls. E. E. Connor*, S. M. Barao, and G. E. Dahl, University of Maryland, College Park.

The relationship between serum growth hormone (GH) concentration, after GHRH-stimulated release, and subsequent weight gain in weanling black Angus bulls (n = 38) was evaluated. Bulls averaged 272 d (SD = 29) of age when challenged with 1.5 and 4.5 μg/100 kg BW bovine GHRH (1 - 30) analog (i.v.) following a 19-h fasting period. All bulls were challenged with one of 2 doses of GHRH on consecutive days and dose was randomized by day. Two h prior to each GHRH challenge, all bulls received a "clearance" dose of 4.5 μg/100 kg BW bovine GHRH (1 - 30) analog to reduce variation in subsequent response to GHRH challenge. Blood was collected via jugular venipuncture at 0 and 10 min relative to each injection of GHRH for serum GH determination by RIA. Pearson's ranked correlation revealed responses from the two 4.5 μg GHRH/100 kg BW clearance doses were consistent within animal over time (r = .38; P = .03). The relationships between GH response to each challenge dose of GHRH versus ADG during a 112-d growth performance test were evaluated using simple linear regression. A positive relationship (r^2 = .18; P = .007) was demonstrated between GH response to the 1.5 μg GHRH/100 kg BW challenge versus ADG. Response to the 4.5 μg GHRH/100 kg BW challenge tended to be positively related to subsequent weight gain (r^2 = .08; P = .09). The relationship between response to GHRH challenge and carcass composition at d 112 of the growth performance test will be evaluated. Results of this study suggest that GH response to GHRH challenge is a useful tool for identifying beef bulls superior for growth.

Key Words: Beef cattle, Growth, GHRH

169   Effects of varying degrees of muscularity and muscular hypertrophy in Hereford, Limousin, and Piedmontese F2 crossbred calves on traits measured through weaning. R. E. Short*, M. D. Grosz, M. D. MacNeil, E. E. Grings, and R. A. Bellows, *USDA-ARS, Ft. Keogh LARRL, Miles City, MT.*

Breeds that are similar in mature weight but differ in muscularity, especially with breeds that express muscular hypertrophy (double muscling), may affect production traits. Hereford (normal muscling, H), Limousin (moderate muscling, L), and Piedmontese (muscular hypertrophy, P) sires (20 to 25 per breed) were bred to crossbred cows at random to produce F1 calves. F1 progeny were inter se mated within sire breed to produce F2 calves. P-cross F2 calves were genotyped for the G-A transition mutation at the myostatin locus characteristic of P, and their genotypes were classified on the basis of having 0 (P_0), 1 (P_1), or 2 (P_2) copies of the mutant allele (mhP). Sires and dams of P-cross F2 calves were assumed to be P_1, and H- and L-cross calves were assumed to have P_0 genotypes. Included in the ANOV model were breed, sex, year, age of dam (first calf heifers, F or cows, C), and selected 2-way interactions for birth wt, kg (BWT, SD=5.0), calving difficulty score (CD, SD=.72, 1 = no CD to 4 = caesarean section, abnormal presentations omitted), % with CD > 1 (%CD, SD=34), and weaning wt, kg (WWT, SD=24). We conclude that differences in muscularity affected BWT with both the L and P_2 genotypes increasing BWT. WWT was lowest in P but was not affected by the mhP allele. CD and %CD in F were decreased in P_0 but were dramatically increased by the addition of the mhP allele. In C there were no effects of genotype on CD or %CD. Breeding schemes for optimal use of the mhP allele could use P_1 dams mated to P_0 as F and to P_2 as C.

| | Genotype means | | | | | Genotype comparison | | | | | |
Trait	H	L	P_0	P_1	P_2	HL	HP_0	LP_0	P_0P_1	P_0P_2	P_1P_2
BWT	35.6	38.2	35.7	36.9	39.1	†	-	†	-	†	-
CD -F	1.63	1.57	1.26	1.91	2.32	-	-	-	†	†	-
CD -C	1.05	1.03	1.02	.99	1.11	-	-	-	-	-	-
%CD-F	35.9	31.1	12.8	43.0	54.8	-	†	-	†	†	-
%CD-C	1.7	2.6	.8	-.1	9.1	-	-	-	-	-	-
WWT	183	188	178	176	169	-	-	†	-	-	-
n	221	206	48	118	36						

†P < .1.

Key Words: Cattle, Muscularity, Preweaning Traits

170   The influence of body weight and marbling EPD on the relationship of intramuscular fat content and body composition. K. W. Bruns*, R. H. Pritchard, and D. L. Boggs, *South Dakota State University, Brookings.*

Angus steers of known parentage were used in a two year study (n=40 year 1, n=45 year 2) to evaluate the relationship between intramuscular fat content and carcass characteristics of non-implanted steers with varying EPD for marbling. Steers were sorted by paternal grand-sire EPD for marbling (MEPD) into high marbling (HM) and low marbling (LM) groups. Average marbling EPD in year 1 were +.21 ± .10 for HM and -.19 ± .04 for LM and year 2 were +.28 ± .08 for HM and -.02 ± .19 for LM. All steers were fed a corn based 90 percent concentrate diet. Steers were randomly allocated into 5 harvest groups. Data were analyzed as a completely random design with a factorial arrangement of treatments (Year, MEPD and Harvest group). Harvest group hot carcass weights (HCW) were 208 ± 15, 246 ± 23, 296 ± 19, 353 ± 25, and 381 ± 28 kg. MEPD did not affect (P>.10) backfat, longissimus muscle area, yield grade, or marbling score. HM and LM treatments had similar (P>.10) HWC and 12th rib lipid content for harvest groups 1,2,3 and 4. HM steers in harvest group 5 had heavier HCW (393 vs. 368 kg; P<.05) and a greater amount of 12th rib lipid content (9.0 vs 7.7%; P<.10). Harvest group affected the level and extent of marbling (P<.01). There was not a Harvest group x MEPD group interaction indicating no differences occurred in the pattern of marbling development due to marbling EPD. Carcasses expressed Small degrees of marbling between the HCW of 246 and 296 kg (harvest group 2 and 3). These data indicate that EPD for marbling of parental grand-sires was not indicative of differences in the onset or the rate of development of marbling. Greater differences in MEPD may be needed to recognize these differences.

Key Words: Marbling, Serial slaughter, Body composition

171   DNA binding site requirements for Lhx3-mediated gene activation. J. L. Bridwell*, A. L. McCutchan, J. R. Price, K. W. Sloop, and S. J. Rhodes, *Indiana University-Purdue University at Indianapolis, Indianapolis, IN.*

Cell-specific gene expression is temporally and spatially regulated by the coordinated actions of transcription factors that activate or repress the transcriptional activity of target genes. Lhx3 is a LIM-Homeodomain transcription factor expressed early in development in the brain and Rathke's pouch, the structure that forms the anterior and intermediate lobes of the adult pituitary. This protein plays a role in the development of certain subpopulations of motorneurons and is critical in the establishment and differentiation of four of the five hormone-secreting cell types of the anterior pituitary including, the growth hormone, prolactin, thyroid stimulating hormone and luteinizing/follicle stimulating hormone cells. Knockout mice lacking a functional Lhx3 protein die at birth with no anterior/intermediate pituitary development. Since little is known about the transcriptional mechanism of this developmentally important protein, site-selection methods employing gelshift analysis and polymerase chain reaction (PCR) using degenerate oligonucleotides were used to identify the preferred target sequence for porcine and murine Lhx3. Results of this study show that Lhx3 binds to an A/T-rich DNA sequence and that the LIM domains of the protein regulate binding affinity to the DNA, but not specificity. This binding site is capable of conferring Lhx3-dependent transcription to heterologous promoters in transfection assays. Both full-length Lhx3 and LIM-deleted Lhx3 are capable of bending target DNA. We are currently using these results to investigate potential Lhx3 target genes in the pituitary and brain. Supported by the NRICGP/USDA and the NSF.

Key Words: Transcription, Pituitary, Trophic hormones

172   Cross-species conservation of protein structure and function of the LIM homeodomain transcription factor Lhx3. K. W. Sloop*, J. L. Bridwell, B. C. Meier, G. E. Parker, and S. J. Rhodes, *Indiana University-Purdue University at Indianapolis, Indianapolis, IN.*

Lhx3/P-Lim is a LIM homeodomain transcription factor critical to anterior pituitary organogenesis and motor neuron pathfinding in vertebrate development. This factor contains two cysteine-rich zinc finger-like LIM motifs in the amino-terminus that mediate protein-protein interactions and a DNA-binding homeodomain in the carboxyl-terminus. The objective of this study was to compare conservation of protein structure and function between the human, porcine, and murine Lhx3/P-Lim. Pituitary complementary DNA (cDNA) bacteriophage libraries screened with radiolabelled probes and 5' RACE (Rapid Amplification of cDNA Ends) were used to identify Lhx3/P-Lim cDNAs. Electrophorectic mobility shift assays (EMSA) and in vitro luciferase reporter assays were used to assess DNA binding and promoter activation specificity. DNA sequence analysis of the human, porcine, and murine Lhx3/P-Lim revealed high conservation in the LIM and homeodomains, but low similarity outside of these regions. In addition, DNA binding and activation of pituitary hormone reporter genes was similar among the three factors. We conclude that the functional domains of the Lhx3/P-Lim transcription factor are structurally and functionally conserved throughout evolution. Supported by a grant from the NRICGP/USDA to S.R.

Key Words: Transcription, Pituitary, Trophic hormones

173   Mono-ADP-ribosylation in skeletal muscle cell cultures and modification of intermediate filaments *in vitro*. T. W. Huiatt*, W. Tong, J. Yuan, D. J. Graves, and R. M. Robson, *Iowa State University, Ames.*

Mono-ADP-ribosylation is a covalent protein modification of proteins involving transfer of ADP-ribose from NAD to a protein by an ADP-ribosyl transferase (ADPRT). Arginine-specific ADPRTs have been identified in many tissues including skeletal muscle. We showed previously that inhibitors of the arginine-specific ADPRT inhibited differentiation of chick muscle cells in culture and that the muscle intermediate filament (IF) protein desmin is a substrate for the purified enzyme, suggesting that this modification has important functions in skeletal muscle. To further examine the role of ADPRT in muscle differentiation, cultures of the mouse skeletal muscle cell line C2C12 were treated with an antisense oligonucleotide to inhibit expression of the enzyme. A 22 base-pair phosphothioate-modified oligo complementary to the region of the mouse arginine-specific ADPRT message that included the start codon was synthesized. Oligo was added to C2C12 cultures at a concentration of 1.5 uM either 1 d prior to or at the time the medium

was changed from proliferation medium (20% fetal calf serum) to differentiation medium (4% horse serum). Antisense treatment reduced AD-PRT expression more than 50% in comparison to controls treated with random oligo and concomitantly inhibited differentiation to the same extent, as measured by creatine kinase activity. These results suggest that ADPRT has an essential role in regulation of muscle differentiation. In addition, the effect of ADP-ribosylation on the properties of purified desmin was further characterized. We established previously that ADP-ribosylated desmin is incapable of assembling into IFs *in vitro*. In this study, we demonstrated that treatment of assembled desmin IFs with ADPRT resulted in disassembly, and that modified desmin does not coassemble with unmodified desmin. Further, stepwise enzyme cleavage of the ADP-ribose moiety attached to desmin was used to characterize chemical features of the ADP-ribose moiety necessary to inhibit assembly. These results provide additional information to suggest that ADP-ribosylation could regulate desmin assembly in muscle cells, and thus, ADPRT may be involved in regulation of both differentiation and IF assembly/disassembly in muscle. (Supported by USDA NRICGP Grant 96-35206-3857).

Key Words: skeletal muscle, ADP-ribosylation, myogenesis

174 Changes in serum and muscle myostatin proteins in response to weight restriction and compensatory growth. S. Q. Ji, R. L. Godat*, G. M. Willis, G. R. Frank, S. G. Cornelius, and M. E. Spurlock, *Purina Mills, Inc., Gray Summit, MO.*

The objective of this study was to determine if there are changes in myostatin expression and tissue protein in conjunction with compensatory growth in pigs. Forty eight pigs were assigned to 4 dietary treatments at approximately 14.5 kg BW. For the duration of the study (31 d), one group of pigs was allowed ad libitum (AL) intake and an alternative group allowed only that level of intake estimated for maintenance of BW (MNT). The third group was allowed maintenance intake for 21 d and ad libitum intake for the remaining 10 d (MNT-AL) whereas the fourth group was allowed ad libitum intake and switched to maintenance intake (AL-MNT). At the conclusion of the study, blood samples were obtained and all pigs were killed for collection of longissimus and semitendinosus muscle samples. Immunoreactive myostatin protein in serum and muscle extracts was quantified on a relative basis by immunoblotting procedures. For the initial 21 d, pigs consuming maintenance intake gained less than 50 g. Also, BW change in pigs allowed maintenance intake in the final 10 d was less than 50 g. Growth rate was 14.1% greater (P<.01) in the MNT-AL pigs than in the AL group over the final 10 d. In longissimus muscle extracts, 3 immunoreactive myostatin bands were detected (approximately 35, 45 and 90 kDa) consistent with the monomer and dimer of the 45 kDa (unprocessed) protein and the amino terminal of the processed protein. Abundance of the 90 kDa protein was about 21% higher (P<.01) in the MNT group than in other groups. In serum, only the 45 kDa protein was detected and was higher in concentration (17%, P<.05) in pigs consuming maintenance intake during the final 10 d (i.e., AL-MNT and MNT groups). Myostatin mRNA (per unit of 18S rRNA) tended to be lower (P<.10) in pigs that had intake restricted for all or part of the study vs. the AL group. Furthermore, deep red semitendinosus muscle contained less (P<.05) myostatin mRNA than white semitendinosus or longissimus muscle. The data reported herein provide the first evidence of the presence of the unprocessed myostatin protein in the blood of pigs and of the processed and unprocessed proteins in muscle extracts. The data also indicate that greater concentrations of myostatin protein in muscle and serum may be associated with restricted weight gain.

Key Words: Pig, Myostatin, Blood

175 Regulation of PPAR but not leptin gene expression by dietary fatty acid supplementation. M. E. Spurlock*[1], K. L. Houseknecht[2], C. P. Portocarrero[2], S. G. Cornelius[1], and G. M. Willis[1], [1]*Purina Mills, Inc.,* [2]*Purdue University.*

Leptin and PPARγ are adipocyte genes which are important in the regulation of appetite (leptin) adipogenesis (PPARγ) and whole-body energy homeostasis (both). To determine the effect(s) of dietary fatty acids on expression of these genes, adipose tissue was obtained from control pigs that were a part of a larger study designed to evaluate the effect of dietary fat source on immunological response criteria. The experiment reported herein utilized 48 pigs (progeny of Pig Improvement Company [PIC] Camborough females mated to Line 63 males) from four treatment groups (n = 12). The pigs were confined in individual pens in an environmentally regulated building for the duration of the study

(84 d). Corn-soybean meal diets (growing and finishing phases) contained no added fat (NO), or 10% beef tallow (BT), safflower oil (SO) or fish oil (FO). Feed and water were provided on an ad libitum basis. At the completion of the study, blood samples were obtained by jugular venipuncture for serum recovery, and the pigs were then killed by exsanguination following mechanical stunning. Subcutaneous adipose tissue was collected immediately and frozen in liquid nitrogen. The abundance of leptin, PPARγ1, and PPARγ2 mRNA was quantified relative to 18S rRNA using ribonuclease protection assays. Overall, ADG was not improved (P>.05) by adding fat but pigs fed the FO diet had lower (P<.05) ADG than pigs fed either BT or SO. Gain:feed was improved (P<.05) 21% by adding fat with a corresponding reduction (P<.05) in feed intake. Neither leptin nor PPARγ1 mRNA abundance was responsive to added fat (P>.15). However, the abundance of PPARγ2 mRNA was increased 4-fold by SO compared to the NO diet. These data implicate caloric intake, but not dietary fatty acids per se in the regulation of leptin gene expression in swine. Furthermore, they provide a potential mechanism by which dietary fatty acids may stimulate adipogenesis via up-regulation of PPARγ.

Key Words: Pig, leptin, fatty acids

176 Analysis of leptin and leptin receptor mRNA expression in the sheep placenta. R. A. Ehrhardt*, A. W. Bell, and Y. R. Boisclair, *Cornell University, Ithaca, NY.*

Leptin and its receptor have been shown to be expressed in the placentae of humans and murines. Historically, the sheep has been an important model for investigations during pregnancy. The objective of the present work was to determine whether the sheep might serve as a good model for investigations of leptin biology during pregnancy. Placentomes were obtained from multiparous Finn x Dorset ewes at d 85, 110 and 140 post coitus (PC). Poly A RNA (5 μg) obtained from these placentae was subjected to Northern analysis and probed with a partial cDNA corresponding to exon 2 of the sheep leptin gene. This probe was labeled to high specific activity using a polymerase chain reaction (PCR) based method. No detectable signal for sheep leptin was found in any of these placental samples using this high specific activity probe and prolonged autoradiographic exposure (14 d). A sheep leptin receptor cDNA was generated by reverse transcriptase-polymerase chain reaction (RT-PCR) of total RNA obtained from sheep hypothalamus. This cDNA was used to design a ribonuclease protection assay (RPA) capable of detecting simultaneously the long isoform and short isoforms of the leptin receptor. Only the signal for the short isoforms of the receptor was detected in total RNA (30 μg) of placentae at d 85, 110 and 140 PC by RPA. Next, specific expression of the long isoform was assayed by RT-PCR of total RNA (30 cycles) using oligonucleotide primers specific for the intracellular domain of the sheep leptin receptor. Expression of the long isoform in the sheep placenta was evident at d 85, 110 and 140 PC. These data suggest that the sheep differs from other mammals examined in that leptin mRNA expression in the placenta is very low or perhaps absent from mid to late pregnancy based on our inability to detect it with the methods employed. These results also suggest that the short isoforms of the leptin receptor are the most abundant in the sheep placenta from mid to late pregnancy. However, the long form of the leptin receptor was readily detectable by RT-PCR in the sheep placenta at all stages of pregnancy examined. As current evidence indicates that the long isoform is the most competent in leptin signaling, these results suggest that the sheep placenta may be a target for leptin action.

Key Words: Leptin, Placenta, Sheep

177 Glucocorticoid receptor (GR) mRNA expression in porcine fetal liver and placenta. H. G. Klemcke*, J. L. Vallet, and R. K. Christenson, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, Nebraska.*

The glucocorticoid cortisol is present within porcine fetuses or their uterine environment throughout gestation. If cortisol is to influence fetal development, then GR must be present. The current study was conducted to determine the presence of fetal GR mRNA in fetal liver and placentae and to examine effects of breed and uterine environment. Porcine fetuses were obtained on days (d) 24, 30, and 40 of gestation from each of 3 treatments: intact (INT), unilaterally hysterectomized-ovariectomized white crossbred (UHO), and intact Meishan (ME) gilts (n = 5-6/treatment/day). A 436-bp cDNA was produced using reverse transcription and polymerase chain reaction procedures with pig liver

total RNA and primers complementary to porcine GR. The cDNA was cloned into a PCR II vector and sequenced. Northern hybridization analyses were conducted using 30 μg of total RNA. Glyceraldehyde-3-phosphate dehydrogenase (GAPDH) mRNA expression was measured to adjust for lane loading differences. Relative concentrations of GR mRNA were reported as arbitrary units after analysis of covariance using GAPDH as a covariate. Embryonic liver steady state GR mRNA expression did not vary among treatments but was highest (P < 0.01) on d 24 (15402 ± 849 vs 12150 ± 737 vs 12246 ± 777; d 24, d 30, and d 40, respectively). Placental GR mRNA was lower (P = 0.03) in UHO fetuses on d 24 (14540 ± 1027) compared with INT fetuses (17646 ± 1149). ME placental GR mRNA increased (P < 0.01) between d 30 (13393 ± 1158) and d 40 (18703 ± 1141) and on d 40 was greater (P = 0.02) in ME than in white crossbred fetuses (14843 ± 1477). These data indicate the presence of GR mRNA in porcine fetal tissues during early gestation and provide strong evidence for an involvement of cortisol in porcine fetal development.

Key Words: Pig, Fetus, Glucocorticoid Receptor

178   Pharmacokinetics of pig beta-adrenergic receptors. T. Naile*, H. Cao, W. Liang, and S. E. Mills, *Purdue University, W.Lafayette, IN.*

Beta-Adrenergic receptors (βAR) from pig adipose and muscle tissue are activated fully by only a few βAR ligands and exhibit only partial activation to the common drugs used in animal growth trials. Partial agonist-responses are not related to ligand binding, but rather to incomplete βAR activation. To determine if the high degree of selection is inherent in the βAR protein, cloned pig β1AR and β2AR expressed in Chinese hamster ovary cells were used in adenylyl cyclase (AC) induction studies. CHO cells were grown to confluence, ruptured in hypotonic saline, and total cell membranes isolated by centrifugation. Membranes were incubated for 10 min at $37°$ in the presence of various ligands and cAMP determined by RIA. For the β1AR, results were consistent with data from pig tissue. Maximum rates of AC activation were compared with 10^{-4} M ligand. Isoproterenol (ISO), epinephrine, and norepinephrine exhibited similar efficacies (P>.05). None of the other 16 ligands tested exceeded 40% of the ISO response. Of the ligands used in pig growth studies, L-644,969 was the most efficacious (22%), followed by cimaterol, ractopamine, clenbuterol, and salbutamol (5-15% of ISO). Results for the β2AR differed from the β1AR. Relative maximal-responses were greater for several ligands. In particular, L-644,969 (62% of ISO), salbutamol (36%), ractopamine (28%) and clenbuterol (10%) showed increased efficacy towards the β2AR. For both the β1AR and β2AR, potency for activation of AC (EC$_{50}$) were highly associated with binding affinity (r^2>.9). Data support our hypothesis that pig βAR are highly selective to the ligands which activate AC and that selection is inherent to the βAR protein. The β1AR exhibited greater selectivity than the β2AR, however, the β2AR clone had nearly a 4-fold greater receptor density than the β1AR, which may have contributed to the greater responses. The β1AR is the predominant βAR in pig adipose and muscle tissue and an attenuated response at this receptor may account for the apparent resistance of pig adipose tissue to growth modification by most tested ligands *in vitro* and *in vivo*.

Key Words: pig, beta-adrenergic receptor, adenylyl cyclase

179   IGF-I expression levels in striated and cardiac muscle of IGF-I transgenic swine. K. Maruyama*, V. G. Pursel, K. D. Wells, and A. D. Mitchell, *USDA, ARS, Beltsville, Maryland.*

The objective of this study was to evaluate IGF-I expression among muscles from 9 lines of transgenic (TG) pigs. Founder TG pigs carrying a fusion gene composed of avian skeletal α -actin regulatory elements and a cDNA encoding hIGF-I were mated to non-TG pigs to produce G1 TG and non-TG progeny. At 120 kg, TG pigs and control pigs were killed to collect cardiac (H)and skeletal muscles (SM): *Gastrocnemius* (GC), *Gluteus medius* (GM), *Longissimus dorsi* (LD), *Semitendinosus* (ST), and *Serratus ventralis* (SV) for total RNA. IGF-I mRNA was only found in 6 of 9 TG lines, and one line had several indistinct bands instead of a single band. Further evaluations were confined to 17 progeny from five TG lines. In Northern Blot, IGF-I mRNA was probed with hIGF-I cDNA and quantitated by chemifluorescence intensity. IGF-I mRNA abundance was then normalized for β -tubulin mRNA for comparison. The mean and S.E. of IGF-I mRNA in H, GC, GM, LD, ST and SV were 3.7±.72, 3.2±.97, 5.1±1.33, 1.4±.37, and 1.8±.48, respectively.

Interaction of line X muscle was significant (P<.05). In Line 4, IGF-I mRNA was more abundant in H than in SM (P<.05) and IGF-I mRNA in LD was more abundant than in GC, ST, and SV (P<.05). In Line 9, IGF-I mRNA was more abundant in LD than other muscles (P<.05). IGF-I expression in H and SM muscle was similar for TG males and females. Loin eye area (LEA) was 4.6 cm^2 higher for TG pigs than for non-TG siblings (P<.05), but the increased LEA among TG pigs was not correlated with the abundance of IGF-I mRNA of the LD (r=0.46). The findings suggest the level of IGF-I expression was adequate in all five lines for maximum muscle stimulation by this growth factor.

Key Words: Swine, Transgenic, IGF-I

180   Intramuscular injection of DNA encoding IGF-I increases IGF binding protein-2 expression in pigs. R. S. R. Everett, D. E. Gerrard, and A. L. Grant*, *Purdue University, West Lafayette, IN.*

To characterize the role of IGF-I and its interaction with IGF-binding proteins in vivo, we have been investigating a direct DNA injection approach for obtaining production of IGF-I in porcine skeletal muscle. Objectives of the present study were to determine if intramuscular injection of DNA encoding IGF-I results in recombinant IGF-I production, and to determine effects of local IGF-I production on IGF binding protein-2 expression in porcine skeletal muscle. To distinguish exogenous IGF-I from endogenous IGF-I, a plasmid DNA vector was designed to express recombinant IGF-I with an 11-amino acid epitope tag (T7 tag) driven by a constitutive CMV promoter (TIGF-I). This construct results in production of biologically-active recombinant IGF-I in muscle cell cultures. Each longissimus muscle of six 7-d old suckling pigs was injected with TIGF-I DNA at two sites (100 μg/site). A third site was injected with vehicle only (negative control). At d10 of age, two of the injected pigs were euthanized for muscle collection, two pigs were weaned, and two pigs remained with the sow. At d11 of age, the remaining four pigs were euthanized. Muscle samples from injection sites were sectioned and immunoreactive TIGF-I was localized to myofibers of DNA-injected muscle. Amounts of TIGF-I in muscle homogenates were quantified by western blotting and ELISA. TIGF-I, expressed per 10 μg muscle protein, was .39, .35, and .2 ng, in d10 suckling, d11 suckling, and d11 weaned pigs, respectively (P<.01). Relative amounts of IGF binding protein-2 and binding protein-2 mRNA were determined by ligand and northern blotting. At d10, IGF binding protein-2 and mRNA were at least 6.7-fold and 1.6-fold greater, respectively, in muscle expressing TIGF-I than in negative controls. Weaning blunted (P<.01) the TIGF-I induction of IGF binding protein-2. We conclude that direct DNA injections can be used for production of a biologically-active recombinant IGF-I, and that increased production of IGF-I results in increased production of IGF binding protein-2.

Key Words: IGF-I, IGF binding protein, Muscle

181   Nutritional regulation of the genes encoding the sheep acid labile subunit and other components of the circulating IGF system in sheep. R. P. Rhoads*, A. W. Bell, P. L. Greenwood, and Y. R. Boisclair, *Cornell University, Ithaca, NY.*

In sheep, the perinatal period is associated with maturation of the endocrine arm of the insulin-like growth factor (IGF) system, which is characterized by two developmental events. First, concentrations of circulating IGF-I increase rapidly after birth and become responsive to changes in nutrition and growth hormone (GH) status. Second, the liver initiates synthesis of a serum protein called the acid labile subunit (ALS). ALS promotes the endocrine actions of IGF-I and -II by extending their half-lives in circulation. This action of ALS is a consequence of its ability to recruit IGF-I or -II and IGF-binding protein-3 (IGFBP-3) to a complex of 150 kDa. In this study, we examined the effect of nutrition on the hepatic expression of the sheep ALS gene and other genes encoding important components of the circulating IGF system during late fetal and neonatal life. To study the effect of nutrition during fetal life, livers were obtained from normal or growth retarded lambs (50% of normal size, P< 0.05) at 130 d of gestation (n=8) and at birth (n=7). Growth retardation is the result of placental insufficiency and represents chronic fetal undernutrition. At 130 d of fetal life and at birth, chronic undernutrition caused lower expression of the ALS and IGF-I genes (P< 0.05). Fetal undernutrition also decreased the levels of IGFBP-3 mRNA at birth (P< 0.05), but did not affect expression of the IGFBP-2 gene at either times. To study the effect of nutrition in early

postnatal life, lambs (n=18) were fed a milk replacer to sustain gains of 150 or 337 g/d. Hepatic gene expression was analyzed between day 12 and 38 after birth. The high plane of nutrition increased the expression of the ALS and IGF-I genes and decreased the expression of the IGFBP-2 gene (P< 0.05). Expression of the IGFBP-3 gene was identical across treatments. In summary, expression of the sheep ALS gene is modulated by nutrition in late fetal and in early postnatal life. These results are consistent with the hypothesis that changes in circulating ALS may be partly responsible for the effects of nutrition on circulating IGF-I.

182   Somatotropin inhibits sensitivity and responsiveness to the antilipolytic effect of insulin in adipose tissue from growing, but not neonatal pigs. Y. X. Wang*, S. K. Fried, and P. A. Schoknecht, *Rutgers University, New Brunswick, NJ.*

We previously demonstrated that somatotropin (ST) antagonizes the stimulatory effect of insulin on lipogenesis in adipose tissue of both neonatal and growing pigs. The purpose of this study was to determine if ST also influences the antilipolytic effect of insulin. Subscapular adipose tissue fragments from five neonatal (3.2 ± 0.2 kg, 7-d of age) and five growing (15.4 ± 0.7 kg, 62.4 ± 0.5-d of age) crossbred pigs were cultured without or with ST (4.5 nM) for 24h. Isolated adipocytes were then prepared from cultured adipose tissue and acutely incubated for 2h with varying concentrations of insulin (0, 10, 25, 40, 400 pM) and 8-Br-cAMP (1 mM) to stimulate lipolysis. To minimize variability, all incubations contained the adenosine analog (PIA, 20 nM) and adenosine deaminase to remove endogenous adenosine. Glycerol accumulation in the medium was used as an index of lipolysis. In both age groups, culture with ST significantly increased 8-br-cAMP-stimulated lipolysis. In growing pigs, insulin significantly inhibited lipolysis, but the maximal effect was greater in controls (decreased by $79 \pm 5\%$ (C) vs $58 \pm 1\%$ (ST); $p < 0.01$). Culture with ST also decreased sensitivity to insulin (rightward shift in dose-response curve). ED_{50} was significantly increased from 12 ± 3 to 40 ± 3 pM ($p < 0.01$) by culture with ST. In contrast, in neonatal pigs, culture of adipose tissue with ST did not affect responsiveness or sensitivity to the antilipolytic effect of insulin (maximal decreased by $66 \pm 2\%$ (C) vs $68 \pm 3\%$ (ST); ED_{50}: 9 ± 1 pM (C) vs 12 ± 2 pM (ST)). Taken together with our previous results, ST increases basal and cAMP-stimulated lipolysis in adipose tissue of both neonatal and growing pigs. However, in contrast to growing pigs, ST does not affect sensitivity and responsiveness to insulin's antilipolytic effect in neonatal pigs. Thus, the mechanism by which ST leads to lower lipid deposition differs in neonatal and growing pigs.

Key Words: Somatotropin, Insulin, Lipolysis

183   Increased insulin-like growth factor-1 concentrations following injection or implantation of a human growth hormone-releasing factor (GRF) analog in growing pigs. P. Dubreuil*[1] and P. Brazeau[2], [1]*Faculty of Veterinary Medicine,* [2]*Notre-Dame Hospital, Univ. of Montreal, Montreal, Quebec, Canada.*

Previously, hexenoyl trans 3 human (h) GRF(1-44)NH2 (TH9507) has been shown to be 80 times more potent than the hGRF(1-44)NH2 (hGRF) on ST release. To evaluate TH9507 on IGF-1 increment, 16 barrows (43.9 ± 4.9 kg) were injected sc BID for 6 consecutive days with either 3.0 or 30.0 μg/kg/injection. IGF-1 concentrations on days 0,2,4,6,7, and 8 reached 178, 244, 281, 307, 249, 218 ng/mL; SEM = 18 and 166, 254, 318, 342, 293, 229 ng/mL; SEM = 17 for 3 and 30 μg/kg doses, respectively. All values were significantly different than day 0 at the exception of day 8 at the 3.0 μg/kg dose. Secondly, 64 barrows (40.6 ± 2.6 kg) were allotted in 8 treatment groups: 1) control; 2) hGRF (30 μg/kg sc SID) injected for 6 consecutive days; groups 3-8 were implanted sc (3 mm) with hGRF; 3) 1x7.5 mg; 4) 2x7.5 mg; 5) 4x7.5 mg; 6) 2x15 mg; and TH9507: 7) 1x7.5 mg; 8) 2x7.5 mg. Sera were obtained on days 0,1,2,3,4,5,6,8,10,12,14,16 for IGF-1 determination and hGRF was assayed from d 0 to 8. GRF AUCs were 1824, 2817, 2190, 1936, 2984, 2412, 3087, 4835 ng/mL/d; SEM = 224 and IGF-1 AUCs were 3606, 3989, 4197, 4587, 3987, 4022, 6041, 6367 ng/mL/d; SEM = 210 for groups 1 to 8, respectively. The injection of either 3.0 or 30.0 μg/kg of TH9507 over 6 consecutive days produced increases of 72% and 106% of IGF-1 concentrations, respectively. The 3.0 μg/kg dose produced an increase in IGF-1 similar to the 30 μg dose as previously reported on ST release. When hGRF was compared to TH9507, the immunoreactive GRF was significantly increased only after TH9507 implantation which also produced significant increases in IGF-1 AUCs over 16 days. Compared to control, one and 2 implants of TH9507 produced daily increases

of IGF-1 during 8 and 16 days, respectively and hGRF did not produce any significant increase . These data indicate that this analog is more potent than hGRF in increasing IGF-1. Sponsored by Theratechnologies Inc. Montreal, QC, Canada.

Key Words: GRF, IGF-1, Pig

184   The interaction of recombinant bovine somatotropin (rbST) and cottonseeds in the diet on performance, plasma hormone concentration and muscle fatty acids composition in Holstein-Friesian male calves. Z. Holzer*[1], Y. Aharoni[1], A. Brosh[1], A. Orlov[1], and D. Sklan[2], [1]*ARO, Institute of Animal Science, Newe Yaar Research Center, Israel,* [2]*Faculty of Agriculture, The Hebrew University, Rehovot, Israel.*

In a former study (Holzer et al., 1999, JAS, in press) we have found a trend toward an increase in polyunsaturated fatty acids (PUFA) in rbST treated animals. The objective of the present study was to assess the interaction between rbST treatment and a diet containing delinted whole cottonseeds (CS), rich in PUFA, on performance, plasma hormone concentration and muscle fatty acids composition in Holstein-Friesian male calves. Fifty-six male calves, about 223 d old with an average weight of 276 kg at the start of the experiment, were assigned at random, in an a 2x2 factorial design (n=14), with two levels of rbST (0; rbST) and two diets (with and without 9.5% CS). The diets contained about 2.7 Mcal/kg DM, metabolizable energy, and 13.4% crude protein. The rbST treated and the control animals received injections of 500 mg Posilac®, and placebo every 14 d. The experiment lasted 170 d and the animals were slaughetered at an average weight of 486 kg. There were no significant interactions between rbST and CS treatments, as for performance. The plasma concentrations of GH and IGF-1 was higher (P<.001) in the rbST treated animals. There was a highly significant (P<.001) interaction between rbST and CS as for urea-N concentration in blood (rbST, CS animals had 23% less urea in blood than the CS fed and rbST untreated animals). Concentration of C16:0 was decreased and of C16:1 was increased by rbST in the muscle of the CS fed calves. These interactions were highly significant (P<.001). rbST decreased the C18:1 (P<.05), and increased the C18:2 (P<.05), C18:3 (by 87% but NS), and C20:4 by 18% (NS). The results of the present study indicated the possibility of manipulating the muscle fatty acid composition by combining rbST treatment with a diet containing PUFA.

Key Words: Male Calves, Bovine Somatotropin, Cottonseeds

185   Effect of Posilac® and Revalor®-S alone and in combination on soft tissue composition and rate of soft tissue gain in feedlot steers. T. C. Bramble*[1], R. A. Roeder[2], B. C. Peterson[2], M. J. Roeder[2], and G. T. Schelling[2], [1]*Texas Tech University,* [2]*University of Idaho.*

This study evaluated soft tissue carcass composition and rate of soft tissue gain in 18 Angus crossbred steers averaging 345 kg treated with Posilac® and Revalor®-S, alone and in combination, in a 120-d feedlot trial. In a completely randomized design treatments were: 1) CON (Control); 2) POS (Posilac® 320-mg recombinant bovine somatotropin s.c. injection/14 d); 3) REV (Revalor®-S, 120-mg trenbolone acetate and 24-mg estradiol 17-β implant); and 4) POS+REV. The left side of the carcass was seperated into the chuck, rib, round, loin, brisket, foreshank, flank, plate, and KPH fat. Individual cuts were weighed and separated into lean tissue, fat, and bone. All soft tissue was ground through a .64-cm plate followed by a .32-cm plate and analyzed for protein, ether-extractable fat, and moisture. Selected treatment effects are summarized below.

			Treatment			
Item	CON	POS	REV	POS+REV	*Prob.*	SE
Carcass Composition						
Protein, %	14.98^a	16.09^b	16.25^b	16.36^b	*	.37
Fat, %	30.43^a	27.33^b	25.92^b	24.21^b	*	1.58
Moisture, %	54.59^a	56.58^b	57.83^b	59.43^b	**	1.29
Rate of gain						
Protein, (g/d)	99.67^a	112.08^{ab}	122.35^b	117.43^b	*	7.73
Fat, (g/d)	209.12^a	180.80^{ab}	181.90^{ab}	159.39^b	**	15.56
Moisture, (g/d)	318.88^a	352.80^{ab}	384.65^b	396.53^b	**	18.88

^{a,b} Means within a row with different superscripts differ at $^*P < .10$, $^{**}P < .05$. Carcass protein was increased 7.4, 8.7, and 9.2% while carcass fat was concomitantly reduced 10.2, 14.8, and 20.3% by POS, REV, and POS+REV, respectively as compared to CON. Furthermore, REV increased the rate of protein deposition 22.8%, while POS+REV decreased fat deposition 23.7% when compared with CON. These data demonstrate the anabolic and catabolic effects of Posilac® and Revalor®-S when used alone and in combination on protein deposition and fat reduction in feedlot steers

Key Words: Steers, Growth, Somatotropin

186   Growth performance and carcass characteristics of feedlot steers fed MGA. W. M. Moseley*, D. M. Meeuwse, J. F. Boucher, K. J. Dame, and J. W. Lauderdale, *Pharmacia & Upjohn Animal Health.*

Growth and carcass performance response was examined in finishing steers fed 0, 0.1, 0.2 and 0.4 mg MGA/head/day. Cross bred steers averaging 665-925 lbs were assigned to 5 replicates of 4 pens/replicate, ≈170-200 head/pen. Pen weights were collected on Day 0, 56 and 7 days prior to slaughter (≈130 days on feed). ADG was 3.98, 4.08, 3.97 and 4.02 lbs/day and FE was 5.90, 5.80. 5.86, and 5.81 in steers receiving 0, 0.1, 0.2, and 0.4 mg MGA/head/day. Only 0.1 mg MGA dose group had statistically significantly higher gains (2.4%, P=0.008) than controls whilst 0.2 and 0.4 mg MGA dose groups were not different. Small improvements in FE for 0.1 (1.7%, P=0.031) and 0.4 (1%, P=0.048) MGA dose groups were statistically better compared to controls whilst 0.2 mg MGA dose was not different. No significant differences were detected between controls and MGA treatment groups for quality grade, marbling scores, yield grades, back fat thickness, hot carcass weights, dressing %, and rib eye area. Incidence of dark cutter carcasses and bullers ranged from 0.34% to 0.61% and 1.11% to 0.44%, respectively, for treatment groups. In conclusion, MGA fed to finishing steers produced small improvements in growth performance at 1 mg MGA/head/day but none of the doses produced improvements in carcass quality or yield grade measurements. No evidence of a detrimental effect on performance or carcass characteristics was detected in steers fed 0.1 to 0.4 mg MGA/head daily during the finishing period.

Key Words: MGA, Steer, Growth

187   Effect of endotoxin (LPS) challenge on thyroid hormone status in cattle: effect of diet and somatotropin (bST) treatment. S. Kahl*[1], T. H. Elsasser[1], T. S. Rumsey[1], and R. Hoffman[2], [1]*USDA, Agricultural Research Service, Beltsville, MD,* [2]*Monsanto Co., St. Louis, MO.*

Thyroid status is compromised in a variety of acute and chronic nonthyroidal illnesses. Our objective was to determine the effect of graded levels of LPS challenge (0, .2, 1.0, 3.0 μg/kg BW, i.v. bolus, *E. coli* 055:B5) on plasma thyroxine (T_4) and triiodothyronine (T_3) concentrations and on hepatic 5'-deiodinase activity (5'D). We also studied the modifications of these responses by recombinant bST treatment (.1 mg/kg BW, i.m. daily for 11 d) and diet (all-concentrate [C] vs 60% forage [F]; 5 wk of adjusted intake to gain 1.25 kg BW/d). Four heifers and 28 steers (Angus × Hereford, 243 ± 4 kg) were assigned in a factorial arrangement in two replications to treatments consisting of +/- bST (n = 16), C/F diet (n = 16), and LPS dose (n = 8). Treatment with bST was switched between the replications. Saline or LPS were injected through the jugular vein and blood samples were collected at 0, 3, 6, 12, 24, and 48 h relative to injection. Liver biopsy samples were obtained 8 h after LPS injection. All LPS doses decreased (P < .01) plasma T_4 and T_3 at 6, 12, and 24 h: negative response, measured as area under the time × concentration curve (AUC), increased with LPS dose fitting a linear relationship with the LPS dose for T_4 ($r^2 = 0.996$, P < .05) and with the log of LPS dose for T_3 ($r^2 = 0.999$, P < .05). At all LPS doses, plasma T_4 response (negative AUC) was less in C-fed than in F-fed animals (-155 vs -343 ng/mL × h, SEM = 40, P < .01). The bST treatment did not affect plasma T_4 and T_3 concentrations and response to LPS. Hepatic 5'D activity (nmol I^- × h^{-1} × mg protein^{-1}) was increased by bST treatment (2.02 vs 1.36, SEM = .12, P < .01), was greater in F-fed than in C-fed animals (1.90 vs 1.49, P < .05) but was not affected by LPS challenge. Results suggest that the reduction in plasma T_4 and T_3 in the early phase of acute response to LPS is related to reduced thyroid secretion which could be modified by diet but not by bST treatment.

Key Words: Thyroid hormone, Endotoxin, Somatotropin

188   Effect of selection for weight on body composition and carcass characteristics of *Bos indicus* and *Bos taurus*. R. F. Nardon[1], A. A. M. Sampaio[2], A. G. Razook[1], L. O. Tedeschi*[3], L. A. Figueiredo[1], C. Boin[4], and M. L. P. Lima[1], [1]*Instituto de Zootecnia, Nova Odessa, Brazil,* [2]*FCAV-UNESP, Jaboticabal, Brazil,* [3]*Cornell University, Ithaca, NY,* [4]*ESALQ-USP, Piracicaba, Brazil.*

This work evaluated the growth performance, and body and carcass composition of 144 animals of three *Bos indicus* breeds (selected Nelore - NeS, Guzera - GuS, and control Nelore - NeC) and one *Bos taurus* (Caracu - CaS) in order to verify the effect of genetic selection on weight at 378 days of age (P378). These animals were born at Estaçao Experimental de Zootecnia de Sertaozinho, SP, Brazil. The sampling was based on the average of P378 for each herd. The diet was composed of corn silage (45%, DM) and concentrate (55%, DM). The slaughter periods were performed at 88, 173, and 266 days of feedlot. At that time, animals had 16.1 ± 0.8, 19 ± 0.9, and 22 ± 1.1 months of age, weighing 385 ± 33, 464 ± 33, and 547 ± 53 kg respectively. NeS animals had higher (P<.05) carcass weight (289.3 vs 259.3 kg) and half carcass edible meat (98.4 vs 88.7 kg) than NeC, respectively. However, NeS and NeC had similar (P>.05) half carcass trimmed tissues (19.8 vs 18.1 kg). Also, NeS had higher (P<.05) carcass weight and half carcass edible meat than GuS (268.4 kg and 90.8 kg), but identical (P>.05) half carcass trimmed tissues than GuS (18.0 kg). In contrast to NeC and GuS, CaS had similar (P>.05) carcass weight (280.8 kg) and half carcass edible meat (97 kg) to NeS, but lower (P<.05) half carcass trimmed tissues (16.5 kg) than NeS. Regarding the empty body weight comparisons, NeS had higher (P<.05) carcass edible meat percentage and hindquarter edible meat percentage than GuS and CaS (46.0, 44.1, and 44.6%; 20.7, 19.6, and 19.7%) respectively, but was similar (P>.05) to NeC (46.0 and 20.8%). CaS showed lower (P<.05) shear force (3.55 kg) than NeS, GuS and NeC, which had similar (P>0.05) shear force (4.58, 4.65 and 4.73 kg, respectively).

Key Words: Body composition, Carcass characteristics, *Bos indicus*

189   Adipocyte cellularity in Korean Native Cattle. C. B. Choi*[1], S. K. Hong[2], H. C. Kim[2], K. J. Na[2], and S. H. Lee[2], [1]*Department of Animal Science, Yeungnam University, Gyeongsan, Korea,* [2]*National Livestock Research Institute, Suweon, Korea.*

One hundred and twenty (120) Korean Native Cattle (steers) were used to investigate changes in adipocyte cellularity during various physiological stages. Experimental animals were castrated at five months of age and assigned to the experiment at six months of age after a month acclimation period. Contents of crude protein and total digestible nutrients in concentrate were 15% and 70%, 12% and 71%, and 11% and 72% during the growing period, fattening period, and finishing period, respectively. Concentrates and rice straw, as a sole roughage source, were fed ad libitum during the entire experimental period. Starting from six months of age, eight to ten animals were sacrificed at two month intervals until termination of the experiment at 30 months of age. Adipose tissue from perirenal, mesenteric, subcutaneous, and intramuscular fat depots was fixed in osmium-collidine buffer and measured for adipocyte diameter, area, and volume using a Coulter Counter. Perirenal fat showed the fastest adipocyte growth and reached maximum diameter ($210\mu m$) at about 24 months of age. Adipocyte cellularity determined by diameter, area, and volume was in the order of perirenal> subcutaneous> mesenteric> intramuscular fat depot at the same physiological stage. Extension of the feeding period beyond 24 months did

not affect adipocyte cellularity in any fat depot except intramuscular fat in which adipocytes kept growing until 30 months of age. Visually, intramuscular fat started to accumulate at about 10 months of age. However, dissection of fatty mass for cellularity determination was impossible until the animals reached 14 months of age. The results indicate that there might be at least three - 12, 18 and 24 months of age - important threshold-like physiological stages in Korean Native Cattle for accumulation of triglycerides in adipocytes. In conclusion, the current study provides basic information about adipocyte growth in Korean Native Cattle. The data could be used to manipulate nutrient content in the diet of beef cattle, in relation to fat accumulation in various fat depots and body growth, at different physiological stages.

Key Words: Adipocyte, Cellularity, Beef cattle

190   Effect of a nutritionally-directed compensatory growth regimen on growth potential and lactational performance of beef heifers. W. W. Poland*[1], K. A. Ringwall[1], R. D. Danielson[2], J. W. Schroeder[2], and C. S. Park[2], [1]*North Dakota State University, Dickinson,,* [2]*Fargo, ND.*

A nutritionally-regulated and time-dependent compensatory growth regimen during the hormone-sensitive growth phase prior to first parturition can effect mammary development and subsequent lactational performance. The objective of this study was to determine the effect of a stair-step nutrition program imposed during the pubertal phase on growth performance and lactation potential of beef heifers. Ninety-six beef heifers (285 ± 17.8 kg; $6.2 \pm .38$ body condition score [BCS]; approximately 305 d of age) were blocked by weight and assigned to either a control (CON) or stair-step compensatory nutrition (SSCN) regimen. Heifers assigned to CON were fed a diet balanced to meet the nutrient requirements of heifers gaining .68 kg/d for 20 wk. Heifers assigned to SSCN were fed an energy restricted diet for 10 wk. ME of the energy restricted diet was similar to CON, however, DMI was restricted to 60% of that of the CON. CP was increased in the restricted diet to allow similar daily intakes between dietary treatments. Following the restricted phase, SSCN heifers were given ad libitum access to a high energy diet (130% ME and 100% CP of CON) for 10 wk. Subsequently, all heifers were managed as CON through breeding. ADG (.56 vs .07 kg/d; $P = .04$), BCS (6.0 vs 5.2; $P = .03$) and growth efficiency (gain x 100/DMI; 8.4 vs 1.7%; $P = .08$) were reduced in the SSCN group during the energy restricted phase. Conversely, ADG (.84 vs 1.57 kg/d; $P = .01$), BCS (6.2 vs 6.7; $P = .03$) and growth efficiency (11.4 vs 17.4%; $P = .01$) were improved by SSCN during the high energy phase. DMI (7.4 vs 9.1 kg/d) was increased by SSCN during the later phase. Over the entire feeding period, ADG (.70 vs .82 kg/d; $P = .16$) and DMI (7.1 vs 6.7 kg/d; $P = .14$) were not affected by dietary regimen. However, growth efficiency (10.0 vs 12.0%; $P = .07$) and heifer conception rate during the breeding season (75.0 vs 89.6%; $P = .06$) were improved by the SSCN regimen. These results indicate that beef heifers raised on a stair-step nutrition and feeding regimen during puberty had improved growth performance.

Key Words: Beef Heifers, Compensatory Growth, Growth Performance

191   Effects of increased feed intake in early gestation on sow farrowing performance and offspring carcass characteristics. R. E. Musser*[1], S. S. Dritz[1], M. T. Tokach[1], D. L. Davis[1], R. D. Goodband[1], J. L. Nelssen[1], M. Heintz[2], and J. Bauman[2], [1]*Kansas State University, Manhattan,* [2]*Global Ventures, Pipestone, MN.*

Three hundred and ninety-four sows (PIC C15) were used to determine the effects of increased feed intake during two stages of fetal development on farrowing performance and offspring carcass characteristics. Sows were fed either 3.62 kg/d of a gestation diet (.65% lysine, .9% Ca, and .8% P) for one of three periods, d 10 to 30, d 30 to 50, or d 10 to 50 of gestation or 1.81 kg/d (control). Increased feed intake did not affect the number of pigs born alive, stillborn, or mummified per litter. No differences were observed (P > .10) in litter birth weight. Sows fed 3.62 kg/d of complete diet from d 10 to 30 of gestation tended to have offspring with numerically heavier hot carcass weight (84.9 vs 83.8 kg; P = .16) compared to offspring from sows fed 1.81 kg/d of feed during gestation. Sows fed 3.62 kg/d of feed from d 30 to 50 produced offspring with greater backfat (15.8 vs 14.8 mm; P < .01) and decreased percentage lean (55.9 vs 56.6%; P < .01) than those from sows fed 3.62 kg/d from d 10 to 30 or control sows. No differences were observed in subsequent performance; however, sows fed 3.62 kg/d from d 10 to 50 had a longer weaning to estrus interval. Sows fed added feed from either d 30 to 50

or d 10 to 50 of gestation had greater plasma free IGF-I concentrations (P < .01) on d 50 compared to sows fed either 1.81 kg/d or added feed from d 10 to 30 of gestation. In conclusion, increased feed intake from d 10 to 50 of gestation had no affect on farrowing performance of sows. Offspring from sows fed high feed intake from d 30 to 50 of gestation had increased backfat and decreased percentage lean than control offspring; while offspring from sows that fed increased feed from d 10 to 30 tended to have heavier carcasses compared to controls. Effects observed in the carcass characteristics are inconsistent with previous findings thus more research is needed to determine mechanisms involved.

Key Words: Gestation, Feed Intake, Offspring

192   Alterations in *in vivo* whole-body insulin resistance according to physiological state in Karakul ewes. R. M. Slepetis*, R. A. Ehrhardt, S. S. Block, Y. R. Boisclair, and A. W. Bell, *Cornell University, Ithaca, NY.*

Pregnancy and lactation have been shown to increase insulin resistance on a whole-body basis and in major insulin responsive tissues in many animal models. The time course of this phenomenon has not been studied *in vivo* in domestic ruminants throughout the reproduction-lactation cycle. The objective of the present study was to examine alterations in whole-body insulin resistance *in vivo* in the fat tailed sheep (Karakul breed) before mating (non pregnant, non lactating), and during mid pregnancy (d 50-60 post coitus [PC]), late pregnancy (d 125-135 PC) and early lactation (d 15-22 post parturition). The same multiparous ewes (n=8) were studied at each period. Blood samples were obtained periodically for approx. 2 h pre-injection, then a single injection of insulin was given I.V. (300 I.U./kg body weight) and serial blood samples were taken via a jugular catheter for 3 h post-injection (time 0). The difference in plasma glucose concentrations at time 0 and at the nadir in plasma glucose post injection (Δ glucose) was used as an index of whole-body insulin resistance. Δ glucose decreased between pre-mating (44.1 mg/dL) and mid pregnancy (38.6 mg/dL) (P<0.05) and was further decreased (32.4 mg/dL) in late pregnancy (P<0.05). Δ glucose did not change between late pregnancy and early lactation. These data indicate that pregnancy associated insulin resistance increases progressively during pregnancy and remains enhanced during early lactation in the fat tailed ewe. These data lay the groundwork for future studies aimed at understanding the regulation of insulin resistance and energy balance during these physiological states. The fat tailed sheep, in particular, provides a good model to study sequential physiological changes in adipose tissue metabolism and gene expression.

Key Words: Karakul Sheep, Insulin, Glucose

193   Effect of zinc deficiency on thyroid hormone action in the rat. K. K. Guda*, H. C. Freake, and S. A. Zinn, *University of Connecticut, Storrs.*

Both zinc and thyroid hormone influence growth and development by poorly understood mechanisms. Since the thyroid hormone receptor is thought to be a zinc protein, we sought to determine whether the effects of zinc deficiency were mediated in part by impaired thyroid hormone function. Four week old male Sprague-Dawley rats (n=45) were randomly assigned to treatment in a 3X3 factorial design with main effects of Zn status (Zn-deficient (Zn-D), pair-fed (PF) and control (CON) Zn-sufficient feed) and thyroid status(Hypo-, Eu- and Hyper-thyroid). Rats were made Zn-deficient by feeding a Zn-deficient diet (Dyets Inc. Bethlehem, PA). Food intake of Zn-D rats was recorded daily and PF animals were given this amount of food the next day, corrected for metabolic body weight. Hypothyroidism was induced by inclusion of .025% methimazole in the drinking water and hyperthyroidism by daily injection with T3 (15 μg/100g BW i.p). Rats averaged 107+3g BW at the start of the experiment and gained 43, 81 and 166g over the 25 days of the experiment in Zn-D, PF and CON groups respectively. Within a feed group, the hypo rats gained less weight (p<.05) than the eu and hyper-thyroid rats. Daily feed intake by the Zn-D group was 61% of the feed consumed by the CON group and within each feed group hypo rats had reduced (p<.05)feed intake compared with eu and hyper-thyroid rats. White adipose tissue was reduced (p<.05)as a percent of BW in hypo and Zn-D rats. Heart weight was increased (p<.05)in hyperthyroid rats, in all dietary groups. Serum Zn concentrations were 10.7, 32.8 and 30.9 μM in the Zn-D, PF and CON groups, respectively. S14 mRNA, a well-described sequence known to be responsive to thyroid hormone in liver, was measured as an index of thyroid hormone action in liver. While S14 expression was responsive to thyroid hormone status, this response did not differ between the three dietary groups. Thus, Zn deficiency and

hypothyroidism reduced feed intake, growth rate and white adipose tissue mass. However Zn status did not influence thyroid hormone action on S14 gene expression in liver.

MEAT SCIENCE AND MUSCLE BIOLOGY

194   The influence of ageing and type of muscle on lysosomal proteinases degradation. F. Nicastro*, *Università di Bari, Dipartimento di Produzione Animale, Bari, Italy.*

Post-mortem storage or ageing of meat has long been regarded as essential to the production of tender meat. With the increasing consumer emphasis on quality rather than quantity, the importance of this process in meat production is greater than ever before. Activity of lysosomal proteases is an important factor contributing to post-mortem changes in muscle, including increased tenderness. The purpose of our contribution is to evaluate the role of one catheptic enzyme, cathepsin D, in post-mortem proteolysis in the longissimus thoracis (LT) and in the semimembranosus (SM) muscles from 24 lambs at 24h and 7 days ageing after the slaughter. A part from each muscle (20g) was minced and homogeneized in 3 vol of the lysing buffer (50 mM sodium citrate buffer, 1mM EDTA and 0.2% Triton X-100 (vol/vol), pH adjusted to 5.0 with acetic acid). Haemoglobin was used as substrate at the 0.6 final concentration (in % w/v). All samples and blank assayed in quadruplicate, were incubated at $45°C$ for 1h and the enzyme activity was defined as the increase in absorbance at 280 nm and 700 nm for hour at $45°C$ and pH 3.7. The value of cathepsin D was expressed in terms of tyrosine equivalents from a tyrosine standard curve, and reach the maximum value in the SM muscle at both 24h and 7 days of ageing. In the same muscle (SM) the results of the specific activity (17,02 vs 14,19 μg of tyrosine/g protein/h at $45°C$) and total activity (μg of tyrosine/g muscle/H at $45°C$) of cathepsin D are lower in lambs ageing 7 days after slaughter. These results show one more time the different response of the muscles to the myofibrillar degradation. Anyhow the two muscles are not completely aged to the time tested, in order to optimise the storage duration to evaluate the meat tenderness.

195   Purification and characterization of a cysteine myosin-degrading protease. W.-C. Lai*, R. H. McCusker, and J. E. Novakofski, *University of Illinois at Urbana-Champaign.*

Myosin is the major muscle protein accounting for almost 30% of protein in an adult muscle. However, the protease system responsible for myosin degradation has not yet been clearly described. Although most cellular proteins are degraded by proteasomes, evidence indicates that proteasome activity is not rate limiting for myosin degradation. However, a neutral cysteine protease is capable of degrading native myosin II. The myosin-degrading protease was purified from porcine skeletal muscle. After a 35% ammonium sulfate cut, the protease was concentrated with 55% ammonium sulfate. It was further purified by four chromatographic steps using Phenyl-Sepharose, SP-Sepharose, Q-Sepharose, and Casein-Affinity whereby activity eluted with H_2O, 0.3 M NaCl, 0.3 M NaCl, and 5 mM EGTA, respectively. The purified myosin-degrading protease hydrolyzed native chicken myosin II at $50°C$ in the presence of 0.4 M NaCl. The protease also digested denatured casein at $37°C$ in 0.15 M NaCl. Proteolytic activity was inhibited by a cysteine protease inhibitor (E-64), but not affected by serine protease inhibitors (3,4-dichloroisocoumarin, AEBSF, benzamidine, TLCK, and TPCK), or an aspartic protease inhibitor, (pepstatin). While similar to calpain I in requiring μmolar of Ca^{2+} for activity, the myosin-degrading-protease preparation did not react with antiserum to calpain I. Chicken myosin was degraded into limited fragments (Mr of 150,000-140,000, 90,000-80,000, and 30,000). The protease preferred charged amino acids in the P1 position. This report describes a novel protease which is a likely candidate for regulating myosin turnover.

196   The role of the muscle specific calpain p94 in intermuscular variation in tenderness in the sheep. M. Ilian* and R. Bickerstaffe, *Lincoln University, Canterbury, New Zealand.*

Tenderisation of different muscles during postmortem storage at $4°C$ in an individual animal is variable. The biochemical basis underlying intermuscular variations in tenderness is not fully understood. The mechanism of meat tenderisation is under investigation by many labs worldwide. Proteolysis of key cytoskeletal proteins is responsible for improvement in meat tenderness during ageing. There has been considerable debate about the specific proteases responsible for meat tenderisation. Available evidence indicates that the majority of postmortem tenderisation is mediated by the calpains. However, calpains in skeletal muscle comprise the ubiquitous calpain I and calpain II active at μM and mM Ca^{2+} concentrations respectively and the muscle specific calpain p94. Current literature on the role of calpains in meat tenderisation applies to the ubiquitous calpains as it is these that are accessible for assaying enzyme activity. No research has been published on the role of p94 in meat tenderisation. The objective of our study was to further investigate the biochemical basis for intermuscular variation in tenderness by studying the role of p94 in this process using a molecular approach. An S1 nuclease protection assay was developed and validated to determine p94 mRNA levels in sheep skeletal muscle. Six lambs were used. Muscles studied were; *Longissumus dorsi* and *Semimembranosus* as type IIA and *Psoas major* and *Semitendeneosus* as IIB fibre type. Our results show that the relative rate of tenderisation is fibre type dependent. A possible determinant of meat tenderness is the muscle specific calpain p94 as shown by a strong correlation (r= 0.71, P≤0.05) between the relative rate of tenderisation and the p94 mRNA level across all muscles studied.

197   Immunochemical study of the calpain system in porcine longissimus muscle with high and low shear force values. T. Parr[1], P. L. Sensky*[1], G. P. Scothern[1], R. G. Bardsley[1], P. J. Buttery[1], J. D. Wood[2], and C. Warkup[3], [1]*University of Nottingham, Nottingham, U.K.,* [2]*University of Bristol, Bristol, U.K.,* [3]*Meat and Livestock Commission, Milton Keynes, U.K.*

Immunochemical methods have been developed to test whether differences in calpains and calpastatin could underlie the variable shear force values (SF) encountered in commercially-produced pig carcasses. Molecular recombinant technology was used to generate fusion proteins and specific antisera to porcine μ- and m-calpain large subunit and calpastatin for quantitative immunoblotting. Samples (5 g) were taken 2 h postmortem from the last rib region of 112 animals at a commercial abattoir and snap-frozen in liquid nitrogen. Chops from the same muscle were conditioned for 8 d at $2°C$, at which point SF measurements were used to identify 12 tough (SF = 6.71 $\pm$ .28 kg, mean $\pm$ SEM) and 12 tender (SF = 3.87 $\pm$ .11 kg) carcasses for calpain analysis. Whole muscle homogenates or cytosolic extracts prepared from 2 h samples were subjected to 8% SDS-PAGE and immunoblotting. Extracts were screened using μ- and m-calpain and calpastatin antisera and homogenates probed for calpastatin. Immunoreactivity was visualized by enhanced chemiluminescence and quantified by densitometry. Characteristic 80 kDa μ- and m-calpain bands but no autolysed forms were detected, and their electrophoretic mobilities and intensities were the same in high and low SF groups. Both extracts and homogenates showed a dominant 135 kDa calpastatin band which had the same mobility in both groups, but whose intensity correlated positively with SF (P < .05). The electrophoretic mobility data suggest that variable SF in porcine longissimus cannot be attributed to expression of different isoforms, autolysis, or splice variants of μ- and m-calpain and calpastatin. However, the intensity of the 135 kDa calpastatin band in 2 h samples correlates positively with SF, suggesting that the natural abundance of this factor could influence pork quality.

198   Changes in porcine skeletal muscle calpastatin expression induced by a single dose of a β_2-agonist. T. Parr[1], P. L. Sensky*[1], C. Warkup[2], R. G. Bardsley[1], and P. J. Buttery[1], [1]*University of Nottingham, Nottingham, U.K.,* [2]*Meat and Livestock Commission, Milton Keynes, U.K.*

The effects of short-term dietary administration of the β_2-adrenergic agonist clenbuterol on the calpain proteinase inhibitor calpastatin in skeletal muscle was investigated in Large White-type pigs. Animals

were trained to eat their daily diet within a 1 h feeding period. Sixteen h before slaughter 6 control (C) pigs were given the standard diet whilst 5 received the same diet supplemented with .4 mg kg^{-1} body weight clenbuterol (B). Samples of longissimus were taken within 10 mins of slaughter and snap frozen in liquid nitrogen. pH$_{45}$ did not differ significantly between groups although all clenbuterol-treated animals exhibited signs of DFD on the basis of pH$_u$ > 5.9. Calpastatin activity in extracts was significantly higher (P < .05) in the treated animals (C, 23.2 ± 1.3 (mean ± SEM); B, 29.0 ± 1.5 x 10^7 fluorescence units kg^{-1}). Extractable and whole muscle calpastatin protein levels were determined on western blots, using an anti-calpastatin antibody raised against a recombinant protein containing inhibitory domains 3 and 4. The extractable (C, .509 ± .191; B, 1.04 ± .12 Abs units μg^{-1} protein) and whole muscle (C, 52.5 ± 8.75; B, 87.5 ± 20.8 Abs units mg^{-1} tissue) calpastatin was higher in treated animals but this was only significant for the extracted calpastatin (P < .01). A cDNA probe complementary to a region encoding domains 3 and 4 was used to probe N-blots of 20 μg total RNA from the two groups. Multiple transcripts were detected but bands at 5.4 and 2.8 kb predominated. After reprobing the blots with an actin cDNA, the ratios of the 5.4 kb/actin (C, 2.27 ± .28; B, 4.09 ± .72) and the 2.8 kb/actin intensities (C, 1.24 ± .12; B, 2.15 ± .32) increased significantly in treated pigs (P < .05 for both bands). These results suggest a single dose of β_2-agonist is sufficient to induce calpastatin expression detectable at transcriptional level 16 h later.

Key Words: Calpastatin, Skeletal Muscle, beta-Agonist

199 Effects of genetic type and production system on carcass traits of beef steers. A. H. Brown, Jr*, Z. B. Johnson, M. A. Brown, E. L. Oxford, P. K. Camfield, and L. Y. Rakes, *University of Arkansas, Fayetteville.*

Steers (n=335) of known genetic backgrounds from four fundamentally different genetic types were subjected to two production systems to study differences in carcass traits. Genetic types were large frame-late maturing, intermediate frame-intermediate maturing, intermediate frame-early maturing, and small frame-early maturing. Five calves from each genetic type were assigned to one of two production systems in each year of a 9-year study. Twenty-five steers were removed from the study because of accident or illness. System I included management on forage from weaning to slaughter at approximately 20 mo of age, while system II included management in the feedlot from weaning to slaughter at approximately 14 mo of age. Data collected were preslaughter shrunk body weight (SBW); hot carcass weight (HCW); chilled carcass weight (CCW); dressing percentage (DRESS); fat thickness at the 12th and 13th rib interface (FAT); percentage kidney, pelvic, and heart fat (KPH); longissimus muscle area (LMA); marbling score (MARB); quality grade (QG); and yield grade (YG). Data were pooled across years and analyzed by least-squares ANOVA with unequal subclass numbers. Included in the model were the dependent variables of carcass traits and the independent variables of year, genetic type, production system, 2- and 3-way interactions, and residual error. Within each production system steer age was included as a covariate. Year and genetic type were significant for all carcass traits. System was a significant source of variation for SBW (P<.10), but not for carcass traits. The genetic type x system interaction was significant for SBW, HCW, CCW, MARB (P<.05), FAT, and YG (P<.01), but was nonsignificant for DRESS, KPH, LMA, and QG. Carcass differences in measures of fatness were greater and more attainable in the feedlot based system which are important using current methods of evaluation. These data could aid producers in the match of beef genetic type to the production system most suitable for the efficient use of resources.

Key Words: Genetic Types, Production Systems, Carcass Traits

200 Effect of supplemental vitamin E in the diet of finishing steers on meat color stability after 1, 3, 5 and 7 days postmortem. J. F. Calderon-Cortes*[1], F. Figueroa S.[1], A. Plascencia J.[1], N. F. Gonzalez M.[2], H. Gonzalez R.[2], and R. A. Zinn[3], [1]*University of Baja California, Mexicali, B.C., Mexico,* [2]*Centro de Investigacion en Alimentacion y Desarrollo, A.C., Hermosillo, Son., Mexico,* [3]*University of California, El Centro, CA, USA.*

Forty eight crossbred finishing beef steers (368±1.5 Kg) were used in a completely randomized block design experiment to evaluate the effects of four levels (0, 500, 800 and 1,200 IU/d)of vitamin E (DL α-tocopheryl acetate) supplementation in the diet for the last 38 days of feeding on meat brightness and color stability after 1,3, 5 and 7 days postmortem.

Chilled *Longisimuss dorsi* muscle samples (500 g) were taken 12 h after slaughter, polyurethane and plastic wrapped, maintained in marked-like refrigerated conditions (±4°C), and meat visual characteristics evaluated for 7 days. Muscle brightness (L*) and color indexes a* and b* were carried out in a Hunterlab D25M optical sensor, Restom, Virginia, USA. There were no significant differences (P<.10) between the levels of vitamin E supplementation on meat brightness (L*) or on color indexes a* and b*. However there was a tendency, not due to vitamin E, on all treatments to show more brightness of the meat from three days postmortem than at one day after, which was probably due to postmortem muscle water liberation. There was a slight but significant increase in meat color index b* with 1,200 IU/d from day three postmortem. It is concluded that vitamin E at the levels studied here did not show any benefit on meat color stability postmortem.

Vitamin E supplementation on diet, IU/d.					
Time postmortem, d	0	500	800	1,200	C.V.
Meat brightness index (L*)					
1	27.6^{ac}	27.5^{bc}	27.3^{bc}	26.5^{ac}	7.5
3	30.7^{bd}	30.4^{abd}	30.0^{abd}	30.4^{bd}	6.5
5	31.1^{be}	31.1^{abe}	30.4^{ae}	31.2^{be}	7.4
7	31.0^{bf}	31.3^{af}	30.6^{af}	31.1^{bf}	6.5
Meat color index (a*)					
1	13.8^{ac}	14.4^{ac}	14.1^{ac}	12.7^{ac}	13.3
3	13.0^{ad}	11.7^{ad}	11.8^{bd}	13.2^{ad}	19.4
5	12.5^{ae}	11.9^{ae}	11.9^{abe}	12.9^{ae}	17.1
7	12.5^{af}	12.0^{af}	11.9^{abf}	12.8^{af}	14.6
Meat color index (b*)					
1	7.8^{ac}	8.0^{ac}	7.7^{ac}	7.5^{bc}	12.0
2	8.5^{ad}	7.9^{ad}	7.8^{ad}	8.6^{ad}	12.3
5	8.4^{ae}	8.1^{ae}	8.1^{ae}	8.4^{abe}	12.2
7	8.5^{af}	8.3^{af}	8.2^{af}	8.4^{abf}	10.0

^{ab}Means within columns with different letter are significantly different (P<.05).
^{cdef}Means within rows with the same letter are not significantly different (P>.10).

Key Words: Finishing steers, Meat color stability, Vitamin E

201 Effects of graded levels of potato by-products in barley and corn-based beef feedlot diets I. Feedlot performance, carcass characteristics, meat composition and appearance. M. L. Nelson*, J. R. Busboom, J. D. Cronrath, L. Falen, and A. Blankenbaker, [1]*Washington State University, Pullman.*

To measure effects of diet on feedlot performance, carcass characteristics and beef appearance, one hundred forty-four crossbred beef steers (333 kg) were allotted within weight block (3) to a randomized complete block design with a 2 x 3 factorial arrangement of dietary treatments. Main effects were grain (barley or corn) and level of potato by-product (PB) (0, 10 or 20% of diet PM). Steers were fed diets containing 83% concentrate (grain plus PB), 10% supplement and 7% alfalfa on a DM basis for an average of 130d. Level of PB quadratically affected (P ≤ .10) DM intake and gain such that steers fed 10% PB ate more and gained faster. Corn-fed steers were more (P ≤ .05) efficient (5.8 vs. 6.3 kg DM/kg gain) and had more (P ≤ .05) kidney, pelvic and heart fat (2.2 vs. 2.0%) than barley-fed steers. A grain by PB interaction was detected (P ≤ .10) for marbling score where it was minimized in barley diets (small 0) but maximized in corn diet (small 30) at 10% PB. Diet did not affect beef firmness or beef color score. Barley-fed beef had whiter fat (P ≤ .05) than corn-fed beef (2.6 vs. 2.9 on an F scale), however, fat luster score was not affected by diet. Overall, differences were small and probably not biologically important. These results indicate minimal effects of diet on beef appearance and carcass characteristics, meat composition and appearance.

Key Words: Growth performance, Carcass characteristics, Beef appearance

202   Effects of graded levels of potato by-product in barley and corn based beef feedlot diets. II. Palatability. J. R. Busboom*[1], M. L. Nelson[1], L. E. Jeremiah[2], S. K. Duckett[3], J. D. Cronrath[1], and L. Falen[1], [1]*Washington State University, Pullman,* [2]*Agriculture and Agrifood Canada, Lacombe, AB,* [3]*University of Idaho, Moscow.*

The objective of this study was to evaluate the effects of barley- or corn-based diets containing 0, 10 or 20% potato by-product DM (PB) on Warner Bratzler shear force and palatability of beef. One hundred forty-four crossbred beef steers (333 kg) were allotted within weight block (3) to a randomized complete block design with a 2 x 3 factorial arrangement of dietary treatments. Steers were fed diets containing 83% concentrate (grain plus PB), 10% supplement and 7% alfalfa (DM basis) for an average of 130d. Longissimus muscle were evaluated by a professional flavor/texture profile panel, a ten member trained laboratory panel and by consumer panels. Diet did not affect ($P \geq .05$) Warner Bratzler shear force or trained laboratory panel tenderness, juiciness and flavor intensity scores. However, flavor intensity scores tended ($P \leq .10$) to decrease linearly from 6.2 to 6.0 to 5.8 $\pm$ .15 as PB increased. The flavor/texture profile panel scores indicated that beef from steers fed 10 or 20% PB had lower incidences of inappropriate aromatics and after tastes, which may have a slightly beneficial affect on beef flavor, but flavor amplitude was not affected by level of PB. Feeding a corn-based diet as opposed to barley-based diet produced a more appropriate well balanced, and well blended beef flavor and texture, but the magnitude of the differences were small, and the flavor and texture of both barley- and corn-fed beef were well within the acceptable range. Moreover, consumer panel scores for tenderness, juiciness, flavor and overall acceptability were not affected by diet. Thus, the few statistically significant differences that were observed among diets were probably of limited practical importance in palatability of beef.

Key Words: Beef palatability, Potato by-products, Grain

203   Compositional analysis of beef 6-12 rib sections by dual-energy x-ray absorptiometry. A. D. Mitchell*, T. S. Rumsey, M. B. Solomon, and S. Fritsche, *USDA, Agricultural Research Service, Beltsville, MD.*

Dual-energy x-ray absorptiometry (DXA) was used as a non-invasive method to measure composition of 6-12 rib sections obtained from the carcasses of 75 Charolais steers. Carcass weights ranged from 171.6 to 385.5 kg. The weights of the rib sections ranged from 6.15 to 14.93 kg. Each rib section was scanned twice by DXA (Lunar, DPXL), once in the pediatric-medium (PM) mode and once in the adult-detail (AD) mode. After scanning, each rib section was dissected into fat, lean, and bone. The dissected soft tissue (fat plus lean) was analyzed chemically for lipid, protein, and water content. DXA lean values were corrected for amount of bone (less BMC, bone mineral content). There was no difference in the amount of fat measured by DXA-PM (2430 g), DXA-AD (2522 g) or dissection (2239 g) (P > 0.05). Likewise, there was no difference in the percentage fat in the soft tissue measured by DXA-PM (23.41%), DXA-AD (24.15%) or by solvent extraction (24.01%) (P > 0.05). However DXA-PM measurements of both total and percentage fat were more highly correlated (r) with the dissection (0.962) and chemical (0.915) values than were the DXA-AD measurements (0.765 and 0.138). The lower correlation for the DXA-AD measurements was attributed to inconsistencies in measuring the lighter weight ribs. The DXA-AD measurement of lean tissue (5635 g) was less (P < 0.05) than DXA-PM (6136 g), but neither DXA measurement was different (P > 0.05) from the dissected lean weight (5923 g). The DXA-PM measurement of percentage lean was significantly correlated (P < 0.05) with the soft tissue percentage protein by chemical analysis (r = 0.728), soft tissue percentage water (r = 0.954) and the carcass yield grade (r = 0.737). These results are consistent with a previous DXA measurement of beef 9-10-11 rib sections and suggest that the DXA-PM scan may be useful for evaluating beef carcass yield and composition.

Key Words: Beef, Carcass Composition, Dual-Energy X-ray Absorptiometry

204   Breed effects on cholesterol and fatty acids in longissimus muscle of Hereford, Limousin, and Piedmontese F2 crossbred cattle at slaughter. D. C. Rule*[1], R. E. Short[2], M. D. Grosz[2], and M. D. MacNeil[2], [1]*University of Wy, Laramie,* [2]*USDA,ARS, Miles City, MT.*

Meat from cattle breeds that differ in muscularity and(or)express muscular hypertrophy (double muscling) may differ in muscle lipid composition. Hereford (normal muscling, H), Limousin (moderate muscling, L), and Piedmontese (muscular hypertrohy, P) sires (20-25 per breed) were bred to crossbred cows at random to produce F1 calves. F1 progeny were inter se mated within sire breed to produce F2 calves that were weaned at 6 mo of age and placed on a growing diet until 341 kg for females and 386 kg for males. Calves were then fed a finishing diet for either 90 or 132 d and slaughtered. P cross calves were genotyped for the G-A transition mutation at the myostatin locus characteristic of P, and their genotypes were classified on the basis of having 0 (P_0), 1 (P_1), or 2 (P_2) copies of the mutant allele (mhP). One 2.5-cm cross section of longissimus (LD) from the 12-13 rib was sampled from H (n=12), L (n=12), P_0 (n=19), P_1 (n=13), and P_2 (n=12). Visible intramuscular fat was separated from lean tissue. Fat was analyzed fresh, and lean was freeze-dried, finely ground, and homogenized. Both tissues were analyzed for cholesterol content and fatty acid composition by capillary column GLC. LD cholesterol (mg/100 g) was greater ($P = .01$) for P_2 (67.1) than for P_0, L, and H (58.5, 60.6, and 59.2, respectively) and intermediate for P_1 (62.4). Fat tissue cholesterol was numerically highest for P_2 (137.1 mg/100 g), but not different ($P = .23$) than the others (range 105.6-125.8). For LD fatty acids P_2 had the lowest ($P < .01$) 16:0 (21.2%) and 18:1 (32.7%), whereas P_2 had higher ($P < .01$) 18:0 (13.3%) than P_1 or P_0, but not H or L. P_2 had the highest ($P < .01$) 18:2 (11.7%), 18:3 (.7%), and 20:4 (5.6%). In fat, P_2 had higher ($P < .01$) 18:0 (17.2%) and 18:2 (2.3%). P_{0-2} had greater ($P = .02$) 18:3 than H or L. We conclude P_2 contain greater LD cholesterol, and associated fatty acids reflect this change by containing greater proportions of unsaturated fatty acids.

Key Words: Cattle, Muscularity, Muscle Lipids

205   Deposition of energy and nutrients in the carcass during growth and meat quality of different cattle breeds. B. Ender*[1], H. J. Papstein[2], G. Nuernberg[2], M. Gabel[1], and K. Ender[2], [1]*University of Rostock, Agricultural Faculty, D-18051 Rostock, Germany,* [2]*Research Institute for the Biology of Farm Animals, D-18196 Dummerstorf, Germany.*

It was the objective of this study to determine the effects of selection on dynamic development of tissue and nutrients during the course of growth and on meat quality. For this purpose bulls from the following breeds were selected: German Angus (GA), Galloway (Ga), German Holstein (GH), and White−blue Belgian (WBB) with muscular hypertrophy. The recording of the substantial components of the value of the carcass was carried out during the growth period from birth to the age of 24 months, using the method of serial slaughterings of different age groups which was then followed by an analysis of the carcass. In order to indicate the dynamic development of tissue and nutrients during the course of growth, a time−dependent growth function was applied. White−blue Belgians show very high protein contents and very low fat contents. The content of protein is not high enough to attain an energy content in total that is comparable to the other breeds. The edible part of the carcass of these bulls contains almost 50% less energy. The ratio of protein to water in the edible parts of the carcass (weight of meat and fat), calculated at a standard live weight of 600 kg, is 1 : 0,2 with WBB and 1 : 1,2 with Ga and therefore shows a wider range than with GA (1 : 1,2) and GH (1 : 1,1). Selection did not have an impact on the ratio of protein to water which is 1 : 3,4−3,7. This ratio remained constant during growth. However, the ratio of fat to water varies strongly, depending on the direction of selection and the animals' weight. Selection did have an impact on the size of the rib−eye area and the intramuscular content of fat. WBB showed the palest meat. The intramuscular content of fat increased with age, the *M. longissimus* being the muscle with the highest fat content. The meat quality is causally related to the different chemical components of the carcass due to selection; it also depends on a multitude of other features, however.

Key Words: Growth, Meat Quality, Cattle

206   Effects of antioxidant and antimicrobial addition to ground beef and lamb on microbial growth, lipid oxidation and color. S. L. Cuvala*, S. K. Duckett, G. T. Pritchard, and J. G. Andrae, *University of Idaho, Moscow.*

The objective of this study was to determine the effect of adding an antioxidant and/or antimicrobial to ground beef (GB) and ground lamb (GL) on microbial growth, lipid oxidation, and color over four d of storage at 4°C. Replicate samples of freshly ground lamb and beef were divided into four, 400 g batches. The four batches were treated with nothing (CON), ascorbic acid (AA; .05% v/w), chlortetracycline (CTC; .0001% v/w), or a combination of AA and CTC (COMB). Ground samples were placed on styrofoam trays, over-wrapped with oxygen permeable film, and stored under fluorescent lights at 4°C for 4 d. Total aerobic plate counts (APC), lipid oxidation (TBARS), pH, and discoloration were determined on all samples at d 0, 1, 2, and 4. Data were analyzed by the repeated measure analysis of the General Linear Model of SAS with ground meat type, antimicrobial, antioxidant, and time as main effects with all interactions tested. Ground meat type and AA did not alter (P > .05) APC. Aerobic plate counts were lower (P < .05) at d 4 for CTC treated ground meat. In GL, AA treatment did not influence (P > .05) TBARS. In GB, however, AA treatment reduced (P < .05) TBARS at 0, 1, 2, and 4 d. Meat pH values were higher (P < .05) in GL than GB. Antioxidant or CTC treatment did not alter (P > .05) pH values over time. Discoloration scores were higher (P < .05) for CON and CTC than AA and COMB at 1, 2, and 4 d; however, GB values were higher (P < .05) than GL for CON and CTC. At d 0, 1, and 2, discoloration scores were similar (P > .05) for AA and COMB in both GB and GL. At d 4, GB had higher (P < .05) discoloration scores than GL for AA treatment but were similar (P > .05) for the COMB treatment. Scores for AA in both GB and GL were higher (P < .05) than COMB. As expected, CTC addition to ground meat reduced APC and AA addition reduced discoloration scores and lipid oxidation. However, the effect of AA treatment on lipid oxidation was only observed in ground beef. The combination of CTC and AA resulted in lower discoloration scores than AA at d 4 or CTC at d 1, 2, and 4. Overall, AA treatment alone maintained color in the ground meat samples for 4 d of refrigerated storage but APC exceeded spoilage levels ($> 10^7$) unless CTC was also included.

Key Words: Beef, Lamb, Bacteria

207   Effect of chilling on fresh pork quality. S. Ohene-Adjei*[1], M. Ellis, F. K. McKeith, and J. E. Cannon, [1]*University of Illinois at Urbana-Champaign,* [2]*Dekalb Swine Breeders Inc.*

A study was conducted to characterize the effect of chilling rate on fresh pork quality. A 2x3x3 factorial design (two chilling conditions, three genotypes and three sites within the muscle) was utilized. Pigs (Durocs, n=24), between 90-120kg, were genotyped for the halothane gene and allocated to three classifications: normal (n=7), carriers (n=10) and reactors (n=7). The pigs were slaughtered on four separate days after resting overnight. Intact sides were randomly allocated to accelerated (AC: -30^{0}C for 150 min then 4^{0}C for 22-23hr) or conventional (CC: 4^{0}C for 24 hr) chill conditions. Muscle samples were obtained from inner (I), mid (M) and outer (O) sites of the *Semimembranosus* (SM) and the *Biceps femoris* (BF). The *Longissimus* (LD) and the *Gluteus medius* (GM) were also evaluated. Color (L* a* and b*) was evaluated using a Hunter colorimeter at 24hrs postmortem. Drip loss and ultimate pH were evaluated 48hr postmortem. AC resulted in a reduced L* for the LD muscle and the SM. In addition, the a* was increased in the LD and GM and AC reduced drip loss in the GM. Genotype had no consistent effect on effect on fresh pork quality attributes. Site within muscles had variable effects on quality. The inner portion of the SM had the highest L*, however, in the BF the outer section had the highest L* and the mid portion had the lowest L* and the highest drip loss. Results from this study suggest that AC can have some positive effects on the quality attributes of the loin but its effects were limited in the hams. Halothane status had no consistent effect on quality, however, site within the muscle had variable on quality attributes.

Key Words: Chilling, Pork, Quality

208   Influence of two dietary fat sources and energy levels on lipogenic activity in tissues of pigs. G. Bee*[1] and C. Wenk[2], [1]*Swiss Federal Research Station for Animal Production, Posieux, Switzerland,* [2]*Institute of Animal Science ETH-Zurich, Switzerland.*

Fat deposition rate and fatty acid profile are affected by factors such as dietary energy levels and fat sources. The aim of the study was to determine the relationship between high and low digestible energy levels (9.4 vs. 14.5 MJ DE/kg) and either tallow or soybean oil supplementation (5%) on lipogenic activities and fatty acid profile of the subcutaneous adipose tissue and liver in finishing pigs. 20 Large White pigs were allocated into four dietary groups and fed the diets ad libitum from 30 kg up to slaughter at 106 kg live weight. The lipid content and fatty acid composition of the tissues were determined and glucose-6-phosphate dehydrogenase (G6PDH), malic enzyme (ME) and fatty acid synthase (FAS) activity were measured. Lipid deposition rate of animals fed the low energy diets was lowered regardless of fat supplementation. Unlike lipid deposition, fatty acid profile was influenced by both dietary factors. Pigs fed the low energy diet supplemented with soybean oil exhibited the lowest level of saturated (P<.001), monounsaturated (P<.001) and the highest level of polyenic fatty acids in the adipose tissue. The opposite occurred for the pigs fed the high energy diet supplemented with beef tallow. The fatty acid profile of the adipose tissue of animals fed the other two diets were intermediate. Independent of treatments, lipogenic activities were up to 10 times higher in the adipose tissue than in the liver. In the latter, G6PDH activity was higher (P<.05) due to high energy diet, whereas the activity of ME and FAS were not affected. Animals fed the high energy diet either supplemented with tallow or soybean oil exhibited higher ME activity (P<.04) in the backfat, without any effect on G6PDH activity. In contrast, dietary fat sources affected the FAS activity, with lower activity (P<.04) exhibited in the backfat of animals fed the soybean oil diets. The results suggest that FAS activity is downregulated by the high level of dietary polyenic acids from soybean oil, whereas ME activity by the low energy supply.

Key Words: pig, adipose tissue, lipogenesis

209   Interaction of halothane and Rendement Napole genotypes on carcass and meat quality characteristics of pigs. D. N. Hamilton*, K. D. Miller, D. F. Parrett, F. K. McKeith, and M. Ellis, *University of Illinois, Urbana, IL/USA.*

The objective of this study was to determine the effects of halothane and Rendement Napole (RN) genotypes on carcass and meat quality characteristics in pigs. Halothane and RN carrier (Nn/RN$^-$rn$^+$) Hampshire boars were mated to dams that were homozygous for the normal allele of both genes (NN/rn$^+$rn$^+$). Progeny were classified into four genotypes 1. (NN/rn$^+$rn$^+$) (n=31), 2. (Nn/rn$^+$rn$^+$) (n=27), 3. (NN/RN$^-$rn$^+$) (n=30), and 4. (Nn/RN$^-$rn$^+$) (n=23). A DNA test was used to determine halothane genotype and longissimus glycolytic potential was used to predict the RN genotype. Halothane carriers (Nn/_ _) in comparison to halothane normal (NN/_ _) animals tended to have shorter carcasses (81.8 vs. 82.7, SE =.61 mm, P=.06) greater loin eye area (44.6 vs. 42.6; SE=1.21 cm2, P=.07), and showed a reduced ultimate pH (5.32 vs. 5.45, SE= .767, P<.05) and lower subjective longissimus firmness scores (1.97 vs. 2.32, SE=.139, P<.05). Carriers of the detrimental RN allele (_ _/RN$^-$rn$^+$) in comparison to homozygous normal animals (_ _/rn$^+$rn$^+$) had lower longissimus ultimate pH (5.26 vs. 5.51 SE=.042, P<.05) and higher cooking loss (26.26 vs. 23.99, SE= .767, P<.05). The interaction between halothane and RN genotype was significant for a number of meat quality traits. Animals that were carriers for both genes (genotype 4) had the poorer values for subjective color score (2.60 vs.1.88 vs. 1.85 vs. 1.95, SE=.180, P<.05, for genotypes 1, 2, 3, and 4, resp.), Minolta L* (47.7vs. 52.7vs. 53.6 vs. 55.2, resp., SE=1.47, P<.05), and drip loss (3.44 vs. 5.84 vs. 6.77 vs. 7.28, resp., SE=.966, P<.05) suggesting paler meat with a lower water holding capacity for this genotype compared to the other 3. Marbling scores were higher for genotype 1 (2.11 vs. 1.44 vs. 1.53 vs. 1.55, SE=.152, P<.05) and shear force was highest for genotype 2 (3.83 vs. 4.41 vs. 3.79 vs. 3.70, resp., SE=.172, P<.05). This study shows that the detrimental alleles of both genes result in a reduction in fresh-meat quality, particularly in terms of color and water-holding capacity and that in combination the two detrimental alleles produced the palest meat with the highest drip loss of any of the genotypes evaluated.

Key Words: Rendement Napole, Halothane, Meat quality

210   Effect of genotype on carcass composition and meat quality characteristics. B. F. Wolter*[1], M. Ellis[1], F. K. McKeith[1], and M. Culbertson[2], [1]*University of Illinois,* [2]*Cotswold USA.*

Thirty pigs from each of five great grandparent lines of pigs (N=150) were evaluated for carcass composition and meat quality characteristics. Lines evaluated included: Landrace (L), Maternal Large White (MLW), Terminal Large White (TLW), Duroc (D), and Pietrain (P). Slaughtering took place on 5 occasions with six animals from each line, selected on the basis of sire, on-farm weight, and birth date, being slaughtered on each occasion. Measurements were obtained on the left side of the carcass and quality assessment was carried out on longissimus chops obtained posterior to the tenth rib. Results are presented as line deviations from the population mean. Dressing percentage was highest (P<.001) for P (deviation from mean = +1.08%) and lowest for MLW (-.57%) and L (-.63%). Tenth rib backfat was greatest (P<.01) in lines D and P (+2.0 and +2.1 mm, respectively), least for lines MLW and TLW (-1.5 and -2.0 mm, respectively), and intermediate for L (-.5 mm). Interestingly, line P had the highest tenth rib backfat, but also the greatest (P<.001) loin eye area (+4.1 cm$_2$). Deviations from the mean for loin eye area were +.4, -1.8, +.4, -3.2 cm$_2$ for lines D, MLW, TLW, and L, respectively. Ultimate pH was lowest (P<.001) for line P (-.11), highest for D and MLW (+.09 and +.06, respectively), and intermediate for lines TLW and L (.00 and -.03, respectively). Subjective marbling was significantly higher (P<.001) and twenty-four hour drip loss was lower (P<.001) in line D (+1.1, and -1.7%, respectively) than for the other lines which were similar for these traits. In addition, Hunter L* values indicated that muscle color was less pale (P<.001) for line D (-2.60) than for lines P, MLW, TLW, and L (+1.05, -.38, +1.11, and +.84, respectively) which were similar. There were significant differences (P<.001) between the lines for Warner-Bratzler shear force and taste panel tenderness (evaluated on a 15 point scale) with line L having higher shear force and lower tenderness values (+.66 kg and -.52, respectively), both indicating a lower degree of tenderness than lines D (-.35 kg and +.58, respectively) and P (-.49 kg and +.40, respectively). Generally, line P had greater carcass muscling, and line D demonstrated superior meat quality characteristics compared to the other lines evaluated in this study.

Key Words: Meat Quality, Carcass Traits, Pigs

211   Sensory evaluation of loin chops from lambs fed concentrate or grazed on ryegrass to traditonal or heavy weights. R. J. Borton*, K. E. McClure, and D. M. Wulf, *The Ohio State University / OARDC.*

Palatability of loin chops from lambs either fed concentrate in drylot (C) or grazed on ryegrass (F) with slaughter weights at 65 or 100% of physiological mature BW of their dams was evaluated. Lambs (64) were randomly allotted by sex with initial BW for ewes (E) and wethers (W) (23 and 24 kg) in a 2x2x2 factorial design. Slaughter weights at 65% of E and W at normal (N) BW were 49.5 and 53.2 kg slaughter weights at 100% for E and W at heavy (H) BW were 75.9 and 81.8 kg. Days on test for CN, CH, FN, and FH were: 82, 161, 171, and 448. Boneless loin chops obtained from 53 (ECN=8, ECH=8, EFN=8, EFH=3, WCN=7, WCH=8, WFN=5, WFH=6) carcasses were vacuum packed, frozen and stored at -10°C. Chops were thawed, wrapped in foil, baked at 177°C for 30 minutes and evaluated by a 10 member panel. Panelists rated the chops for off-odor (OO), lamb flavor (LF), off-flavor (OF), tenderness (T), juiciness (J) and overall acceptability (OA) using a scale of 0-9 with 0 representing the least and 9 the most of each attribute. Data were analyzed using a General Linear Models Procedure. OO was more (P≤.001) for F than C (1.48 ± 0.12 vs 0.94 ± 0.10). LF was higher (P≤.001) for the C than for F (5.53 ± 0.12 vs 4.58 ± 0.14). OF was stronger (P≤.001) for F than C (2.01 ± 0.16 vs 1.06 ± 0.14). OF was stronger (P≤.05) for H than N (1.78 ± 0.16 vs 1.30 ± 0.15). ECH were more T (P≤.03) than ECN or WFN (6.34 ± 0.32 vs 5.09 ± 0.30 or 5.00 ± 0.38). WC were more J (P≤.01) than EC, EF, or WF (5.39 ± 0.12 vs 4.73 ± 0.12, 4.77 ± 0.15 or 4.63 ± 0.14). CH were more J (P≤.01) than CN, FN, or FH (5.54 ± 0.12 vs 4.59 ± 0.12, 4.78 ± 0.14 and 4.62 ± 0.15). OA was higher (P≤.001) for C than for F lambs (5.51 ± 0.12 vs 4.72 ± 0.14). Chops from C lambs had less OO and OF and more LF. This could be related to the fact that C lambs were younger and appeared fatter than the F lambs. The magnitude of differences found by the panel, while significant, were small enough to indicate H or F lamb chops were acceptable.

Key Words: Lamb, Flavor, Sensory Evaluation

212   Effects of Dorper genetics on tenderness, fatty acid and cholesterol content of lamb. S. K. Duckett*[1], S. L. Cuvala[1], and G. D. Snowder[2], [1]*University of Idaho, Moscow,* [2]*U.S. Sheep Experiment Station, Dubois.*

The objective of this study was to assess the effects of Dorper (D) genetics in comparison to Suffolk (S) on the longissimus muscle tenderness, fatty acid and cholesterol content. Lambs (n = 30) were sired by either Suffolk or Dorper rams and gestated by Columbia mature ewes. Fatty acid composition and cholesterol content of subcutaneous (SQ) and intramuscular (IM) lipid were determined by GLC. Fatty acid and cholesterol data were analyzed using the GLM procedure of SAS with breed and tissue as main effects with the two-way interaction tested. Warner-Bratzler shear force data was analyzed as above with only breed in the model. Warner-Bratzler shear force values for rib chops aged 10 d were 1.1 kg lower (P < .05) for D than S. Total fatty acid and cholesterol contents of the IM and SQ were similar (P > .05) between breeds. However, the total fatty acid content was higher (P < .05) for SQ than IM and cholesterol content lower for SQ than IM. For all the fatty acid percentages, no breed by tissue interactions were significant (P > .05). The percentage of palmitic acid in the IM was lower (P < .05) for D than S. The percentages of palmitoleic acid, stearic acid and total odd chain fatty acid were higher (P < .05) in D than S IM. Fatty acid percentages differed (P < .05) between IM and SQ tissues. Intramuscular lipid contained higher (P < .05) percentages of myristoleic, palmitoleic, oleic, linoleic, and arachadonic acids than SQ. The percentage of monounsaturated and polyunsaturated fatty acids was also higher (P < .05) for IM than SQ. Subcutaneous lipid contained higher (P < .05) percentages of capric, myristic, pentadecylic, margaric, and stearic acids than IM. Total saturated and odd chain fatty acid percentages were higher (P < .05) in SQ than IM. Conjugated linoleic acid content (18:2c9t11; mg/g lipid) did not differ (P > .05) between breed or tissue. The use of Dorper genetics increased the tenderness and reduced palmitic acid content in the longissimus. Intramuscular lipid contains higher percentages of monounsaturated and polyunsaturated fatty acids than SQ.

Key Words: Lamb, Tenderness, Fatty acids

213   Effects of rearing system on meat quality in young kids. A. Argüello*[1], A. Marichal[1], R. Ginás[1], J. Capote[2], J. M. Afonso[1], and J. L. López[1], [1]*Animal Production Unit, Las Palmas de Gran Canaria University, Arucas, Las Palmas, Spain,* [2]*Animal Production Unit, Pastures and Forage, ICIA, Tenerife, Spain.*

The objective of our study was to examine the effects of rearing system, nursed from their dams (ND) and fed a commercial milk replacer (CR), on meat quality in young kids. Thirty male and twin kids were allotted in two feeding regimens (15 ND and 15 CR). All the kids were slaughtered at live weight of ten kg. After slaughter, pH was measured on *Longissimus dorsi* (LD), *Semimembranosus* (SM) and *Triceps brachii* (TB). Twenty-four hours later (the carcasses were chilled at 4C), pH, Warner-Brazler shear force (WBSF), Color (Lightness, L, Croma, C, Hue, H), Water holding capacity (WHC) of LD, SM and TB muscles were measured. In LD muscle it didn't founded differences between ND and CR group for all measurements. In TB muscle, it didn't founded differences between groups for WBSF, C and H; in contrast, CR group have a higher value of L (56.28±2.65 *vs* 50.77±5.13, P≤.05), smaller WHC (6.5±1.04 *vs* 9.27±3.12 (%), P≤.05) and pH 24 hours postmortem (5.73±.07 *vs* 5.84±.10, P≤.05). In LD muscle only, it didn't founded differences for C value (16.84±7.18 *vs* 8.97±7.55, P≤.05, in CR and ND respectively). Feeding a commercial milk replacer has small effects in kids' meat quality, almost exclusively in TB muscle. Standard ANOVA procedures were used to analyze the differences between muscles; TB muscle was more firm (8.58±1.53 kg, P≤.05), had less WHC (7.96±2.72 (%), P≤.05) and a higher pH final (5.79±.11, P≤.05). Differences between muscles could be raised on different metabolic activities.

Key Words: Kid, Rearing System, Meat Quality

214   Survival of *Escherichia coli* O157:H7 in soil. R. G. Espinosa*, B. Larkin, J. Thomas, and T. May, *New Mexico State University, Las Cruces.*

Enterohemmorhagic *E. coli* O157:H7 is a major concern of the food industry and the general public. Cattle have been implicated as the primary reservoir for this pathogen. It is of interest to study the characteristics of this microorganism's survival in the environment. Our

goal was to establish the survival of *E. coli* O157:H7 in soil. A soil sample was divided into groups to test survival at 4°C, 25°C, and 37°C. A nalidixic acid resistant strain of *E. coli* O157:H7 932 was inoculated to each sample. Samples of soil were taken over time, serially diluted, and plated to sorbitol MacConkey (SMAC) plates with nalidixic acid (50μg/mL). Plate counts were made and the population of *E. coli* O157:H7 was enumerated. Random colorless colonies were verified to have the O157 lipopolysachharide antigen by latex agglutination. When *E. coli* O157:H7 was not detected by standard plating, an enrichment of one gram of soil in 100mL of trypticase soy broth (50μg/mL nalidixic acid) was incubated at 37°C and shaken at 150 rpm on an orbital shaker. At 37°C, *E. coli* O157:H7 was not detectable after three days by standard plating. Enrichment of the soil and subsequent plating on SMAC plates with nalidixic acid produced *E. coli* O157:H7 colonies through day fourteen. By day fourteen, *E. coli* O157:H7 was not detectable in the 25°C system by standard plating. Enrichment of the soil sample and subsequent plating on SMAC plates produced *E. coli* O157:H7 colonies through day 42. At day 56, *E. coli* O157:H7 was detected in the soil sample incubated at 4°C by standard plating. According to these results, *E. coli* O157:H7 is able to survive long periods of time in soil. Moisture content of the soil may be a factor that affects this characteristic. The survival of this organism in soil may be a route by which cattle-to-cattle transmission occurs.

Key Words: E. coli O157:H7, Shiga like toxin, Microbial Ecology

215   Contribution of the lean meat consumption to meet the nutrient requirement in Switzerland. M. Leonhardt and C. Wenk*, *Swiss Federal Institute of Technology Zurich - Institute of Animal Sciences, Switzerland*.

In the present study, the contribution of average lean meat consumption in Switzerland in 1997 to meet the requirements for selected vitamins and trace elements (thiamin, riboflavin, alpha-tocopherol, iron and zinc) was calculated. For that purpose, the nutrient content of the following meat cuts was examined: pork (chop and shoulder), beef (prime rib and shoulder), veal (chop) and chicken (breast and thigh). Pork was the best thiamin source and there was no significant difference in thiamin content of longissimus dorsi and shoulder muscles. In contrast, the riboflavin content significantly differed between the muscles within species (pork and chicken) examined. With the average lean meat consumption (102 g/day), the recommendation given by the National Research Council (RDA, 1989) for daily thiamin intake was met to 29% (men) and 40% (women). Recommendation for daily riboflavin intake was met to 12% (men) and 15% (women) and for daily vitamin E intake to 4% (men) and 5% (women). Beef and pork shoulder were the best sources of iron, heme iron and zinc. With an average daily pork consumption, recommendations for daily iron intake were met to 11% (men) and 7% (women) and for zinc intake to 25% (men) and 32% (women). The requirement for absorbed iron was met in the range of 10-30% and 7-20% for men and women, respectively, and daily requirement for absorbed zinc was covered to 32-56%. In addition, the efficacy of the same vitamin E supplementation (200 mg alpha-tocopherol acetate/kg) to pig and laying hen diets, in order to increase the alpha-tocopherol contents of the respective animal products, was studied. Alpha-tocopherol accumulation differed according to the following ranking: egg yolk > liver > adipose tissue > longissimus dorsi muscle. Results showed that pork from animals fed a vitamin E enriched diet is not an important supplier of vitamin E. On the contrary, egg yolk became a good source of vitamin E for human nutrition by dietary modification.

Key Words: Lean meat, Nutrient requirement

216   Determination of chemical compounds responsible for boar taint. J. L. Xue*, J. Wang, Z. Vickers, and G. Reineccius, *University of Minnesota, St. Paul, MN*.

Two compounds, androstenone and skatole, are considered primarily responsible for boar taint. Previous studies indicated that other compounds are also involved in boar taint. The objective of this study was to determine the compounds for boar taint. Fat tissues were obtained from 30 entire male pigs at the shoulder area in a slaughterhouse. All pigs were from the same farm with the same genetic background. Mean carcass weight was 85.6 ± 8.7 (SD) kg. A frozen sample (2 g) in a Petri dish was heated in microwave oven for 40 sec. Then 10 sensory judges were asked to smell the fat, rate the overall intensity of taint using 9-point scores from 0 to 8 (8 = strongest taint), and indicate

taint due to androstenone, skatole, or other. The sensory test was duplicated for all samples. Data was analyzed using GLM and CORR in SAS. Independent variables included sample, judge, duplication, and interactions. Four tainted samples were selected for gas chromatography (GC) and mass spectrometer (MS) assay of taint compounds. One gram of fat was used for extraction of taint compounds. One of the judges in sensory test conducted the sniffing in GC. Approximately 1 μl of the concentrated extracts was injected to the GC-MS system. No linear relationship was detected between carcass weight and taint intensity (r = 0.27, P > .1). Regression analysis detected interactions of androstenone-skatole-other (P < .05), androstenone-skatole (P < .05), androstenone-other (P < .04), and skatole-other (P < .050) on taint intensity. Three androstenone-like odors were detected. The compounds for the second and third peaks were determined as androstenol and androstenone, respectively. We failed to identify the chemical for the first peak. Concentrations of androstenone, androstenol, and the unknown compound were 3.07 ± 1.27, $2.02 \pm .79$, $1.97 \pm .74$ (μg/g fat), respectively. Our study suggests that boar taint detected by sensory panel was a mixed result of androstenone, androstenol, skatole, and the unknown compound, which was likely a steroid.

Key Words: Boar Taint

217   Differences in the effects of the halothane gene and muscle fiber type composition on pork carcass composition and quality. J. M. Eggert*, F. F. S. Depreux, N. Ratliff, A. P. Schinckel, A. L. Grant, E. B. Sheiss, E. P. Berg, and D. E. Gerrard, *Purdue University, West Lafayette, IN*.

The objective of this study was to determine the impact of myosin heavy chain (MHC) isoforms (I, IIB and IIA) on pork composition and quality traits. Gilts (n = 32) were randomly assigned to a 2 × 2 factorial of genotype and slaughter weight (120 and 135 kg). European Large White-Landrace **(G1)** pigs were used to represent the upper 5th percentile for percent lean in the U.S. and a commercial terminal-cross line **(G2)** was used to represent average U.S. pigs for percent lean. Each genotype × slaughter weight group consisted of 6 halothane-negative **(NN)** and 2 halothane-carrier **(Nn)** pigs. Muscle samples were subjected to an ELISA assay for determining MHC content. No significant differences in fiber type composition (MHC) were observed for any genotype × halothane group. Regression analyses were conducted for quality traits of both NN and Nn gilts. Main effects were type I **(I)**, type IIB **(B)**, type IIA **(A)**, I/B, I/A, B/A, genotype and slaughter weight. Least significant effects were individually deleted from the model. Only I/B accounted for variation in drip loss of NN gilts (I/B: P < .05; $r^2 = .18$), while only genotype was significant for drip loss of Nn gilts (genotype: P < .01; $r^2 = .70$). B/A and A accounted for variation in loin eye area of NN gilts (B/A: P < .05; A: P < .10; $r^2 = .18$), while A, I/B and B/A were significant for Nn gilts (A: P < .05; I/B: P < .10; B/A: P < .05; $r^2 = .53$). Only I explained variation in 24-h pH of NN gilts (I: P = .11; $r^2 = .09$), while I/B, I/A and B/A were significant for Nn gilts (I/B: P < .01; I/A: P < .01; B/A: P < .01; $r^2 = .97$). In conclusion, fiber type composition accounts for a larger proportion of variation in the quality traits of Nn compared to NN gilts. Thus, fiber type composition appears to have a greater impact on the quality of halothane carrier compared to halothane negative gilts.

Key Words: Pigs, Myosin Heavy Chain, Pork Quality

218   Effects of corn, conjugated linoleic acid (CLA) and duration of storage on the shelf-life of fresh pork. J. M. Eggert, C. A. Stahl*, M. A. Latour, B. T. Richert, D. E. Gerrard, J. C. Forrest, B. C. Bowker, E. J. Wynveen, J. E. Hammelman, and A. P. Schinckel, *Purdue University, West Lafayette, IN*.

Gilts (n = 78; 25 kg) were fed one of four corn-based diets (high oil corn **(HOC)**, Optimum® high oleic high oil corn **(HOHOC)**, conventional corn **(CONV)** and conventional corn supplemented with choice white grease **(CWG)**) *ad libitum* to 115 kg. Each diet was supplemented with either 1 % CLA oil **(CLA)** or 1 % sunflower oil **(SFO)** from 90 ' 115 kg. CLA oil contains 60 % CLA isomers. At 24-h postmortem, color evaluation of loins was performed both subjectively (1 = pale, pinkish gray; 5 = dark, purplish red) and objectively (Hunter L*, a* and b*). Loins were sampled for TBAR assay to determine their level of oxidation. Left and right side loin sections (rib 6 ' 10) were vacuum packaged and assigned to frozen storage duration of either 14 or 35 days. Loin sections thawed for 36-h at 2°C and were sliced into five 2 cm chops.

The three internal chops were assigned to a 1, 3 or 5 day shelf-life duration and reevaluated for color and sampled for TBAR analysis after the assigned duration. At 24-h postmortem, color evaluations of the loins were significantly affected by corn (HOC: 2.29; HOHOC: 2.33; CONV: 2.51; CWG: 2.28 ± .06; P < .05) and CLA (CLA: 2.44; SFO: 2.27 ± .04, P < .01), but these effects were not detected by Hunter L*, a* or b* values. At day 5, corn had a significant effect on a* values (HOC: 10.12; HOHOC: 10.69; CONV: 9.56; CWG: 10.28 ± .26, P < .05). Corn type or CLA were not significant for any other color measures. At day 5 of shelf-life, loins frozen for 14-d received significantly higher color evaluations (2.45 vs 2.34 ± .03, P < .01), lower L* values (59.8 vs 61.2 ± .3, P < .01), higher a* values (10.9 vs 9.4 ± .2, P < .01) and lower b* values (16.8 vs 17.6 ± .1, P < .01) than loins frozen for 35-d. In conclusion, corn type or CLA have minimal effects on the color characteristics of frozen and displayed loin chops. Longer duration of frozen storage has detrimental effects on loin chop color.

Key Words: High Oil Corn, Shelf Life, Color

219   Determination of freezing and thawing parameters for cooked-cured ham. D. S. Webb and R. L. Hendrickson, *Oklahoma State University.*

The objective of this research was to evaluate the effect of refrigerated and frozen storage conditions on the quality of cured cooked hams as to recommend the best freezing and best thawing conditions for these products. Quality and shelf life of fresh and processed meat are both affected by the rate of chilling. Quality characteristics such as water-holding capacity, purge loss and microbial load can be affected by chilling and (or) thawing rates. Hams (n=242) were assigned to one of seven treatment groups. Treatments included a control (-1°C) as well as two freeze groups in combination with three procedures. Freeze groups were either a fast (-34°C) or slow (-18°C). Frozen hams were then divided into one of three thaw treatments, single stage (3°C), dual stage (-8°C; -2°C) or a triple stage thaw (-12°C; -6°C; 3°C). Purge, cooking loss, lean color stability, bacteria levels, salt percentage, proximate analysis and presence of pale soft exudative pork (PSE) lean were assessed for each ham following its freeze/thaw combination. In summary hams, which were fast frozen at -34°C and thawed using a three-stage procedure displayed the least purge loss. Moisture loss during cooking was the lowest for the control hams (32.07% loss), compared to 33.52% and 40.58% for frozen and thawed hams respectively. Freezing or thawing showed no effect on either proximate analysis or salt determination. Differences in cooking loss could not be identified by a particular freeze or thaw method. No PSE pork was found by the use of visual appraisal of hams. The use of a single stage thaw versus either a dual or triple stage thaw had a significantly (P<.05) higher b* value indicating a more pale lean color. Microbial plate counts indicated there were no problems with bacteria counts with any of the procedures. In order to maintain acceptable quality when freezing hams fast freezing in combination with a dual or triple stage thaw shows to be the most beneficial.

Key Words: Freezing, Thawing, Purge

220   Pre- and post-harvest tenderization of callipyge lamb. S. K. Duckett*[1], J. G. Andrae[1], G. T. Pritchard[1], S. L. Cuvala[1], K. Watson[1], P. S. Kuber[2], and G. D. Snowder[3], [1]*University of Idaho, Moscow,* [2]*Washington State University, Pullman,* [3]*U. S. Sheep Experiment Station, Dubois.*

Twenty callipyge lambs (54 kg) were used to assess the effect of pre-harvest calcium propionate administration and/or post-harvest freezing before aging on tenderness. The lambs were randomly assigned to one of the following treatments: controls (C; n = 10) and calcium gel administered (GEL; n = 10). At about three h prior to slaughter, the GEL lambs were drenched orally with 250 mL of a calcium propionate-propylene glycol gel that contained 25 g of calcium, 105 g propionate, and 100 g propylene glycol. At 24 h postmortem, carcass data were collected and chops (2.54 cm thick) removed from both longissimus muscles. The chops from the left side were vacuum packaged and aged at 4°C for 1, 3, 7, 14, and 28 d (FRESH). The chops from the right side were vacuum packed, frozen at - 20°C for 14 d, thawed then aged for 1, 3, 7, 14, and 28 d (FROZEN). Data were analyzed using the repeated measures analysis of General Linear Model Procedure of SAS with calcium treatment, fresh/frozen treatment, postmortem age, and all interactions tested. Serum total, ionized and normalized calcium levels taken at slaughter were higher (P < .05) for GEL than C by 22, 18 and 24%,

respectively. However, Warner-Bratzler shear force values did not differ (P > .05) between C and GEL treatment. The two- and three-way interactions for calcium treatment with freezing treatment and/or age were non-significant (P > .05). The interaction between freezing treatment and postmortem age was significant (P < .05). Warner-Bratzler shear force values for FROZEN were lower (P < .05) than FRESH by 1.3 to 2.2 kg at 3, 7, 14, and 28 d of aging. Postmortem aging rate was faster (P < .01; -.287 vs -.146 kg/d) for FROZEN (d 1 - 14) than FRESH (d 1 - 28). Pre-harvest tenderization of callipyge was unsuccessful; however, freezing prior to aging accelerated the rate of aging and reduced shear force values to acceptable levels.

Key Words: Lamb, Callipyge, Tenderness

221   Color and tenderness of case-ready Chevon cuts as influenced by storage time. G. Kannan*, B. Kouakou, S. Gelaye, and T. H. Terrill, *Agricultural Research Station, Fort Valley State University, Fort Valley, GA.*

Goat meat (chevon) is currently sold either as bone-in cubed meat or as whole carcasses, primarily to consumers of ethnic origin and to individuals who prefer lean red meat. The objective of this study was to evaluate the effects of storage time on color stability and tenderness of chevon fabricated into case-ready cuts. Eight-month-old Spanish does were slaughtered and the carcasses chilled for 24 h at 4°C. Carcasses were then fabricated according to a proposed IMPS barbecue style (Olson et al., 1999). Leg, shoulder, rib, and loin primal cuts were trimmed and sliced into 2.5 cm-thick steaks/chops using a band saw. The cuts were placed on styrofoam trays and wrapped with polyvinyl-chloride film. These case-ready leg and shoulder steaks and loin/rib chops were stored at 2 °C for either 0, 4, 8, or 12 d. Ultimate pH and myoglobin were analyzed in the different cuts 24 h after slaughter. Percent met-myoglobin (MetMb), CIE Lab color coordinate values, shear values and cooking loss were measured on stored cuts. Myoglobin content and pH were not significantly different among the different cuts, although mean pH in the shoulder was high (6.3). Percent MetMb increased (P<.01) with storage time in all of the cuts, but the pattern of increase was not different among the different cuts. Type of cut had a significant effect (P<.05) on L*(lightness), a* (redness), and hue values. Shoulder cuts had the lowest L* and hue values and the highest a* values. Time had a significant effect (P<.01) on a* and hue values, with redness decreasing and hue angle increasing as storage time increased. Warner-Bratzler shear force values were higher (P<.01) for Semimembranosus muscle (leg steak) than Triceps brachii (shoulder steak) or Longissimus (rib chop) muscles, and the values for each cut did not decrease markedly over the time periods tested. Cooking loss was influenced by type of cut (P<.01), with losses being highest in leg, lowest in rib, and intermediate in shoulder. Cooking loss was also influenced by storage time (P<.05) and was higher on day 0 than other storage periods. Results indicated that different case-ready chevon cuts underwent the same amount of discoloration over time and that storage time did not markedly affect tenderness.

Key Words: Chevon, Storage time, Color

222   Effect of supplemental dietary vitamin E on the color and case-life of top loin steaks and ground chuck patties in map case-ready retail packaging systems. R. L. Stubbs[1], P. K. Bates*[1], J. B. Morgan[1], H. G. Dolezal[1], F. K. Rav[1], and S. E. Williams[2], [1]*Oklahoma State University,* [2]*Roche Vitamins Inc.*

Ground chuck and top loin steaks from cattle supplemented with either 0 (CON) or 500 (VITE) IU/head/day of α-tocopheryl acetate were packaged in a modified atmosphere case-ready beef packaging system (MAP). Random samples were taken from the strip loins and bulk ground chuck of each treatment at fabrication in order to determine the α-tocopherol concentrations in the product. Cuts were stored at 4°C ± 1°C for 0, 2, 4, 8, 10, 12, or 14 d. Following storage, products were displayed in a retail case at 2°C ± 1° for 8 d. Twice daily, objective and subjective measures of display color properties were obtained. Lipid oxidation (TBARS) was measured on display 0, 4, and 8 for each supplementation by storage group combination. Analysis of retail samples revealed higher (P≤0.01) concentration of tocopherol in VITE when compared to CON products for both top loin steaks and ground chuck patties. Lipid oxidation was significantly (P≤0.01) reduced during both storage and display with VITE supplementation. CON products displayed increased

(P≤0.01) TBARS values during the display period after 2 or more days of storage in MAP packaging. Regardless of display, VITE steaks stored 10 d or less and ground chuck stored 6 d or less exhibited stable lipid properties. CON ground chuck samples exhibited complete brown surface color if stored more than 6 d, where VITE ground chuck was able to maintain displayable red color after 10 d of storage. Both VITE top loin steaks and ground chuck patties maintained more acceptable visual scores for lean color, percent discoloration, and overall appearance, for a greater portion of the display period than did their CON counterparts. Fat color in steaks was unaffected (P≤0.05) by supplementation, but improved in ground chuck patties. Maximum display life, when averaged across all display days, was improved by approximately 3 and 0.9 d with VITE supplementation for top loin steaks and ground chuck patties, respectively. This study suggests that VITE supplementation would be beneficial in improving lipid and color stability of beef products stored in high oxygen MAP packaging systems.

Key Words: Vitamin E, Modified Atmosphere Packaging

223   Effect of supplemental dietary vitamin E on the color and case-life of top loin steaks and ground chuck patties in various case-ready retail packaging systems. R. L. Stubbs, M. R. McGee*, J. B. Morgan, H. G. Dolezal, F. K. Ray, and S. E. Williams, *Oklahoma State University*.

Ground chuck and top loin steaks from cattle supplemented with either 0 (CON) or 500 (VITE) IU/hd/d for at least 100 d, of α-tocopheryl acetate were packaged utilizing two case-ready beef packaging systems. Random samples were taken from each sub-primal at fabrication in order to determine the α-tocopherol concentrations in the products. Cuts were stored at 4°C ± 1°C for 0,2,4,6,8,10,12, or 14 d for ground chuck samples and additionally for 16,18,20, and 22 d for top loin samples. After storage, products were displayed in a retail case at 2 to 6°C for 8 d. Twice daily, objective and subjective measures of display color properties were obtained. Lipid oxidation (TBARS) was measured on display d 0,4, and 8 for each supplementation by storage group combination. A higher (P<0.03) concentration of α-tocopherol existed in VITE than in CON products for both case-ready package types. Lipid oxidation was markedly reduced (P<0.01) across the display period for both VITE top loin steaks and ground chuck patties compared to controls. Storage did not affect lipid oxidation of steaks from either TRT group however, VITE reduced (P<0.05) lipid oxidation during the storage of ground chuck patties. CON steaks responded better (P<0.05) than VITE steaks during a 2h bloom period after being stored more than 6d as indicated by higher a* values. VITE steaks were shown to retain red color more consistently throughout the display period for most storage days. VITE increased (P<0.05) color retention when displayed 3d or more. Fat color of top loin steaks was unaffected by supplementation. Maximum display life increased with VITE by approximately 3d and 1.3d for top loin steaks and ground chuck patties, respectively. This study suggests that vitamin E would be very useful in overcoming the oxidative problems associated with case-ready retail beef systems by providing extended periods of storage and display.

224   Comparison of vitamin E and natural antioxidants on the lean color and retail caselife of ground beef. A. E. Down, K. C. Childs*, D. N. Vargas, D. S. Webb, J. B. Morgan, and H. G. Dolezal, *Oklahoma State University, Stillwater, OK.*

Beef trimmings from cattle supplemented with either 0 or 500 IU/head/day of α-tocopherol acetate were obtained and divided into the following treatments: control (CON), vitamin E (VITE), Duralox^{TM} (DURA), a rosemary based natural antioxidant product, and Herbalox^{TM} (HERB), a natural antioxidant product consisting of rosemary and citric acid. Natural antioxidant products DURA and HERB were added to non supplemented beef trimmings at .25% and .20% of meat weight, respectively. Products were packaged using oxygen permeable film and exhibited in a commercial display case at 2°C ±1°C for six d. Objective and subjective measures of display color were taken twice daily. Lipid oxidation (TBARS) was measured on 0, 2, and 4 d of display for each treatment group. Packages representing CON treatment displayed increased (P < .01) TBARS values for the overall display period compared to DURA, HERB and VITE treatments. Treatment groups VITE, DURA and HERB exhibited stable lipid properties after 4 days of display while CON treatment samples did not. Ground beef packages containing packages from VITE, DURA and HERB treatments maintained their lean color for a longer portion of the display, this was especially noticed following 3 d of display. L* mean values were significantly

higher (P < .05) for VITE, DURA and HERB treatments as compared to the CON group. Mean a* values across all display days were significantly higher (P < .05) for VITE and DURA treatment groups when compared to their CON opponents. Treatment groups VITE, DURA and HERB exhibited an increase in lean color acceptability of 1.21, .81 and .65 days, respectively when compared to their CON counterparts. The same treatment groups also improved overall case-life by .94, .51 and .44 days, respectively compared to CON product. This trial suggests that both vitamin E and natural antioxidants can be beneficial in maintaining lipid stability and prolonging the case-life of ground beef packages.

Key Words: Natural Antioxidants, ground, case-life

225   Effects of including AGRADO^{TM} in finishing diets for beef cattle on retail case-life of ground beef and top loin steaks. C. E. Walenciak*, B. A. Gardner, H. G. Dolezal, and F. N. Owens, *Oklahoma State University, Stillwater.*

Steers (n=120) were randomized into two groups to evaluate the effects of supplementing AGRADO^{TM} (150 ppm DM basis for 123 days), a feed additive with antioxidant properties, on case-life of ground beef and longissimus steaks and sensory characteristics of longissimus steaks. Strip loins (n=120) and shoulder clods (n=32), representing four pens of treatment and four pens of control, were collected. Shoulder clods were coarse ground, adjusted to 85±2% lean, then fine ground onto styrofoam trays, overwrapped with oxygen permeable film, and placed in a retail case (1.6^{o}C; 200 fc light). Two steaks (2.54 cm thick) were removed from strip loins 14-days postmortem for case-life and sensory panel evaluation. A trained evaluation panel scored ground beef and top loin steaks for lean color, % discoloration, and overall desirability at 0800 and 1600 hr for six days. A Minolta CR-300 colorimeter was used to determine L*, a*, b* values. Taste panel steaks were broiled in an impingement oven to 70°C internally for sensory evaluation. A 5g sample of ground beef was plated on Tryptic Soy Agar and on Violet Red Bile Agar to enumerate total plate counts and coliforms, respectively. No differences (P>.05) were noted between treatments for L*, a*, or b* values or visual panel scores for ground beef or top loin steaks. Ground beef from AGRADO^{TM} supplemented steers had lower (P<.05) TBARS than control for all days of display (overall .09 vs .19 mg MGA/kg respectively). There were no differences (P>.05) between treatments for juiciness, cooked beef fat, tenderness, connective tissue amount, or off flavors. Steaks from steers supplemented with AGRADO^{TM} had lower (P<.05) sensory panel scores for flavor intensity. There were no differences (P>.05) among treatment groups for total plate or coliform counts. Results indicate that supplementing AGRADO^{TM} in the finishing diets of steers inhibited lipid oxidation of ground beef and decreased flavor intensity, but did not affect tenderness, juiciness, or overall desirability of longissimus steaks.

Key Words: Beef, Case-life, Lipid oxidation

226   Effects of vascular infusion of cattle after exsanguination with saccharides,sodium chloride, and phosphates,and either vitamin C, E or C+E on carcass traits and meat palatability. M. E. Dikeman*[1], T. E. Dobbels[1], E. J. Yancey[1], E. Katsanidis[2], and P. B. Addis[2], [1]*Kansas State University, Manhattan*, [2]*University of Minnesota, St. Paul.*

Grain-finished Charolais crossbred steers (n=36) were used to evaluate the effects of vascular infusion on carcass traits and meat palatability. Twenty-seven steers were infused via the carotid artery immediately after exsanguination at 10% of live weight with a solution containing 98.52% water, .97% saccharides, .23% NaCl, and .28% phosphates (MPSC standard solution, MPSC, Inc., Eden Prairie, MN) plus either 500 ppm vitamin C(MPSC+C, n=9), 500 ppm vitamin E (MPSC+E, n=9), or 500 ppm each of vitamin C+E (MPSC+C+E, n=9). Nine steers served as non-infused controls (NI). After infusion, steers were dressed and chilled conventionally. Carcasses were fabricated at 48 h postmortem, muscles were vacuum packaged, and then aged until 14 d postmortem. Dressing percentages were increased (P<.05) 3.5, 1.7 and 2.1% for MPSC+C, MPSC+E, and MPSC+C+E treatments, respectively. Liver, heart, and head weights were increased (P<.05) by all infusion treatments. Infusion had no effect on USDA yield and quality grade factors, or percentage of purge of five vacuum packaged muscles at 14 d postmortem. Infusion had no effect (P<.05) on Warner-Bratzler shear force or descriptive attribute sensory panel evaluations of

the Longissimus thoracis (LT) and Semitendinosus (ST) muscles. However, infusion with the MPSC+C or MPSC+C+E solutions increased the metallic and soapy/chemical flavor of the LT as evaluated by a trained flavor profile sensory panel. Infusion with MPSC+E reduced beef flavor identity and bloody serumy and increased soapy/chemical of the ST, whereas infusion with MPSC+C+E reduced soapy/chemical flavor. When LT and ST muscles were cooked, chilled and warmed over, infusion with MPSC+E increased soapy/chemical flavor, whereas MPSC+C+E decreased soapy/chemical flavor compared to NI. Infusion with MPSC+C or MPSC+C+E increased beef flavor identification and brown roasted flavor of freshly cooked ground beef, but decreased these same traits in warmed-over ground beef. Our results suggest that infusing young, grain-fed cattle with MPSC+C, MPSC+E, or MPSC+C+E should increase dressing percentage and some organ weights, have no effect on USDA quality or yield traits, have no effect on tenderness, and have inconsistent effects on the flavor profile of freshly cooked and warmed-over steaks and ground beef.

Key Words: Beef, Vascular Infusion, Meat Palatability

227   Effects of vascular infusion of cattle after exsanguination with saccharides, sodium chloride, and phosphates, plus vitamin C, E, or C+E on meat display color stability. E. J. Yancey*[1], M. C. Hunt[1], M. E. Dikeman[1], T. E. Dobbels[1], and P. B. Addis[2], [1]*Kansas State University, Manhattan,* [2]*University of Minnesota, St. Paul.*

Grain-fed crossbred Charolais steers (n=36) were selected visually for uniformity. Twenty-seven steers were infused at 10% of live weight via the carotid artery immediately after exsanguination with a solution developed by MPSC, Inc. (Eden Prairie, MN) consisting of 98.52% water, .97% saccharides, .23% sodium chloride, and .28% phosphates plus either 500 ppm vitamin C (MPSC+C, n=9), 500 ppm vitamin E (MPSC+E, n=9), or 500 ppm E + 500 ppm C (MPSC+C+E, n=9). Non-infused controls (NI) were slaughtered conventionally. Carcasses were fabricated at 48 h postmortem. Longissimus thoracis (LT), Psoas major (PM), and Semimembranosus (SM) portions were removed, vacuum packaged, and held at 2°C until 14 d postmortem. Steaks 2.54 cm thick were sliced from the LT, PM, and SM, placed on styrofoam trays, and wrapped with polyvinyl chloride film. Ground beef (GB) was formulated from the Quadriceps to contain 15% fat, mounded into .45 kg portions, placed on styrofoam trays, and wrapped with polyvinyl chloride film. Steaks were evaluated for both uniformity and initial color on d 0 of display, and GB was evaluated for initial color on d 0 of display. Instrumental color measurements of L^*, a^*, b^*, and trained sensory panel color evaluations were obtained daily for 4 d (PM and GB) or 5 d (LT and SM) of display. L^*, a^* and b^* values were not different among treatments. The LT from NI cattle was more (P<.05) uniform and more cherry red than for infused cattle on d 0. Display color scores indicated that GB from MPSC+E steers was more red (P<.05) consistently than MPSC+C throughout display, and GB from MPSC+E was more red (P<.05) than NI for the last 3 d of display. All vascular infusion treatments resulted in less color uniformity of the LT muscle on d 0 of display, and the MPSC+E treatment resulted in redder GB than for non-infused controls during the last 3 d of display.

Key Words: Beef, Vascular Infusion, Color

228   Effect of supplementing feedlot steers with vitamin D_3 and E on carcass traits, shelf-life attributes and longissimus muscle tenderness. D. N. Vargas*, A. E. Down, D. S. Webb, H. Han, J. B. Morgan, and H. G. Dolezal, *Oklahoma State University, Stillwater, OK USA.*

Cattle (n=119) of mixed origin were divided into four dietary treatment groups: control (CON), vitamin D_3 (VITD), vitamin E (VITE) and vitamin E and D (COMBO). VITE Treatments (VITE and COMBO) were supplemented with 1,000 IU/hd/d for the final 54 d of the feeding period. Additionally, steers in VITD and COMBO groups received 6 million IU/hd/d of VITD for the final 6 d immediately prior to harvest. Longissimus Lumbarum (LL) samples were divided into four sections and stored in refrigerated conditions for 7, 14, 21 or 28 d postmortem. At the end of each aging period LL sections were cut into three 2.54 cm steaks for shear force determination, shelf-life analysis and sensory evaluation. Shelf-life was evaluated twice per d using a three-member trained panel and a Minolta colorimeter. Tissue oxidation was estimated at the beginning and end of each seven d retail display period using the thiobarbituric acid (TBA) assay. Mean Warner-Bratzler shear force values across all aging periods were higher (P < .05) for CON steaks compared to other treatments (CON 3.88 kg, VITD, VITE, COMBO, 3.65, 3.63, 3.57 kg, respectively). At 7 d VITD steaks had shear force values lower (P < .05) than VITE steaks and tended (P = .06) to be lower than the CON group. Regression analysis showed steaks from cattle in the VITD and COMBO groups required fewer aging days to become "very tender" (shear force ≤ 3.86 kg) relative to CON and VITE treatments (7.4 and 9.8 vs 15.8 and 11.8, respectively). Panel lean color scores were higher (P < .05) at display d 4, 5 and 6 for VITE steaks compared to other treatments. Mean a^* values were higher (P < .05) for VITE and COMBO steaks when compared to CON and VITD; and b values were higher (P < .05) for steaks from cattle in the VITE group relative to all other treatments. Mean TBA values were lower (P < .05) for VITE and COMBO groups compared to CON and VITD (.112 and .059 vs .237 and .372 mg/kg, respectively). Regression analysis predicted VITD and COMBO steaks would remain acceptable in the retail case longer (3.7 and 3.2 d vs 1.9 and 1.2 d, respectively) after reaching 3.86 kg of shear force than VITE or CON treatments. Therefore, in order to optimize the "color-tenderness relationship" of beef, supplementing finishing cattle with both vitamin D_3 and E is recommended.

Key Words: Tenderness, Shelf-life, Vitamins

229   Supplemental vitamin D_3 and beef tenderness. S. S. Swanek, N. A. Elam*, J. B. Morgan, F. N. Owens, D. R. Gill, C. A. Strasia, H. G. Dolezal, and F. K. Ray, *Oklahoma State University, Stillwater, OK.*

The objectives of this study were to determine 1) the effectiveness of supplemental vitamin D_3 (VITD) on altering plasma and muscle calcium levels, 2) whether VITD supplementation improves Warner-Bratzler shear (WBS) force values of steaks from feedlot beef steers, and 3) the tenderness response curve in VITD supplemented longissimus muscle steaks. In Exp. 1, 20 crossbred steers were assigned randomly to one of four treatment diets consisting of either 0, 2.5, 5.0, or 7.5 million IU of VITD per day for 10-d. Blood samples were obtained daily during this supplementation period and 5-d thereafter (d 11-15). Results suggested that between d-6 through d-13 a linear increase (P<.01) in ionized plasma calcium concentrations was observed in steers supplemented with VITD. Compared to non-supplemented steers, serum calcium concentrations of the steers receiving 7.5 million IU of VITD per day were increased between 30% and 50%. In Exp. 2, longissimus dorsi muscle samples from crossbred steers (n=118), which were supplemented with either 0 or 5 million IU of VITD per day for 7-d, were obtained and aged for 7-, 14-, or 21-d. Following the initial 7-d postmortem aging period, VITD supplementation lowered (P<.01) WBS (.58 kg) and increased sensory tenderness rating (.6 units) when compared to cuts originating from non-supplemented steers. In Exp.3, 44 steers were supplemented with either 0 or 7.5 million IU of VITD per day for 10-d immediately prior to harvesting. Results indicated that 1) plasma and longissimus dorsi muscle calcium concentration were higher (P<.05) for steers that received supplemental VITD; 2) compared with non-supplemented cuts, VITD supplementation improved WBS of cuts aged for 7-, 14-, and 21-d (P<.02, P<.07, and P<.13, respectively); 3) sensory panelists preferred samples from VITD supplemented steers; and 4) evidence is presented that activation of calpain proteases could be responsible for the observed tenderization due to the supplementation of VITD.

Key Words: Vitamin D_3, Calcium, Tenderness

230   Effects of feeding Vitamin D_3 on carcass characteristics of beef cattle. K. Karges*, J. B. Morgan, F. N. Owens, and D. R. Gill, *Oklahoma State University, Stillwater, OK.*

Supplemental Vitamin D_3 (Vit. D) has shown to improve tenderness in beef cuts when fed to cattle < 10 d pre-harvest. A trial was conducted to determine how supplemental Vit. D affects blood Ca, carcass traits, Warner Bratzler Shear force values, pH (0, 3, 12, and 24 h post-harvest) and calpastatin activity of three different muscles: Longissimus, Gluteus medius and Biceps femoris. Treatments included no Vit. D supplementation or 6 million IU (MIU) daily for either 4 or 6 d pre-harvest. Utilizing a completely randomized design, 24 steers (545 kg) were allocated to treatments (8 pens) and fed a 90% concentrate ration twice daily (12.35% CP; 61 Mcal NEg/cwt) with Vit. D fed once daily in a pellet as a percent of the total ration. Hot carcass weights decreased (P<.05) due to feeding of Vit. D. At harvest, 3 steaks (2.54 cm) were

cut from each of the specified muscles and aged 7, 14 and 21 d. Steaks were cooked at 185°C to a final internal temperature of 70°C and shear force values were obtained. Effect of feeding and duration of feeding (6 vs 4 d) of Vit. D on shear force was detected in Longissimus and Gluteus medius (P<.05) however, only duration of feeding slightly affected the Biceps femoris (P=.16). Age effects on shear force were apparent for feeding Vit. D at 14 and 21 d for Longissimus and Gluteus medius. Duration of feeding Vit. D by age interaction occurred at 7 d for Longissimus shear force (P<.05). Effect for duration of feeding Vit. D on pH was detected with 6 d being higher than 4 d in all muscle types at 0, 3, and 12 h but lower at 24 h (P<.05). Vit. D also altered pH at 3 h with a feeding effect of Vit. D (P<.05) being detected. No impact for duration or feeding of Vit. D on calpastatin activity in muscle tissue was detected. Plasma blood samples obtained at harvest during exsanguination were analyzed for total Ca concentrations and indicated that Ca increased (P<.05) from both a duration and feeding of Vit. D (P<.05). These data suggest that Vit. D will improve tenderness of various muscles and alter blood plasma Ca concentrations.

Key Words: Vitamin D, Beef, Tenderness

231   Effects of dietary modifications using vitamin D₃ on calcium content and vitamin D residues in tissue and liver. J. L. Montgomery*[1], R. L. Horst[2], D. A. Hoy[2], M. A. Carr[1], G. G. Hilton[1], B. D. Price[1], and M. F. Miller[1], [1]*Texas Tech University,* [2]*National Animal Disease Center USDA/ARS.*

Feedlot steers (n=167) of Bos indicus and Bos taurus breeding were fed one of six vitamin D₃ treatments eight consecutive d starting 10-d prior to slaughter. A total of 42 pens of four steers each were blocked into seven categories according to average weight. The six vitamin D₃ treatments consisted of either no supplemental vitamin D₃, ½ million, 1 million, 2.5 million, 5 million, or 7.5 million IU/steer/d. Plasma calcium was measured during the eight d supplementation period. After slaughter tissue samples from the longissimus lumborum (strip loin) and liver were taken. Residues of vitamin D₃, and two of its metabolites, 25-hydroxy-vitamin D₃, and 1,25-dihydroxy-vitamin D₃ were determined for liver and lean tissues via HPLC and radioactive enzyme techniques. Vitamin D₃ feeding increased plasma calcium (P < .05). At slaughter plasma calcium concentrations were 8.7, 9.2, 9.4, 9.9, 10.1, and 10.4 mg Ca++/dl for 0, ½, 1, 2.5, 5, and 7.5 million treatments respectively. Vitamin D₃ treatments of 1 million IU/steer/d or greater increased vitamin D₃ concentrations in strip loin and liver samples (P < .05). Feeding 5 million IU/steer/d for 8-d resulted in the highest increase in vitamin D₃ concentrations, which were four times higher in the liver and a seven times increase in the strip loin vs. control (P < .05). Cooking liver to 75°C resulted in a 10 to 30% reduction in vitamin D₃ concentrations. Feeding 5 and 7.5 million IU/steer/d of vitamin D₃ increased the metabolite 25-hydroxy-vitamin D₃ concentrations in both liver and strip loin samples. The six treatments did not differ in 1,25-dihydroxy-vitamin D₃ metabolite concentrations in liver and strip loin samples. Thus, vitamin D₃ treatments of 1 million IU/steer/d or greater for 8 consecutive d will increase concentrations of vitamin D₃ and treatments of 5 and 7.5 million IU/steer/d of vitamin D₃ will increase the vitamin D metabolite 25-hydroxy-vitamin D₃ concentrations in muscle and liver.

Key Words: Beef, Vitamin D, Residue

232   Effect of freezing method and calcium chloride injection on beef longissimus muscle tenderness. C. D. Wallace, J. C. Mafi*, J. B. Morgan, L. L. Guenther, K. K. Novotony, H. G. Dolezal, and F. K. Ray, *Oklahoma State University.*

This study evaluated the effects of freezing (FRZ) and crust freezing (CF) in conjunction with calcium chloride (CaCl₂) injection and postmortem aging on beef longissimus tenderness. Steers (n = 75) were fed a high concentrate diet at a commercial feedyard in the Texas Panhandle. Striploins were obtained from both carcass sides and fabricated into 2.54 cm steaks. From the left striploin, four steaks were used as a control (CON) and separated into 3, 7, 14, and 21 d aging treatments. The remaining samples were used for FRZ and CF treatments and aged for 7, 14, and 21 d, respectively. One steak from the right striploin was used as a CON for sensory analysis. The remaining portion of the longissimus samples were injected with a 200 mM CaCl₂ solution (5% of subprimal weight) and allowed 4 h to equilibrate. The injected samples were further fabricated and allocated to three treatment groups: CON, FRZ, and CF and aged for 7 d. Treatments were analyzed for Warner-Bratzler

shear force (WBS), calpastatin activity, sensory evaluation, and cooking loss. Means were separated using Fisher's LSD. Steaks from CF groups had higher (P<.05) WBS force values relative to other treatments. CON steaks had lower (P<.05) WBS force values than FRZ treatments at 14 and 21 days postmortem. CaCl₂ injection significantly reduced (P<.05) WBS force values in both CON and CF treatments relative to their non-injected counterparts. Calpastatin activity was reduced (P<.05) in all CaCl₂ injected treatments. Sensory panelists classified approximately 20% more steaks as being tender due to CaCl₂ injection. Therefore, CF should be eliminated from daily processing due to its detrimental effect on tenderness and cooking loss when not used in conjunction with CaCl₂. Additionally, extensive freezing should not be used as a method to improve palatability, but only for preservation.

Key Words: Tenderness, Calcium Chloride, Freezing

233   Type of container and quantity of explosive in the Hydrodyne process on beef strip loin tenderness. M. B. Solomon* and J. S. Eastridge, *USDA, ARS, MSRL, Beltsville, MD.*

The Hydrodyne process has been shown to instantaneously improve tenderness of whole muscle cuts. Hydrodyne performance between treating meat samples in 115 L disposable plastic containers (GC) was compared to using 1060 L stationary stainless steel tank (HU). Five cm sections of USDA Select grade boneless strip loins were distributed among the following treatments (n=6/treatment): Control; GC (150 g explosive at 38 cm from bottom); HU4 (4 shock absorbers attached to tank and 350 g at 41 cm from bottom); HU8 (8 shock absorbers attached to tank and 350 g at 41 cm from bottom); HU16 (16 shock absorbers attached to tank and 350 g at 61 cm from bottom); HU16 (350 g at 48 cm) and HU16 (150 g at 31 cm). Each section was cut into 2.5 cm thick steaks after being treated and cooked to 71 C on open hearth broilers. Control samples had shear values of 6.98 kg. Shear values as a result of hydrodynamic pressure generated in the different containers was as follows. GC=3.73 kg; HU4=4.23 kg; HU8=5.85 kg; HU16 (350g@61 cm)=6.15 kg; HU16 (350g@48 cm)=5.93 kg and HU16 (150g@31 cm)=5.82 kg. Results suggest that type of container and shock absorbing system, as well as location of explosive (distance from bottom container) play an important role in the performance of the Hydrodyne process to tenderize meat.

Key Words: Hydrodyne, Shear Force, Beef

234   Correlation among trained sensory panel descriptive attribute ratings and consumer ratings of beef longissimus steaks. S. D. Shackelford*, T. L. Wheeler, M. K. Meade, J. O. Reagan, B. L. Byrnes, and M. Koohmaraie, *U.S. Meat Animal Research Center, Clay Center, NE.*

Both strip loins from 104 U.S. Select beef carcasses, that represented a broad range (8.7 to 43.4 kg; CV = 42%) in slice shear force at 14 d postmortem, were used to determine the correlation among trained sensory panel (TSP) descriptive attribute ratings and consumer ratings of beef longissimus steaks. Consumers (n = 503) in the Denver, Colorado metropolitan area prepared and evaluated one low (< 16 kg)- and one high (> 20 kg)-shear force steak in their home. Consumers rated the steaks for like, tenderness, juiciness, flavor like, flavor amount, and overall satisfaction (0 = extremely undesirable and 10 = extremely desirable). An 8-member TSP evaluated steak samples for tenderness, juiciness, and beef flavor intensity (1 = extremely tough, dry, or bland and 8 = extremely tender, juicy, or intense). There was a high level of autocorrelation among all consumer traits (r = .84 to .94); therefore, use of correlations among consumer traits to identify the determinants of consumer satisfaction would be misleading. A more meaningful indicator of the relative importance of the palatability traits to consumer satisfaction is the correlation of consumer traits with TSP ratings. Because tenderness was much more variable than juiciness and flavor intensity (SD 1.5, .4, and .4, respectively), consumer ratings were most highly correlated with tenderness. That is, tenderness is the primary determinant of consumer perceptions of the palatability of U.S. Select strip steaks.

Correlation coefficients	Trained sensory panel ratings		
		Flavor	
Consumer rating	Tenderness	intensity	Juiciness
Like	.72***	.40***	.32**
Tenderness	.75***	.44***	.30**
Juiciness	.59***	.36***	.23*
Flavor like	.63***	.41***	.25*
Flavor amount	.57***	.37***	.22*
Overall satisfaction	.69***	.40***	.26**

*P < .05. **P < .01. ***P < .001.

Key Words: Beef, Consumer, Tenderness

NONRUMINANT NUTRITION

235   Efficacy of two commercially available phytase preparations for weanling pigs fed a low-P plant-based diet. J. P. Rice*, J. S. Radcliffe, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Ninety-six weanling pigs were used in a 5-wk study to compare the effectiveness of two commercially available phytase sources. Following a 7 d adjustment period, pigs were randomly assigned to treatments (one barrow and one gilt per pen) based on gender and BW. All diets were corn-soybean meal-based and formulated to contain adequate amounts of all nutrients except Ca and P (NRC, 1998). Diets 1 and 2 served as the positive (.33% aP, .71%tP, and .75% Ca) and negative controls (.13% aP, .43% tP, .50% Ca), respectively. Diets 3 and 4 were diet 2 plus .25 and .50 g/kg (13,800 and 27,600 PTU/kg-Alltech phytase units) source A phytase (Allzyme), respectively. Diets 5 and 6 were diet 2 plus 250 and 500 U/kg of source B phytase (Natuphos®), respectively. Pig weights and pen feed intake were recorded weekly. During wk 5, six fecal grab samples were collected (3 AM and 3 PM collections). At the end of the study, the barrow from each pen was killed for collection of metacarpals to determine bone shear force and ash. Diet and fecal samples were analyzed for Ca, P, Cr, and DM. The addition of P to the negative control diet increased ADG (P < .001), G:F (P < .004), metacarpal shear force (P < .001) and ash (P < .001), and P (P < .001) digestibility. The addition of phytase from either source increased ADG (P < .004), G:F (P < .05), metacarpal shear force (P < .002), and ash (P < .01), and Ca (P < .01) and P (P < .001) digestibilities. Based on equivalency values generated from response equations for ADG, G:F, metacarpal shear force and ash, and P digestibility, phytase supplementation to diets 4 (source A-27,600 PTU/kg) and 6 (source B-500 U/kg) was equivalent to .127 and .158% P as monocalcium/dicalcium phosphate, respectively. Although phytase from sources A and B did not significantly differ (P > .05) in their ability to improve performance, bone parameters, or mineral digestibility, equivalency values suggest that source A had a slightly higher P replacement value than source B.

Key Words: Pigs, Phytase, Phosphorus

236   The effects of various concentrated immunoglobulin protein sources in phase 1 diets of early weaned pigs. J. A. Godfredson-Kisic*[1], T. E. Shipp[1], and K. C. Ferrell[2], [1]*DuCoa, Highland, IL,* [2]*MFA, Inc., Columbia, MO.*

Previously we reported that weanling mice fed diets supplemented with 2% porcine globulin proteins (GLOB) demonstrated similar gain and feed efficiency as mice fed diets containing 8% spray dried porcine plasma (SDPP). We also reported that the albumin fraction of plasma was not as effective in improving gain and feed conversion as whole SDPP. The objective of this study was to see if similar responses would be observed in early weaned pigs. In addition to SDPP and GLOB, we used a diet supplemented with concentrated porcine albumin protein in combination with spray dried egg, which provided an alternative source of immunoglobulin (ALB+). A total of 160 weaned barrows (13 d old, 4.2 kg BW) were blocked by weight to one of four dietary treatments, 4 pens/trt, 10 pigs/pen. Treatment diets offered were supplemented with either: 1) 8% SDPP, 2) 4% GLOB, 3) 2% GLOB, or 4) 4% ALB+. All diets were equalized for protein, lysine, methionine and energy. Diets were offered *ad libitum* for 7 d postweaning, after which, gain and feed intake were measured. On d 7 postweaning, ADG (g/day) for diets 1, 2, 3 and 4 were 113, 101, 116, 149 (P < .08), respectively. Average daily feed intake (g/day) for diets 1, 2, 3 and 4 were 130, 122, 127, 156 (P < .07), and gain/feed values were 0.88, 0.83, 0.90, 0.95 (P > .1), respectively. Significant differences were not observed among swine fed the first three diets, for gain and intake, yet swine on the fourth diet approached significant improvement. There were no significant differences among all four diets in gain/feed. This study agrees with the mouse

bioassay where a diet supplemented with only 2% concentrated porcine globulin proteins was as effective in maintaining growth and feed intake in early weaned pigs, as a diet containing 8% SDPP. Additionally, ALB+ improved gain, intake and maintained feed conversion in comparison to diets with SDPP and GLOB.

Key Words: Plasma, Immunoglobulin, Weanling Pigs

237   Dose response of Novo SP938 microbial phytase in weanling pigs fed a low-P corn-soybean meal diet. J. H. Skaggs* and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

The objective was to determine the dose response of supplemental Novo SP938 phytase for enhancing performance, bone mineralization and digestibility of Ca and P for weanling pigs (n = 96, 8.2 kg BW initially) fed a low-P, 19.5% CP corn-soybean meal diet for 5 wk. Dietary treatments were: 1) positive control (.7% Ca & .6% P), 2) negative control (.45% Ca & .39% P), and 3-6) treatment 2 + 250, 500, 750, or 1,000 U/kg phytase as a liquid. Body weight and pen feed consumption were recorded weekly. Fecal samples were collected during wk 5 for determination of Ca and P digestibility by the indirect method (.05% Cr_2O_3). At slaughter after wk 5, both tenth ribs were taken for assessment of bone mineralization. Linear increases (P < .001) in ADG, ADFI, and G:F from wk 3 to 5 were observed as the level of phytase or P increased. Tenth rib shear force, energy, ash weight, and ash percentage increased linearly (P < .10 to .001) as the phytase or P level increased. Digestibility of P and Ca linearly increased (P < .001) as the level of phytase or P increased with the two highest levels of phytase (750 and 1,000 U/kg) being equal to or greater than the positive control values. Concentration of P and Ca in fecal DM linearly decreased (P < .001) as the phytase level increased. Based on linear response equations for added P and nonlinear response equations for added phytase for ADG, rib ash percentage and P digestibility, the average P equivalency of 500 U/kg of phytase was 1.06 g of P as monocalcium/dicalcium phosphate. In summary, Novo SP938 phytase effectively improved performance, bone mineralization, P and Ca digestibility, and decreased P and Ca concentration in the feces.

Key Words: Pigs, Phytase, Phosphorus

238   Efficacy and safety of Novo SP938 microbial phytase supplementation of a corn-soybean meal diet fed to growing pigs. A. F. Harper*, J. H. Skaggs, H. P. Veit, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

The efficacy and safety of Novo SP938 phytase in growing pigs (n=126, 28.5 kg BW initially) fed a 15.7% CP corn-soybean meal diet was evaluated in a 6 wk trial. Dietary treatments were: 1) positive control (.54% Ca and .47% P), 2) negative control (.39% Ca and .34% P), and 3-6) treatment 2 + 250, 500, 1,000 or 10,000 U/kg phytase as a liquid. Body weight and pen feed consumption were recorded weekly. Fecal samples were collected during wk 6 for determination of Ca and P digestibility by the indirect method (.05% Cr_2O_3). The right foot of all pigs was removed at slaughter for evaluation of bone mineralization. Cumulative ADG and G:F increased (P < .01) and ADFI increased during wk 4-6 (P < .05) as the level of phytase increased with ADG and G:F of the highest phytase level equal to positive control values. Third metacarpal shear force, energy, ash weight, and ash percentage increased (P < .001) as the level of phytase increased. Digestibility of P and Ca increased (P < .001) as phytase levels increased with values for 1,000 and 10,000 U/kg being equal to or greater than the positive control values. Concentrations of P and Ca in the fecal DM decreased (P < .01) as

dietary phytase increased. Pathological and histopathological examination of liver, kidney, and tibia revealed no adverse effects of treatments. In summary, Novo SP938 phytase supplementation effectively improved performance, bone mineralization, P and Ca digestibility, and decreased P and Ca concentration in the feces of pigs fed a low-P corn-soybean meal diet. The addition of 10,000 U/kg of Novo SP938 phytase did not cause any ill effects on the health of the pigs, but continued to produce positive improvements in performance, bone mineralization, and mineral digestibility.

Key Words: Pigs, Phytase, Phosphorus

239   A new phytase expressed in yeast improves the bioavailability of phytate-phosphorus to weanling pigs. C. H. Stahl, Y. M. Han, K. R. Roneker, J. R. Thornton, and X. G. Lei, *Cornell University, Ithaca, NY.*

We have expressed a new phytase enzyme in a yeast system. Three experiments with a total of 140 weanling crossbreds were conducted to examine the efficacy of this enzyme in improving the bioavailability of phytate-P in a corn-soybean meal basal diet to young pigs. Exp. 1 compared the efficacy of this new phytase with a commercially available phytase (Natuphos, BASF) for 4 wks at an inclusion level of 1,200 U/kg of diet. Exp. 2 compared four doses of the new phytase supplementation (300, 600, 900, and 1,200 U/kg diet) for 4 wks in order to determine an optimal dose. Exp. 3 compared the efficacy of this new phytase and Natuphos at a marginally optimal dose (700 U/kg diet) for 5 wks. A group of pigs were fed the P deficient basal diet as negative control in Exp.1, and a group of pigs were fed the basal diet plus .17 to .22% inorganic P as a positive control in all experiments. In Exp. 1, pigs fed the two sources of phytase had similar ADG (564 vs. 567 g) and plasma inorganic P concentrations (8.9 vs. 8.4 mg/dL) that were higher (P < .05) than those of the negative control. In Exp. 2, plasma inorganic P concentration was a fairly linear response to the phytase dose (r > .83) at wk 1 and 2. Overall ADG of pigs also tended to increase with the phytase dose (P = .15). In Exp. 3, pigs fed the two sources of phytase had ADG (483 vs. 506 g) similar to that of the positive control (508 g). These two groups also had similar plasma inorganic P concentrations (7.7 vs. 7.4 mg/dL) that were lower (P < .05) than that of the positive group (9.7 mg/dL). There was no significant effect of dietary treatments on ADFI or feed use efficiency in all three experiments. In conclusion, our new phytase was as effective as Natuphos, at the level of 700 or 1,200 U/kg of a P-deficient, corn-soybean meal diet, in improving phytate-P utilization by young pigs.

Key Words: Pigs, Phytase, Phosphorus

240   Phytase addition to normal corn- and low phytic acid corn-soybean meal diets for chicks and pigs. J. L. Pierce* and G. L. Cromwell, *University of Kentucky, Lexington, KY.*

Two near-isogenic hybrid corn types (Optimum Quality Grains), one with the mutant *lpa1* gene, were evaluated in corn-soybean meal diets for chicks and pigs. The normal (N) and low-phytic acid (LP) corn analyzed .25 and .28% total P and .20 and .10% phytic acid P, respectively, and 10 vs 50% (chicks) and 20 vs 75% (pigs) of the P was assumed to be bioavailable. In Exp. 1, 3 d-old chicks (5 reps, 6/pen, 71 g BW) were fed one of 10 diets (21.5% CP, 1.0% Ca) containing N-corn (Diets 1-5) or LP- corn (Diets 6-10) for 14 d. Non-phytate P was .45, .35, .35, .25, .15% in Diets 1-5 and Diets 6-10. Phytase (Natuphos®, BASF) was added at 1,200 units/kg to Diets 3, 5, 8, and 10. Weight gain and tibia strength were similar for chicks fed the two corn types at equal dietary non-phytate P, and were improved (P < .01) by phytase additions to either corn (487, 470, 479, 439, 484 and 488, 470, 478, 446, 478 g; 16.9, 13.1, 17.3, 6.7, 12.3 and 17.7, 14.3, 16.7, 9.1, 13.5 kg). Phosphorus excretion was reduced by feeding LP-corn (P < .05) and by adding phytase (P < .01) (174, 144, 130, 123, 114 and 137, 109, 97, 94, 73 mg/d). In Exp. 2, 6 reps of 2 pigs/pen (18 kg) were fed diets (.95% lysine, .60% Ca) containing N- (Diets 1-3) or LP-corn (Diets 4-6) for 42 d. Total P in the 6 diets was .55, .45, .45, .45, .35, .35%, and bioavailable P was .29, .19, .19, .29, .19, .19%. Phytase was included in Diets 3 and 6 at 600 units/kg. Gain and feed/gain were: 808, 690, 699 and 813, 735, 835 g/d; 2.06, 2.43, 2.28 and 2.05, 2.19, 2.15. Phytase addition to the low P diets increased (P < .01) femur strength of pigs similar to that of pigs fed the higher P diets for both N- (272, 231, 265 kg) and LP-corn (282, 232, 283 kg). Fecal P excretion was reduced by feeding LP-corn (P <

.01) and by adding phytase (P < .05) (6.80, 5.95, 5.24 and 4.43, 3.75, 3.34 g/d). These results indicate that phytase is as effective in LP-corn diets as in N-corn diets, P excretion can be reduced by 25 to 35% by substituting LP-corn for N-corn, and P excretion can be reduced by 50% by combining phytase and LP-corn in corn-soy diets for chicks and pigs.

Key Words: Pig, Chick, Phytate

241   Phytase effects on ileal amino acid digestibility and nitrogen balance in finishing pigs fed a low-protein plant-based diet. Z. Zhang* and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Crossbred pigs (n = 120, equal barrows and gilts in 20 pens of six each) were used to investigate the effects of supplemental Natuphos® phytase on ileal digestibility of amino acid (AA) and crude protein (CP) and N balance when a low-protein plant-based diet was fed. During the finisher period (67 to 109 kg), diets 1, 2 and 3 contained 12, 11 and 10% CP (.47% Ca and .4% P) with no added phytase, respectively, and diets 4 and 5 contained 10% CP with either 250 or 500 U/kg phytase, respectively. Similar diets with higher CP (2 percentage units) and Ca:P (.1 percentage unit) levels were fed during the grower period (32 to 67 kg). At the end of grower phase, one barrow and one gilt were removed from each pen; the 12 barrows that were removed for diets 1, 3 and 5 were used in a N balance trial. At the end of the finisher phase, 12 barrows from diets 1, 3, and 5 were used in a N balance trial. Ileal contents were taken (slaughter technique) from all barrows for amino acid analysis. Pig BW and pen feed intake were measured weekly. Fecal collections were taken during the last 10 d of the grower and finisher phases. Daily gain linearly increased (P < .05) as protein or phytase was added to the lowest protein level. Fecal N digestibility and retention coefficients increased (P < .05) as CP or phytase were added to the low CP diet. The digestibility of all amino acids, linearly increased (P < .10 to .01) as the dietary CP level increased or as phytase was added, except glycine for CP, and proline and glycine for phytase. Fecal P and Ca digestibilities improved with added phytase (P < .05). Based on linear responses of added CP or phytase on ileal amino acid digestibilities (averaged), the equivalency of 500 U/kg of phytase was estimated to be .76 percentage units of CP. Nitrogen excretion was estimated to be reduced 5.1% when phytase was added to pig diets at a level of 500 U/kg.

Key Words: Pig, Amino acids, Phytase

242   Effects of microbial phytase on amino acid and mineral digestibilities in pigs fitted with steered ileo-cecal valve cannulas and fed a low protein, corn-soybean meal based diet. J. S. Radcliffe*, E. T. Kornegay, and R. S. Pleasant, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Ten crossbred barrows (48.3 kg initial wt.) fitted with steered ileo-cecal valve (SICV) cannulas were used to investigate the effects of supplemental microbial phytase on the apparent ileal digestibilities (AID) of Ca, P, N, DM, and amino acids, and the apparent total tract digestibilities (ATTD) of Ca, P, N, and DM. All dietary treatments were corn-soybean meal-based and contained .44% Ca and .40% P. Diets 1, 2, and 3 contained 12, 11, and 10% CP, respectively. Diets 4 and 5 were diet 3 plus 250 and 500 U/kg Natuphos® phytase, respectively. Pigs were randomly allotted to one of the five dietary treatments in a paired 5 x 5 Latin square with an extra period to test for carry over effects. Each 14-d period consisted of a 7-d adjustment followed by a 3-d total collection, a 12 h ileal digesta collection, a 3-d readjustment, and a second 12 h ileal digesta collection. Pigs were individually housed in metabolic pens (1.2 m x 1.2 m). Water was supplied ad libitum and feed given at a level of 9% of the pigs metabolic BW (BW $^{.75}$)/d. Increasing dietary CP increased (P < .05) the AID of CP and all amino acids measured with the exception of proline. In addition, the ATTD and retention of N also increased (P < .01) with increasing CP levels. Supplementing diets with phytase increased the AID of Ca (P < .01), P (P < .001), CP (P < .001), and all amino acids (P < .10) measured with the exception of leucine, serine, proline, methionine and tyrosine. Protein and phytase response equations were generated for those amino acids significantly affected by both CP level and phytase supplementation. Based on these equations 500 U/kg of phytase can replace .52 percentage units of the dietary CP which includes a .03 percentage unit improvement in lysine

AID. The results of this study clearly show that supplementing pig diets with microbial phytase improves CP and amino acid digestibilities in addition to Ca and P digestibilities.

243   Bioavailability of phosphorus in meat and bone meal subjected to varying processing pressures for pigs.
S. L. Traylor*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington, KY.*

Processing conditions of meat and bone meal (MBM) affect amino acid availability, but their effects on P availability are not known. Two experiments assessed blended (beef and pork) MBM (23.1% ash, 49.7% CP, 7.4% Ca, 3.7% P) subjected to additional processing pressures of 0, 30, or 60 psi for 20 min. Exp. 1 was a 5-d balance trial involving 8 reps of barrows (63 kg BW). A corn-soybean meal basal diet (.80% lysine, .31% Ca, .31% P) was used. In diets 2-5, monosodium phosphate (MSP) and CaCO3 or MBM processed at 0, 30, or 60 psi were added to provide .125 and .26% added P and Ca. No differences (P = .30) were found, although MSP had numerically higher true P absorption than MBM (87.6 vs 85.1, 75.8, 81.3%, respectively). Further processing of MBM did not affect (P = .22) P balance. In Exp. 2, 36 individually-penned pigs (6 reps, 15.6 kg BW) were fed a low-P, corn-soybean meal basal diet (.95% lysine, .70% Ca, .34% P) or the basal diet with .10 or .20% added P from MSP or .20% added P from MBM (0, 30, or 60 psi) for 35 d. Ca was maintained at .70% in all diets. Average daily gain and feed:gain (F:G) were: 565, 737, 791, 816, 803, 804 g/d; 210, 1.99, 1.90, 1.81, 1.85, 1.84. Femur strength and metacarpal-metatarsal strength and ash were: 80, 167, 265, 205, 218, 244 kg; 20.7, 41.3, 56.0, 49.4, 48.9, 50.5 kg; 1.45, 2.14, 2.73, 2.51, 2.51, 2.63 g. Average daily gain and F:G improved (P < .01) with P addition from either source, and P additions from MSP improved growth and bone traits linearly (P < .01). Growth was unaffected (P = .12) by P source (diet 3 vs 4-6); however, bone strength and ash were lower (P < .05) for MBM than for MSP. Processing pressure of MBM affected femur strength (linear, P < .02), but had no effect on the other traits (P = .25). Bone traits were regressed on added P intake for each P source. Based on slope-ratio (MSP = 100%) the bioavailability of P averaged 80, 81, and 91% (P = .17, SE = 5.4) for the 0, 30, and 60 psi MBM. These results indicate that the availability of P in MBM is relatively high for pigs, and that extremes in processing pressure have only slight effects on bone traits.

244   Bioavailability of phosphorus assessment in commercial dicalcium phosphates and rock phosphates for growing swine.
L. W. O. Souza[1], F. R. Lima*[1], A. S. Moretti[1], F. M. Tucci[1], and P. M. Leal[2], [1]*Faculdade de Medicina Veterinária e Zootecnia, Universidade de Sao Paulo,* [2]*Faculdade de Engenharia Agricola, UNICAMP.*

One hundred ninety two pigs were used in a trial to assess the relative bioavailability of phosphorus (RBP) in six phosphate sources. Phosphates were three feed grade phosphates (FP), two made in Brazil (Tortuga and Serrana), and one USA made (IMC Agrico.), and three rock phosphate samples (RP) originated from two mine sites in Brazil (Araxa and Tapira), and one mine site in Israel (Arad). Levels os Ca, P, and F in RP were 29, 12 and 1.7% (Araxa), 33, 14, and 1.4% (Tapira), and 30, 14, and 3.6% (Arad), respectively. Pigs were fed a corn-soybean meal basal diet (18% CP, 0.95% Lysine, 0.75% Ca, 0.37% P) or the basal diet with 0.15% P from a standard purified grade calcium phosphate dibasic (SP), or with 0.15% P from experimental FP or RP. Each diet was fed to six pen replicates of four pigs per pen (two barrows and two gilts) for 35 d (14.4 to 33.9 kg). Weight gain (WG), feed/gain (FG), plasma P, bone ash (BA), and breaking strength of metacarpals and metatarsals (BS-MM), and femurs (BS-F) were improved (P < 0.01) by SP, FP, and RP. However, performance and bone parameters were depressed (P < 0.01) by RP, as compared to FP dietary supplementation. WG and feed intake (FI) decreased by 9% (536 vs 590 g/d, and 1,276 vs 1,402 g/d, respectively), BA decreased by 9.9% (27.3 vs 30.3%), BS-MM by 17% (16.6 vs 20.0kg), and BS-F by 26.2% (131 vs 177kg). WG, BA, BS-MM, and BS-F were regressed on P added, and slope-ratios were calculated to assess RBP in the FP and RP sources. The average bioavailability of P in the FP and RP sources, relative to SP (given a value of 100), were 89 and 49% (WG), 112 and 49% (BA), 78 and 28% (BS-MM), and 101 and 52% (BS-F), respectively. From these results, low bioavailable P, and

toxicity related to animal performance and bone parameters, should be expected if rock phosphates are used, instead of feed grade phosphates, to feed pigs.

245   Effects of corn and(or) soybean meal on nitrogen and phosphorus excretion of growing pigs.
B. W. Senne*, S. D. Carter, L. A. Pettey, and J. A. Shriver, *Oklahoma State University, Stillwater.*

Six groups of four littermate barrows (initial BW, 29.4 kg) were used to determine N and P excretion of pigs fed corn, soybean meal (48% CP; SBM), or a combination of corn and SBM. Treatments were: (1) fortified cornstarch-casein (control; 2.22%N, .33% P), (2) corn-casein (2.74% N, .40% P), (3) cornstarch-SBM (3.24% N, .49% P), and (4) corn-SBM (3.49% N, .67% P). All diets were formulated to .82% digestible lysine and .31% available P. Crystalline Lys, Thr, Met, and Trp were added to provide an ideal ratio to lysine in Diet 1. A constant ratio of Ca:available P (1.9:1) was maintained across treatments. Diets were fed for 5 d to allow for total collection of urine and feces. Daily N and P intakes were, respectively: 26.9, 38.2, 39.9, 46.8 g and 4.1, 5.6, 6.1, and 9.1 g. Daily DM excretion (12, 94, 49, and 140 g) was lowest (P<.01) for pigs fed the control diet followed by those fed SBM, corn, and corn-SBM. Fecal N, urinary N, and total N excretion for the 4 diets were, respectively: .33, 3.04, 2.55, and 5.90 g/d; 1.22, 2.72, 4.54, and 7.36 g/d; and 1.55, 5.88, 7.26, and 13.26 g/d. N absorption (% of intake) was greater for pigs fed the control diet (P<.01); no differences existed between the corn and SBM diets; however, pigs fed corn-SBM had the lowest absorption of N (P<.01). N retention (% of intake) followed the same trend. Fecal P, urinary P, and total P excretion for the 4 diets were, respectively, .29, 1.73, 1.70, and 3.22 g/d; .22, .12, .32, and .34 g/d; and .59, 1.90, 2.10, and 3.56 g/d. P absorption (% of intake) was highest for pigs fed the control diet (P<.01); no differences existed between corn and SBM, but pigs fed the corn-SBM diet had the lowest absorption of P (P<.04). P retention (% of intake) was highest for pigs fed the control diet (P<.01), and there were no differences among pigs fed corn, SBM, or corn-SBM. These results suggest that corn contributes more to DM excretion than SBM. However, in a typical corn-SBM diet for growing pigs, the amount of N and P excretion attributed to corn or SBM is similar.

246   Effects of fiber addition (10% soybean hulls) to a reduced crude protein diet supplemented with synthetic amino acids verses a standard commercial diet on pig performance, pit composition, odor and ammonia levels in swine buildings.
D. C. Kendall*, B. T. Richert, A. L. Sutton, J. W. Frank, S. A. DeCamp, K. A. Bowers, D. Kelly, and M. Cobb, *Purdue University, West Lafayette, IN.*

One-hundred and sixty grow-finish pigs (Initial BW = 60.3 kg) were placed in two identical, environmentally controlled rooms. There were 4 replications (40 pigs/rep) with treatments rotated between rooms. Pigs in both rooms were fed a standard corn-soybean diet for 3 weeks (13.1% CP, .70% Lysine; Lys), pigs in each room were then fed either a corn-soybean diet (12.4% CP, .65% Lys; HCP) with supplemental Lys(.15%) or a reduced CP diet with the addition of 10% soybean hulls (9.7% CP, .65% Lys; RCPF) with supplemental Lys(.372%), Tryptophan (.005%), and Threonine (.042%) for 6 weeks. Pigs were weighed and feed consumption recorded at 0, 3, 6, and 9 weeks. Aerial ammonia concentration (AAC), pit samples, and odor samples were taken at 3, 6 and 9 weeks. Pigs were ultrasonically scanned for backfat thickness at the tenth rib on weeks 3 and 9. In the first two replications, there was no difference in ADG or ADFI (kg/day, P>.10) between pigs fed HCP and RCPF (.79 vs. .76; 2.79 vs. 2.86, respectively) and there were no differences in backfat at week 9 between pigs fed HCP and RCPF (19.1 vs. 20.1 mm; P>.10). In the second two replications, pigs fed HCP had higher ADG (.88 vs. .73 kg/d; P<.001), ADFI (2.94 vs. 2.76 kg/day; P<.05) and had more tenth rib backfat accretion over the trial period (7.4 vs. 4.4 mm; P<.001) compared to pigs fed the RCPF diet. The rooms where RCPF was fed had 40% lower AAC readings at week 9 (21.3 vs. 12.5 ppm; P<.05). Pit sample analysis showed the rooms with RCPF fed pigs had a greater decrease in pit pH (-.03 vs. -.30 units; P<.07), lower total nitrogen (P<.01) and ammonia (P<.001) concentrations when expressed as a percent of dry matter. The odor samples

collected for olfactometry analysis showed no differences in dilution ratio between HCP and RCPF at week 9 (508 vs. 502; P>.10), and hydrogen sulfide readings were lower for pigs fed RCPF diets (.34 vs. .25 ppm; P<.05). This research suggests that reducing the dietary CP and adding 10% soybean hulls to diets will lower AAC, aerial hydrogen sulfide, pit nitrogen, and pit pH. The variability in growth performance when pigs were fed high levels of soybean hulls requires further study.

Key Words: Fiber, Ammonia, Pigs

247   Titration of pharmacological doses of zinc in the nursery pig. G. M. Hill*, S. D. Carter, R. C. Ewan, D. C. Mahan, P. S. Miller, G. C. Shurson, and T. L. Veum, *NCR-42 Regional Swine Nutrition Committee*.

High concentrations of dietary zinc (Zn) have been shown to increase growth performance in the weanling pig. Therefore, to determine the optimum pharmacological concentration of Zn oxide (ZnO) necessary to enhance growth in the nursery pig, 7 cooperating experiment stations conducted a 4-wk nursery trial. Utilizing the standard management procedures of each station, 1,069 pigs (11 to 25 d of age, 3.4 to 10.3 kg initial wt.) were randomly allotted by weight and sex to 5 dietary treatments. The complex, two-phase diet sequence contained added Zn from ZnO: 0 (control), 500, 1,000, 2,000 or 3,000 ppm. The study was conducted in a randomized complete block design. A minimum of 2 replications were completed at each station. At 6 stations, blood samples were collected at the end of the trial for determination of plasma Zn and Cu. Pigs fed 3,000 or 2,000 ppm Zn had higher ($P < .05$) feed intakes than pigs fed the 500 ppm or control diets. Feed intakes of pigs fed 3,000, 2,000, 1,000, 500 ppm and control diets were .61, .62, .58, .56 and .57, respectively. Average daily gain was greater ($P < .05$) for pigs fed 3,000 and 2,000 ppm Zn than for those fed 1,000 or 500 ppm or the control diet. Daily gain was .38, .39, .36, .35 and .35 kg for pigs fed Zn from 3,000 ppm to the control diet, respectively. Feed efficiency was improved ($P < .05$) in pigs fed 2,000 or 3,000 ppm Zn compared to pigs fed the control diet. Feed efficiencies (G/F) for pigs fed 3,000, 2,000, 1,000, 500 ppm Zn and the cotrol diet were .65, .66, .64, .64 and .62, respectively. Even though this was only a 4-wk study, plasma Zn was elevated and plasma Cu reduced by feeding 3,000 or 2,000 ppm of dietary Zn. However, because of the difference in magnitude for these traits within station, there was a station x treatment interaction ($P < .0001$). In this experiment, 2,000 ppm Zn (supplied by ZnO) increased feed intake and growth and improved feed efficiency in the nursery pig under diverse management conditions to the same extent as 3,000 ppm Zn. Therefore, 2,000 ppm Zn was the optimum dietary concentration to enhance growth in the nursery pig.

Key Words: Nursery pig, Zinc

248   The effects of different zinc oxide sources on weanling pig growth performance. J. C. Woodworth*, M. D. Tokach, J. L. Nelssen, R. D. Goodband, and J. T. Sawyer, *Kansas State University, Manhattan*.

One hundred ninety-two pigs (6.2 kg and 18 d of age; PIC) were used in a 27 d growth assay to determine the effects of different zinc oxide (ZnO) sources on weanling pig growth performance. The four experimental treatments consisted of a control diet or three diets containing ZnO from one of three different sources. The three ZnO sources were analyzed and found to contain 70, 74, and 73% Zn and wide differences in concentrations of other trace minerals. Pigs were blocked by initial weight and randomly allotted to each of the four dietary treatments with eight pigs per pen and six pens per treatment. All diets contained 165 ppm of Zn (ZnO) from the trace mineral premix, but no feed grade antibiotic. All diets were fed in meal form in three phases: d 0 to 7, d 7 to 14, and d 14 to 27. The three experimental treatments fed from d 0 to 7 and d 7 to 14 contained 3,000 ppm of Zn and those fed from d 14 to 27 contained 2,000 ppm of Zn. There were no differences (P > .29) observed between the different ZnO sources for any period of the trial. Additional Zn from any of the ZnO sources improved (P < .02) ADG and ADFI from d 7 to 14, d 0 to 14, d 14 to 27 and d 0 to 27. Gain to feed ratio was highest (P < .04) for pigs fed diets containing high levels of ZnO from d 0 to 7 and d 0 to 14. These results suggest there were no differences in growth performance of pigs fed different ZnO sources. Adding high levels of Zn from ZnO improved ADG and ADFI from d 0 to 14 and d 0 to 27 compared to the control diet.

Key Words: Weanling pigs, Zinc, Growth

249   The interactive effects of zinc source and feed grade antibiotic on weanling pig growth performance. J. C. Woodworth*[1], M. D. Tokach[1], J. L. Nelssen[1], R. D. Goodband[1], J. T. Sawyer[1], and T. M. Fakler[2], [1]*Kansas State University, Manhattan, KS*, [2]*Zinpro Corp., Eden Prairie, MN*.

Two hundred eighty-eight weanling pigs (5.6 kg and 18 d of age; PIC) were used in a 27 d growth assay to determine the interactive effects of Zn source and feed grade antibiotic on growth performance of weanling pigs. Experimental treatments were arranged in a 2 x 3 factorial design with main effects of antibiotic (none or 55 ppm carbadox) and Zn source (none, 250 ppm Zn from a zinc amino acid complex (ZnAA), or 3,000 ppm Zn from ZnO). Pigs were blocked by initial weight and allotted randomly to each dietary treatment with eight pigs per pen and six replications per treatment. All diets contained 165 ppm Zn (ZnO) from the trace mineral premix. Diets were fed in meal form in three phases: d 0 to 7, d 7 to 14, and d 14 to 27. There were no Zn source x antibiotic interactions (P < .2) observed throughout the entire experiment. Antibiotic only increased (P < .05) ADG from d 14 to 27. Pigs fed ZnO had greater (P < .05) ADG compared to pigs fed other treatments from d 7 to 14 and d 0 to 14. Pigs fed ZnO also had increased (P < .03) ADFI compared to ZnAA (d 7 to 14) and no additional Zn (d 7 to 14 and 0 to 14). Gain to feed ratio (G/F) was highest (P < .004) for pigs fed diets containing ZnO compared to pigs fed no additional Zn from d 7 to 14 and d 0 to 14. Pigs fed diets containing ZnAA had higher (P < .04) G/F compared to pigs fed no additional Zn from d 0 to 14. For the entire trial, pigs fed ZnO had increased (P < .04) ADG compared to those fed diets containing no additional Zn, with pigs fed ZnAA having intermediate responses. In addition, pigs fed ZnO from d 0 to 27 had higher (P < .03) ADFI compared to pigs fed diets containing either ZnAA or no additional Zn. These results suggest 3,000 ppm Zn from ZnO should be added to diets fed to pigs from d 0 to 14 after weaning. Antibiotic addition tended to influence growth performance toward the end of the experiment.

Key Words: Weanling Pigs, Zinc, Antibiotic

250   Effect of diet complexity and supplemental zinc amino acid complexes on performance of nursery pigs. B. Z. de Rodas*[1], C. V. Maxwell[1], D. C. Brown[1], M. E. Davis[1], Z. B. Johnson[1], and T. M. Fakler[2], [1]*University of Arkansas, Fayetteville, AR*, [2]*Zinpro Corp., Eden Prairie, MN*.

An experiment involving 144 pigs (17 to 22 d of age; 6.1 kg BW) was conducted to determine the interactive effects of diet complexity and added Zn on performance of weanling pigs. Pigs were blocked by weight, penned six/pen in a conventional nursery, and fed a phase 1 diet (1.35% lys) for 10 d, followed by a phase 2 diet (1.15% lys) for 4 wk, and a common phase 3 diet (1.14% lys) for 2 wk. Treatments were arranged in a 3 x 2 factorial with three diets (complex, intermediate, and simple), and two Zn levels [0 and 100 ppm Zn from Availa-Zn zinc amino acid complex (ZnAA), Zinpro Corp., Eden Prairie, MN]. The phase 1 complex diet contained 7% soybean meal (SBM), 10% soy protein concentrate (SPC), 2% plasma protein, 1.5% blood meal, 2% peptide plus, 5% select menhaden fishmeal (FM), and 20% lactose; the intermediate diet contained 15% SBM, 15% SPC, 2% FM, 7% lactose, and 33% the amount of vitamins and trace minerals added to the complex diet; and the simple diet contained 39.5% SBM with no vitamins, minerals or antibiotics added. Diets were pelleted and pigs were allowed access to feed on an *ad libitum* basis. During phases 1, 2 and 3, increasing diet complexity improved (diet effect, P < .01) ADG and ADFI. Gain:feed during phase 1 was improved with the addition of ZnAA in the intermediate and complex diet, but not in the simple diet (interaction, P < .05). During phase 2, pigs fed the intermediate and complex diets had greater (P < .01) G:F than those fed the simple diet. During the overall experiment, there was a tendency for an improvement in ADG (interaction, P < .1) and ADFI (interaction, P = .12) with the addition of Zn to the intermediate and complex diets, but a decrease with the addition of Zn to the simple diet. In general, the results of this study indicate that complex diets were clearly superior to simple diets in improving performance of weanling pigs, and that 100 ppm Zn from ZnAA improves performance of pigs fed the intermediate and complex diets, but not the simple diet.

Key Words: Pig Performance, Diet Complexity, Zinc

251   Effect of dietary zinc on growth performance and immune response of endotoxemic growing pigs. E. S. Roberts*[1], E. van Heugten[2], G. Almond[1], and J. W. Spears[2], [1]College of Veterinary Medicine, [2]Department of Animal Science, North Carolina State University, Raleigh, NC.

A 2 × 3 factorial arrangement of treatments was used in a randomized complete block design to determine the effects of dietary zinc (Zn) level on performance, plasma Zn, alkaline phosphatase activity (ALP), and immune response of acutely endotoxemic growing pigs (n = 96, initial mean BW was 24.94 kg). Factors included 1) endotoxin (LPS) treatment or control and 2) supplemental (suppl) Zn at 10, 50, or 150 ppm. Diets were fed beginning in the nursery phase and continuing into the growing phase. The basal diet was corn-soybean based with 17% crude protein, 1% lysine, 30 ppm zinc, and was formulated to meet or exceed NRC requirements for all other nutrients. Pigs were acclimated for 12 d (d 0 - d 12) in the grower before LPS treatment. *Escherichia coli* lipopolysaccharide (LPS) at 10 μg/kg was injected intramuscularly on d 13 of the experiment. Gain, feed intake, and feed efficiency were unaffected by supplemental Zn. Feed intake decreased (P < .05) and gain:feed was greater (P < .10) from d 13 to d 16 for pigs injected with LPS; this was not affected by supplemental Zn. Plasma Zn and ALP increased linearly with increasing Zn levels (P < .10). The febrile response to LPS peaked at 6 hr post- exposure and pigs were afebrile within 12 hr. Maximum core body temperature was greater (P < .05) in pigs receiving 50 and 150 ppm supplemental Zn than in pigs with 10 ppm added Zn to the diet. *In vivo* cellular immune response, measured on d 13 by skin thickness response to phytohemagglutinin, was increased after 6 hr (P < .01) in pigs fed 10 ppm supplemental Zn and exposed to LPS compared to all other treatments. Lymphocyte proliferation was not affected by supplemental Zn. Adequate dietary zinc is required for normal cell-mediated immunity and phagocyte function; however, supplemental Zn in excess of NRC recommendations resulted in an enhanced febrile response to iatrogenic endotoxemia. These data suggest that there is no benefit, rather a possible detriment, to immune function with excess dietary zinc.

Key Words: Pigs, Zinc, Immune response

252   Skeletal mineralization of nursery pigs fed diets with pharmacological additions of zinc. T. D. Crenshaw and D. K. Schneider, *University of Wisconsin, Madison, WI.*

Zinc oxide supplemented at pharmacological concentrations (3000 ppm) approaches toxicity. Zn toxicosis is altered by dietary Ca concentrations. Since bone is the major storage site for Zn, the objective of this experiment was to determine if pharmacological concentrations of Zn in nursery diets reduced skeletal mineralization. Weaned (25 d, 8.5 kg) pigs (PIC, Cambrough x Line 19) were randomly allotted within weight blocks to 1 of 4 diets. Thirty six pigs were housed with 1 (3 pens/trt) or 2 (3 pens/trt) pigs per pen and allowed continuous access to feed and water for 28 d. Individually penned pigs (n = 3 /trt) were scanned by dual energy x-ray absorptiometry (DEXA) on d 0 and 28 to measure total body, bone mineral content (BMC). Bone and liver samples were collected (n = 6/treatment) after pigs were scanned. Pigs were fed Phase I diets (1.4% lysine) for 14 d then Phase II diets (1.2% lys) till d 28. Treatments involved a 2 x 2 factorial arrangement of Ca (+Ca, 1.0%; -Ca 0.60%) and Zn (-Zn, 124 ppm; +Zn 3,124 ppm) concentrations. +Zn increased gain and FI in +Ca pigs but depressed responses in -Ca pigs (P < .06). BMC gain over 28 d was greater (P < .02) in pigs fed +Ca than -Ca diets, but Zn did not alter responses (P > .2). Metatarsal bone Zn content was dependent on dietary Ca (Ca x Zn interaction, P < .02). +Zn increased bone Zn more in pigs fed -Ca (367 vs 1086 μg Zn/g ash) than in pigs fed +Ca (322 vs 765 μg Zn/g ash). The percentage ash was slightly less in +Ca pigs fed +Zn (48.4 vs 46.6%), and slightly increased in -Ca pigs fed +Zn (42.8 vs 43.6%; interaction P = .25). However, the ash response might be explained by changes in growth rates among groups rather than a direct effect of Zn on bone mineralization. In conclusion, bone Zn levels were altered by dietary Zn and Ca, but no evidence of toxicosis was detected in mineralization of metatarsal bones.

Key Words: Zinc, Calcium, Bone

253   Effects of length of feeding conjugated linoleic acid (CLA) on growth and body composition of pigs. J. C. Sparks*, B. R. Wiegand, F. C. Parrish, and D. R. Zimmerman, *Iowa State University, Ames, IA.*

Ninety-two pigs weighing 28 kg were fed isocaloric diets containing 1.25% CLA oil (60% CLA isomers) for the last 0, 29, 58, or 87 kg of BW gain to evaluate the effects on growth and carcass composition. Pigs were slaughtered at an average BW of 115 kg. Real time ultrasound (RTU) was used to determine backfat depth (BFD) and loin muscle area (LMA) at the 10th rib when the pigs weighed about 28, 57, 86, and 115 kg. At slaughter, BFD at the 1st rib, 10th rib, and last lumbar and LMA at the 10th rib were measured, and a five point subjective score was used to evaluate marbling, firmness, and color of the loin muscle at 48 h post mortem. ADG and ADFI were not affected by CLA. Gain:feed ratio over the entire experiment increased quadratically (P < .05) in response to length of feeding CLA, with pigs fed CLA for 29 and 58 kg of BW gain having the greatest gain:feed ratios. RTU revealed no treatment differences at 28 and 57 kg BW. At a BW of 86 kg, pigs that had been fed CLA had less (P < .01) BFD than those that had not received CLA. At slaughter, RTU showed a linear decrease in BFD (P < .004) and a linear increase in LMA (P < .01) with length of feeding CLA. However, BFD (P < .07) and LMA (P < .11) had strong trends for quadratic responses. Measurements on carcasses revealed a linear decreases in BFD at the 1st rib (P < .05), 10th rib (P < .01), and last lumbar (P < .02), and a linear increase in LMA (P < .01) in response to increased days of feeding CLA. However, there were also strong trends for quadratic response with P < .15, .08, and .17 for 10th rib, last lumbar, and LMA, respectively. These quadratic responses were indicative of diminishing effects as period of feeding CLA lengthened. There were no treatment differences in color score. Marbling (P < .03) and firmness (P < .07) scores increased linear with increased length of CLA feeding. In summary, responses to CLA were near maximum if fed during the last 58 kg of BW gain.

Key Words: CLA, Pigs, Growth

254   Effects of conjugated linoleic acid (CLA)on the growth, carcass composition and pork quality of two genotypes of lean gilts. J. M. Eggert, A. L. Carroll*, B. T. Richert, D. E. Gerrard, J. C. Forrest, B. C. Bowker, E. J. Wynveen, J. E. Hammelman, and A. P. Schinckel, *Purdue University, West Lafayette, IN.*

Terminal cross gilts (23 kg; n = 160) of two genetic populations (G1 and G2) were assigned to a 2 × 2 × 5 factorial arrangement of genotype, diet and slaughter weight (46 kg, 68 kg, 91 kg, 114 kg or 136 kg). Pigs were fed conventional corn-soybean meal based diets supplemented with either 1 % CLA oil (CLA) or 1 % sunflower oil (SFO) *ad libitum* until reaching their assigned slaughter weight. CLA oil contains 60 % CLA isomers. Composition and quality data (n = 96) was collected at 91, 114 and 136 kg. G1 gilts had less 10th rib backfat (1.55 vs 1.93 ± .05 cm, P < .01), larger loin eye areas (47.6 vs 45.1 ± .9 cm^2, P < .05), higher % fat free lean (55.2 vs 52.9 ± .5 %, P < .01), lower ADG (.89 vs .93 ± .01 kg/day, P < .05), lower color evaluations (1 = pale, pinkish gray; 5 = dark, purplish red; 2.07 vs 2.23 ± .05, P < .05) and lower marbling evaluations (1 = devoid to practically devoid; 5 = moderately abundant or greater; 1.65 vs 1.94 ± .07, P < .01) of the loin at the 10th rib. There were no significant effects of genotype on consumption, feed conversion, loin firmness, belly firmness or Hunter L*, a* and b* values. Gilts fed CLA had less 10th rib backfat (1.63 vs 1.85 ± .05 cm, P < .05), higher % fat free lean (54.8 vs 53.3 ± .5 %, P < .05), firmer bellies (1 = very soft; 5 = very firm; 2.63 vs 1.93 ± .07, P < .01), higher loin color evaluations (2.28 vs 2.02 ± .05, P < .01), higher loin firmness evaluations (1 = very soft; 5 = very firm; 2.22 vs 1.98 ± .05, P < .01) and higher loin marbling evaluations (1.96 vs 1.63 ± .07, P < .01). There were no significant effects of CLA on ADG, feed conversion, consumption, loin eye area, or Hunter L*, a* and b* values. There were no significant genotype × CLA interactions. In conclusion, CLA enhanced the pork quality, belly firmness and % lean of both genotypes.

Key Words: Pigs, CLA, Pork quality

255 Effects of high oil corn and duration of conjugated linoleic acid (CLA) supplementation on pig growth, pork quality and carcass composition. J. M. Eggert, A. L. Carroll, B. T. Richert, D. E. Gerrard, J. C. Forrest, B. C. Bowker, E. J. Wynveen, J. E. Hammelman, and A. P. Schinckel*, *Purdue University, West Lafayette, IN.*

Gilts (n = 224) were randomly assigned to a 4×3 factorial arrangement of diet and duration of CLA supplementation. Pigs (25 kg) were fed one of four corn-based diets (high oil corn (HOC), Optimum® high oleic high oil corn (HOHOC), conventional corn (CONV) and conventional corn supplemented with choice white grease (CWG) *ad libitum* to 115 kg. HOC, HOHOC and CWG diets were isocaloric. CLA treatments included no CLA (1 % sunflower oil; SFO), finishing with 1.0 % CLA oil from 90 to 115 kg (CLA1) and finishing with 1.0 % CLA oil from 65 to 115 kg (CLA2). CLA oil contains 60 % CLA isomers. Corn type affected consumption (HOC: 2.27; HOHOC: 2.32; CONV: 2.28; CWG: 2.20 ± .05 kg/day, P < .01) and feed conversion (HOC: 2.64; HOHOC: 2.62; CONV: 2.77; CWG: 2.53 ± .05, P < .05). Gilts fed HOHOC had higher belly firmness scores (1 = very soft; 3 = very firm; HOC: 1.78; HOHOC: 2.13; CONV: 2.03; CWG: 1.95 ± .08, P < .05) than gilts fed HOC. Corn type did not affect loin eye area, 10th rib backfat depth, ADG, drip loss, % fat free lean, subjective measures of loin color, firmness and marbling, or Hunter L*, a* or b* values. CLA affected belly firmness (SFO: 1.58; CLA1: 2.12; CLA2: 2.21 ± .06, P < .01), consumption (SFO: 2.32; CLA1: 2.27; CLA2: 2.22 ± .05 kg/day), loin firmness evaluations (1 = very soft; 5 = very firm; SFO: 2.07; CLA1: 2.26; CLA2: 2.23 ± .04, P < .01) and marbling evaluations (1 = devoid to practically devoid; 5 = moderately abundant or greater: SFO: 1.36; CLA1: 1.45; CLA2: 1.52 ± .05, P < .01). The duration of CLA supplementation appears to be related to increased loin eye area, enhanced color and decreased 10th rib backfat depth. CLA did not affect ADG, feed conversion, % fat free lean or Hunter L*, a* and b* values. Corn × CLA interactions were not significant. In conclusion, CLA enhanced fresh pork quality and belly firmness. Gilts fed HOHOC had firmer bellies than gilts fed HOC.

Key Words: Pigs, High oil corn, CLA

256 Growth performance, whole body composition, plasma urea nitrogen and serum alpha-1-acylglycoprotein in weanling pigs fed CLA. J. Bassaganya*, K. Bregendahl, and D. R. Zimmerman, *Iowa State University.*

Early-weaned pigs (n=64) averaging 5.3 ± 0.3 kg were utilized to evaluate effects of two (dirty and clean) environments and four (0, .67, 1.33 or 2%) dietary CLA-60 levels on growth performance, whole body composition, plasma urea nitrogen (PUN) and serum alpha-1-acylglycoprotein (AGP). A factorial (2x4) arrangement within a split plot design with 8 litters of 4 pigs each as experimental units within environments (main plot), pigs within litters as experimental units for the CLA levels (subplot), and d 0 as a covariate were used in data analysis. Diets were formulated to exceed NRC (1988) nutrient recommendations for swine and fed ad lib for a period of 7 wk in three phases (I, 1-2; II, 3-5; III, 6-7wk). Within phases, diets were isocaloric and isonitrogenous. On phase I, a linear (P<. 05) decrease in ADFI was found. On phase II, ADG increased quadratically (603, 623, 622 and 548 kg/d; P< .01), ADFI had a linear decrease (873, 840, 867 and 717 kg/d; P< .02) and G:F increased linearly (691, 742, 715 and 763 g/d; P< .07). On phase III, no differences were attributed to dietary treatments. Pigs in the clean room had a higher cumulative ADG (P< .01) and a higher ADFI (P< .01) than pigs in the dirty room. On d 42, three pigs per treatment were killed, ground, sampled and protein, fat and humidity were measured. As dietary CLA increased, a linear increase in humidity (P< .01), a linear decrease in fat (16.4, 15.8, 13.9 and 12.1%; P< .04), and a trend for a linear increase in protein (P< .12) were described. AGP levels were used as indirect indicators of cytokine release, and showed a consistent linear increase on d 14 (P< .02), 28 (P< .01) and 42 (P< .01) as dietary CLA increased. PUN showed a linear decreasing trend on d 14 (P< .14) and 42 (P< .11) as dietary CLA increased. Clean pigs had higher PUN on d 14 (P< .03) and 42 (P< .01) than dirty pigs, which is attributed to higher ADFI of pigs in the clean room. Thus, CLA reduces empty body of fat and feed intake, and has a potential application as an immunomodulator in pigs.

Key Words: Pig, Conjugated linoleic acid, Growth

257 Efficacy of betaine as a carcass modifier in finishing pigs fed normal and reduced energy diets. G. L. Cromwell*, M. D. Lindemann, J. R. Randolph, H. J. Monegue, K. M. Laurent, and G. R. Parker, *University of Kentucky, Lexington.*

Three experiments were conducted to determine if energy density of the diet influences the efficacy of betaine as a carcass modifier. Two dietary energy levels (3,320 vs 3,175 kcal ME/kg) were achieved by feeding a fortified corn-soybean meal diet (CS) or a similar diet with 20% wheat middlings (CSM). The middlings were substituted for corn and soybean meal on a lysine basis. Betaine was included at 1.14 g/kg of diet by adding .125% Betafin® (Finnfeeds, Fenton, MO). Diets consisted of (1) CS, (2) CS + betaine, (3) CSM, and (4) CSM + betaine. In Exp. 1 and 2, 200 crossbred pigs (10 reps of 5 pigs/pen) were fed the 4 diets from 56 to 113 kg BW. Dietary lysine was reduced from .85% to .70% at 87 kg BW. All pigs were scanned by real-time ultrasound at 109 kg BW, and carcass data were obtained on all barrows at termination. ADG was reduced (P<.01) and feed/gain (F/G) was increased (P<.01) by feeding the low energy diet (.95, .97, .90, .94 kg/d; 3.34, 3.31, 3.56, 3.43 for treatments 1-4, respectively). Betaine improved ADG (P<.03) and F/G (P<.08) in pigs fed the lower energy, CSM diets and to a lesser extent in those fed the CS diets. Betaine resulted in numerical improvements in backfat and estimated lean in scanned pigs (20.6, 20.4, 19.4, 18.9 mm; 52.7, 52.8, 53.4, 53.7%) and in barrow carcasses (28.9, 26.9, 28.9, 26.6 mm [P<.07]; 47.9, 48.4, 47.6, 49.0% [P<.07]). Feeding low energy diets improved these traits in scanned pigs (P<.02). In Exp. 3, 120 pigs (6 reps of 5 pigs/pen) were fed the same diets from 24 to 111 kg BW with lysine reduced from 1.00 to .85 and .70% at 52 and 78 kg BW. All pigs were scanned at 102 kg BW. ADG and F/G were affected (P<.01) by dietary energy, but not by betaine (.81, .81, .79, .77 kg/d; 3.01, 2.93, 3.24, 3.20). Scanned BF and estimated lean tended to improve with added betaine (19.1, 17.6, 18.8, 17.8 mm; 53.8, 54.9, 54.0, 55.1%). Overall, betaine reduced backfat by 5.5% and increased lean percentage by 1.0% in pigs fed CS diets and by 5.3 and 2.1% in the lower energy, CSM diets.

Key Words: Pigs, Betaine, Energy

258 Evaluation of chromium tripicolinate addition and dietary energy level and source on carcass composition and accretion rates of growing pigs. C. P. A. van de Ligt*, M. D. Lindemann, and G. L. Cromwell, *University of Kentucky, Lexington, KY.*

Two trials (T1 and T2) evaluated potential interactions of chromium tripicolinate addition with dietary energy levels (T1) and sources (T2). In T1 and T2, respectively, 36 and 40 PIC barrows (25.4 and 23.6 kg mean BW) were used. Pigs were blocked by weight and randomly allotted to six (T1) or eight (T2) treatments in a 2×3 or 2×4 factorial arrangement of supplemental Cr (0 and 200 ppb) and energy level (70, 80, and 90% of ME requirement) or energy sources (basal, starch, choice white grease [CWG], and corn oil [CO]). A corn-soybean meal basal diet supplied all daily protein, mineral and vitamin needs and 70% of the ME need in two meals that approximated 70% of ad libitum feed intake. In T1, additional energy was added to 80 and 90% by a blend (95/5; wt/wt) of corn starch and CO. In T2, additional energy was added to 90% by either the starch blend, CWG, or CO. Meals were adjusted weekly based on BW. Pigs were slaughtered at 70.1 kg mean BW. No effect of Cr or Cr × ME level was observed (P = .10) in T1. ME levels (70, 80, and 90%) had a linear effect (P < .02) on carcass protein (20.8, 20.1, 19.8%), lipid (13.1, 16.4, 18.3%), and water (61.5, 59.5, 57.2%). Accretion rates were linear (P < .05) for ash (21.1, 23.9, 26.4 g/d), protein (99, 113, 118 g/d), lipid (82, 125, 152 g/d), and water (260, 295, 298 g/d). In T2, Cr (0 and 200 ppb) affected (P < .05) carcass ash (3.80, 3.61%) and ash accretion rate (26.9, 24.4 g/d). The basal diet (70% ME) vs others (90% ME) affected (P < .001) carcass ash (4.0, 3.6%), protein (21.3, 19.4%), lipid (13.5, 19.7%), and water (61.0, 56.8%). Accretion differed for basal vs others (P < .01) in ash (23.0, 26.5 g/d), protein (109, 127 g/d), lipid (66, 147 g/d), and water (293, 356 g/d) and between CO and both starch and CWG in ash accretion (P < .05; 28.4, 25.6, and 25.6 g/d, respectively). Energy level affected carcass composition and accretion rates while chromium tripicolinate addition only had an effect on carcass ash and ash accretion rate in T2.

Key Words: Pigs, Chromium, Energy

259 **Effects of dietary lysine and porcine soma-totropin on the amino acid composition of whole body protein and accretion rate of whole body lysine in growing pigs.** W. A. Dozier III*[1], G. L. Cromwell[1], A. J. Lewis[2], and R. M. Diedrichsen[2], [1]University of Kentucky, Lexington, KY, [2]University of Nebraska, Lincoln, NE.

The effects of pST and dietary lysine (near-ideal blend of amino acids (AA)) on the AA composition of empty, whole body (WB) protein and on WB lysine accretion rate in growing pigs were assessed. Forty pigs (22.5 kg BW) were individually penned and assigned to 8 treatments (4 diets; 0 vs 2 mg pST (im)/d; JAS 75(Suppl.1):78, 182, 1997). A basal diet (1.50% total lysine) consisted of fortified corn-soybean meal with added lysine (.33%), threonine (.22%), methionine (.30%), and tryptophan (.03%). Lysine was reduced to 1.25, 1.00, and .75% in 3 diets by diluting the basal with starch, cellulose, and sand. At 60 kg BW, the WB (carcass, head, viscera, blood, nails, hair) was ground and analyzed for protein and AA. Initial composition was determined on 6 additional pigs. The AA in WB protein averaged (mean of initial and final) 6.5% lysine, 3.5% threonine, 3.0% methionine+cystine, 4.6% valine, 3.4% isoleucine, and .85% tryptophan. Administration of pST increased (P < .001) accretion rates of WB protein and lysine. Increasing dietary lysine increased (quadratic, P < .03) accretion rates of WB protein and lysine in pST-treated pigs (124, 158, 167, 166 and 8.57, 10.30, 11.11, 10.17 g/d), but not in untreated pigs (127, 128, 126, 129 and 8.15, 7.90, 8.30, 7.98 g/d). Lysine in the accreted WB protein was linearly (P < .03) affected by diet in pST-treated pigs (6.9, 6.5, 6.6, 6.1%) but not in controls (6.5, 6.2, 6.6, 6.2%). Based on true ileal digestible lysine intakes of 14.2, 19.1, 23.6, and 24.8 g/d for pST-treated pigs and 16.2, 19.1, 24.4, and 26.7 for controls, the efficiencies of lysine utilization for WB lysine accretion (adjusted for maintenance) were 62, 55, 48, and 42% compared with 52, 42, 34, and 30%, respectively; both were linearly affected (P < .01) by dietary lysine. The results indicate that the dietary lysine needed to achieve maximum WP lysine accretion is markedly increased by pST administration.

Key Words: Pigs, Somatotropin, Amino acids

260 **Effects of immunization against GnRH on growth performance, carcass characteristics, and meat quality of intact male pigs.** C. A. Maloney*[1], R. H. Hines[1], J. D. Hancock[1], D. W. Dean[1], J. M. DeRouchey[1], D. J. Lee[1], J. S. Park[1], D. H. Kropf[1], and T. E. Adams[2], [1]Kansas State University, Manhattan, KS, [2]University of California, Davis, CA.

Eight barrows and 32 boars (average initial BW of 29 kg) were used in an 82-d growth assay to determine the effects of immunization against GnRH on growth performance, carcass characteristics, and meat quality of intact male pigs. There was one pig per pen and eight pens per treatment. The barrows and boars were fed the same diets (1.4% lysine for 29 to 58 kg BW, 1.25% lysine for 58 to 91 kg BW, and 1.1% lysine for 91 to 117 kg BW) throughout the experiment. Boars were immunized at 82, 56, and 28-d prior to slaughter with a single, 2 mL, subcutaneous injection of GnRH and keyhole limpin hemocyanin in a 1:1 ratio with Freund's complete adjuvant. Overall (from 29 to 117 kg), barrows consumed more feed (P < .003), were less efficient (P < .001), and had greater average backfat thickness (P < .001) than boars. However, barrows also had greater dressing percentage (P < .02) and produced loin chops with greater marbling (P < .05) and a tendency for greater water holding capacity (P < .08) than boars. Immunization against GnRH did not affect ADG or gain/feed (P > .21), but decreased prostate (P < .008) weights and tended to decrease bulbourethral (P < .06) and testis (P < .07) weights compared to the control boars. Decreasing the time between injection and slaughter from 82 to 26-d resulted in greater gain/feed and less carcass fatness (linear effects, P < .001 and .01, respectively). The longer time interval improved dressing percentage (linear effect, P < .04) and decreased testicular (linear effect, P < .001) and reproductive gland (linear effects, P < .02) weights. Our results indicate that immunization against GnRH is an effective means of reducing sex characteristics (testis weights and gland size) for intact male pigs.

Item	Barrows	Boars	Day Before Slaughter 82	56	26	SE
ADG, kg	1.12	1.11	1.15	1.17	1.09	.03
G/F, g/kg	380	422	389	424	427	10
Avg BF, cm	2.79	2.06	2.44	2.39	2.00	.11
Testis wt, g	N/A	463	210	386	485	46

Key Words: Boars, Immunocastration, Finishing

261 **Amino acid supplementation for sows nursing large litters.** R. C. Ewan*[1], G. W. Libal[2], and C. R. Hamilton[2], [1]Iowa State University, Ames, IA, [2]South Dakota State University, Brookings, SD.

A cooperative study was conducted at two stations of the members of the North Central Regional Committee on Swine Nutrition (NCR-42) to determine the response of lactating sows to dietary amino acid supplementation. Primiparous sows (49) were selected at breeding and fed a corn-soybean meal diet (14.3% CP) at 1.8 kg/d during gestation. At farrowing, sows were allotted to one of four dietary lactation treatments: 1) Control corn-soybean meal diet formulated to contain .6% lysine, 2) a corn-soybean meal diet formulated to contain .9% lysine, 3) treatment 1 with the addition of .3% lysine HCl and 4) treatment 1 supplemented with .3% lysine HCl, .06% L-tryptophan and .16% L-threonine. Sows were weighed at breeding, prefarrowing, within 24 h after farrowing, on d 7, 14, and 21 during lactation and at weaning. Litter size was adjusted to at least 10 pigs per litter within 3 d of farrowing. Individual pig weights were obtained at birth, 7, 14, and 21 d of lactation and at weaning. During lactation, sows were fed three times daily to provide ad libitum access to feed and feed intake was determined on a weekly basis. The days to first estrus were recorded and sows were continued on the experimental treatments for three reproductive cycles. Sows on treatment 3 were heavier than sows on the other treatments at all weigh periods. Birth weights of the pigs were similar among treatments. On d 7, pigs of sows on treatment 3 were heavier than pigs of sows on the other treatments (P < .05). On d 14, 21 and at weaning at 23 d of age, pigs of sows on treatments 2, 3, and 4 were heavier (P < .05) than pigs of the sows on treatment 1. During lactation, ADFI was similar among the treatment groups (6.5 kg) but daily lysine intake increased from 39.7 g/d for treatment 1 to 57.5 g/d for treatment 2 (P < .05) and further increased (P < .05) for treatment 3 (64.1 g/d) and 4 (62.3 g/d). Supplemental lysine from soybean meal or from synthetic lysine improved nursing pig performance. Supplemental tryptophan and threonine did not provide an additional response.

Key Words: Sows, Lactation, Lysine

262 **Lysine requirement of sows nursing large litters. A cooperative study.** D. A. Knabe*, L. I. Chiba, E. T. Kornegay, and J. C. McConnell, S-145 Committee on Nutritional Systems for Swine to Increase Reproductive Efficiency.

A cooperative experiment was conducted at four stations (AL, SC, TX and VA) to evaluate the lysine requirement of sows nursing large litters. Stations could begin with gilts or sows but all females remained on their treatments for three parities unless culled for failure to breed, structural unsoundness, or inadequate litter size. Pigs were transferred among litters to achieve minimum litter sizes of 9 and 10 pigs on d-3 of lactation for gilts and sows, respectively. During lactation, females had ad libitum access to diets formulated to contain .60, .75 or .90% lysine by altering the proportions of corn and soybean meal. All sows were fed 1.8 kg of the .60% lysine diet during gestation. Pigs were weaned at about 28 d of age. Data from 479 litters were collected. Dietary treatments did not affect litter size after transfer (10.8), litter size at 21 d (9.6), sow feed intake to d 21 (5.4 kg/d) or days to postweaning estrus (5.9 d). Increasing dietary lysine resulted in a linear decrease (P < .01) in sow weight loss from farrowing to d 21 of lactation (-6.3, -4.6, -2.2 kg), but most of this response was due to gilts (-10.8, -9.8, -4.9 kg, P < .01) not sows (-3.2, -3.0, -1.4 kg, P > .10). Average pig weights at 21 d were increased linearly (5.2, 5.4, 5.5 kg/pig, P < .01) by increasing dietary lysine, but a treatment x station interaction (P < .05) occurred. At one station (n=254), a linear increase was found, whereas there was no response to .90% lysine at two stations (n=186). At one station (n=39), there was a response to .90% lysine but not .75% lysine. Increasing dietary lysine in the first farrowing tended (linear, P = .07) to increase total (10.5,

10.8, 11.2) and live (9.7, 9.9, 10.2) pigs born/litter in subsequent farrowings. Overall, these data suggest that sows and gilts nursing large litters need at least .90% lysine in corn-soybean meal based diets for maximum reproductive performance.

Key Words: Lysine, Sow, Protein

263   Lysine requirement for maximal lactation and subsequent reproductive performance of multiparous sows. H. Yang*[1], J. E. Pettigrew[2], L. J. Johnston[1], G. C. Shurson[1], and R. D. Walker[1], [1]*University of Minnesota, St. Paul,* [2]*Pettigrew Consulting International, Louisiana, MO.*

The objective of this study is to evaluate the effects of lysine intake during lactation on lactation and subsequent reproductive performance of older sows (PIC C-22). Parity (PA) 2 sows (n = 141; 189 kg BW; 12 mm backfat) and PA 3 sows (n = 103; 204 kg BW; 11.5 mm backfat) were assigned randomly at farrowing to one of five diets (A, B, C, D, E) containing .60, .85, 1.10, 1.35, and 1.60% lysine, respectively, from intact protein sources. All diets contained corn, SBM, 5% corn gluten meal, 5% soybean oil, 2.1 Mcal NE/kg and exceeded NRC (1988) requirements for all other nutrients. Diets were made isoenergetic by including 0 to 8% rice hulls. Each sow nursed 11 pigs and was provided *ad libitum* access to feed during the 19-d lactation. Increasing dietary lysine resulted in a linear reduction in ADFI of sows (PA 2: 6.5, 6.5, 6.2, 5.9, 5.8 kg; P < .01; PA 3: 6.8, 6.6, 6.5, 6.6, 6.2 kg; P < .05 for diets A, B, C, D, E, respectively). Lysine intake had a quadratic effect on litter ADG (PA 2: 2.21, 2.36, 2.31, 2.40, 2.29 kg; PA 3: 2.32, 2.49, 2.42, 2.47, 2.39 kg for diets A, B, C, D, E, respectively; P < .05). Litter ADG did not increase when dietary lysine increased above .85%. Lysine intake had no effect on sow BW and backfat change (-.7 to 5.0 kg; -1.1 to -.3 mm in PA 2; 2.6 to 6.7 kg; -.5 to .8 mm in PA 3), piglet mortality (5.1 to 8.5%), percent of sows mated by d 7 postweaning (89.3 to 100%), or subsequent farrowing rate (72 to 89%) in both parities. Lysine intake during the previous lactation had a quadratic effect (P < .05) on born alive (11.8, 10.1, 10.3, 11.2, 12.4 pigs) at PA 3 but no effect (P > .30) on born alive (11.4, 10.6, 11.3, 11.2, 12.0 pigs for diets A, B, C, D, E, respectively) at PA 4. These results suggest that the lysine requirement for subsequent reproduction is not higher than that for milk production, and the lysine requirement was approximately 55 and 56 g/d for PA 2 and 3 lactating sows, respectively, in this study.

Key Words: Lysine, Sows, Litter size

264   A dynamic model to describe nutrient flow and requirement in lactating sows. S. W. Kim*, M. Grossman, and R. A. Easter, *University of Illinois, Urbana, IL.*

The objective of this research was to construct a dynamic model to describe nutrient flow and to predict nutrient requirements in lactating sows. Information used for the model included: apparent ileal digestibility of various protein sources in lactating sows, nutrient mobilization as influenced by intake or litter size, nutrient uptake by mammary gland as influenced by intake or litter size, nutrient need for mammary gland growth as influenced by intake or litter size, and the growth of nursing pigs in response to maternal nutrient intake, litter size, and the location of suckled mammary glands. Linear or nonlinear regression models were developed to relate information from eight projects to a dynamic model that simulates nutrient flow during lactation period. The model responds differently to inputs such as day of lactation, daily nutrient intake, litter size, and the location of the suckled mammary gland when used to predict body composition, maternal weight changes during lactation, mammary gland growth during lactation, and growth of nursing pigs. The model also predicts ideal nutrient requirements based on various scenarios of pig and mammary gland growth. This model, for example, predicts that sows need 16.5 Mcal ME and 947 g protein daily when nursing 10 pigs for maximum average daily gain (190.9 g per pig) and maximum mammary gland growth (560.4 g per gland) achieved during a 21-d lactation. At d 21, estimated changes of protein and fat amounts in the maternal carcass were 270 g and -1930 g, liver 31.3 g and -5.3 g, gastrointestinal tract 64.2 g and -37.2 g, uterus -385.0 g and -5.4 g, and other organs 21.7 g and 182.47 g, respectively. The amount of ileal digestible protein provided by the corn-soybean meal-based diet was 624.38 g daily. Pig weaning weight on d 21 of lactation averaged 5.56 kg. There was a 2.2 g protein gain and a 1795.4 g fat loss from the sow excluding mammary glands during 21 d of lactation. There was

a 311.7 g protein gain and a 513.0 g fat gain in mammary glands during 21 d of lactation. Total litter weight gain was 40.1 kg. This model enables the prediction of nutrient requirements in lactating sows and the quantification of nutrient mobilization from the sow's body for milk production.

Key Words: Dynamic Model, Lactating sows, Nutrient requirements

265   Relationship between plasma arterio-venous differences of nutrients across the porcine mammary gland and circulating insulin, prolactin, and IGF-1 concentrations. X. F. Guan*[1], J. E. Pettigrew[2], C. Farmer[3], P. K. Ku[1], R. J. Tempelman[1], and N. L. Trottier[1], [1]*Michigan State University, East Lansing, MI,* [2]*University of Minnesota, St. Paul, MN,* [3]*Agriculture and Agri-Food Canada, Research Center, Lennoville.*

The objective of this study was to establish the relationship between plasma mammary arterio-venous (A-V) differences of glucose and essential amino acids (EAA) and circulating insulin, prolactin and insulin-like growth factor-1 (IGF-1). Sixteen sows (Landrace x Yorkshire) were provided *ad libitum* access to 1 of 4 diets (4 sows/diet). All diets were isocaloric (3.4 Mcal ME/kg) and contained different levels of protein (7.8, 13.0, 18.2, and 23.5%) having similar ratios of amino acids. On d 4 or 5 of lactation, sows were fitted with carotid arterial and main mammary vein catheters. On d 10, 14, 18, and 22 of lactation, matched sets of arterial and venous blood were collected every 30 min for 6 h. Plasma samples were pooled by day and analyzed for glucose, EAA, insulin, prolactin and IGF-1. Correlations between these variables (adjusted for effects of dietary treatment and day of lactation) were computed by multivariate linear model analyses. Arterial insulin concentrations were closely associated with arterial glucose (r = .75; P < .01) and EAA (r = .38; P < .05), but prolactin and IGF-1 showed no correlation with these nutrients. Concentrations of nutrients and hormones in the mammary vein were highly correlated (P < .01) to their respective arterial concentrations (glucose, r = .96; EAA, r = .86; insulin, r = .99; prolactin, r = .83; IGF-1, r = .82). Mammary A-V differences of glucose and EAA were positively correlated with their arterial levels (r = .80, P < .01; r = .42, P < .05), and with arterial insulin concentration (glucose, r = .46, P < .01; EAA, r = .31, P < .05), but no relationships were found with arterial prolactin or IGF-1. In conclusion, mammary A-V differences of glucose and EAA during lactation were dependent on their arterial concentrations and insulin, outside of the influence of treatment and time.

Key Words: Porcine mammary gland, Arterio-venous difference, Nutrients

266   Effects of dietary caloric ratios of protein to carbohydrate on plasma arterio-venous differences of insulin and glucose across the porcine mammary gland. X. F. Guan[1], P. E. Pettigrew[2], P. K. Ku[1], and N. L. Trottier*[1], [1]*Michigan State University, East Lansing, MI,* [2]*University of Minnesota, St. Paul, MN.*

The objective of this study was to evaluate the effect of dietary caloric ratios of protein to carbohydrate (P:C) on plasma arterio-venous concentration differences (AV_c) of insulin and glucose across the porcine mammary gland. A corn-SBM basal was diluted with corn starch and sugar to provide 4 isocaloric (3.4 Mcal ME/kg) diets with an identical pattern of amino acids. Dietary caloric P:C ratios (based on ME) were .539, .365, .232, and .125, respectively. Sixteen sows were provided ad libitum access to 1 of 4 diets (4 sows/diet). On d 10, 14, 18, and 22 of lactation, arterial and mammary venous blood were collected simultaneously every 30 min for 6 h. Plasma samples were analyzed for insulin and glucose. Previously estimated milk yield was the highest at a P:C ratio of .232. Interactions between the caloric ratios and day of lactation were significant for plasma arterial concentrations (A_c) of glucose (P < .01) and insulin (P < .05), and for plasma AV_c of glucose (P < .01). Both plasma glucose A_c and AV_c peaked on d 18 of lactation and at the P:C ratio of .232 (Table). Plasma insulin A_c was the highest between d 14 and 22 of lactation and at the P:C ratio of .232. Plasma insulin AV_c was different from zero on d 14 and 22 of lactation and at the P:C ratio of .232 (P < .05). Therefore, the ideal dietary caloric ratio of protein to carbohydrate is .232 for milk production in lactating sows.

	Dietary caloric ratio			
	.539	.365	.232	.125
Glucose A_c, mmol/L	$5.86 \pm .42^b$	$6.04 \pm .48^b$	$8.51 \pm .42^a$	$6.21 \pm .39^b$
Glucose AV_c, mmol/L	$1.44 \pm .16^b$	$1.34 \pm .18^b$	$2.03 \pm .15^a$	$1.46 \pm .13^b$
Insulin A_c, pmol/L	161.2 ± 76.3^b	167.9 ± 88.4^b	429.0 ± 76.3^a	203.1 ± 72.4^b
Insulin AV_c, pmol/L	$.3 \pm 9.1$	14.0 ± 10.3	$29.7 \pm 8.1^*$	4.9 ± 7.4

	Day of lactation			
	10	14	18	22
Glucose A_c, mmol/L	$6.11 \pm .28^b$	$6.32 \pm .30^b$	$7.34 \pm .28^a$	$6.85 \pm .27^b$
Glucose AV_c, mmol/L	$1.20 \pm .11^b$	$1.51 \pm .12^b$	$1.99 \pm .12^a$	$1.58 \pm .12^b$
Insulin A_c, pmol/L	192.9 ± 47.1^b	275.8 ± 46.6^a	234.6 ± 48.0^a	257.9 ± 46.6^a
Insulin AV_c, pmol/L	6.8 ± 6.1	$16.4 \pm 6.6^*$	6.9 ± 6.6	$18.8 \pm 6.6^*$

^{ab}P $<$ .05 and *P $<$ .05.

Key Words: Dietary caloric ratio, Glucose, Porcine mammary gland

267   Effects of dietary fermentable carbohydrates on physical activity and energy metabolism in group-housed sows. M. M. J. A Rijnen*, M. J. W. Heetkamp, M. W. A. Verstegen, and J. W. Schrama, *Wageningen Institute of Animal Science, Wageningen Agricultural University, The Netherlands*.

In growing pigs, it has been demonstrated that non-starch polysaccharides (NSP) reduce physical activity. In this study, the dose response effect of fermentable NSP on physical activity in relation to metabolic rate in sows was examined. Twelve groups of six dry sows were fed one of four experimental diets with 0, 100, 200 or 300 g/kg DM sugar beet pulp silage (SBPS). Diets were identical except for starch and NSP content. This was achieved by exchanging SBPS for tapioca. Each group of sows was housed in climatically controlled respiration chambers and fed an amount equivalent to 1.25 times their energy requirements for maintenance. The study consisted of a 5-wk adaptation period and a 1-wk experimental period. Heat production, nitrogen and energy balance, and fecal digestibilities were measured. Intake of digestible starch and NSP decreased and increased, respectively, with increasing dietary SBPS content (P < .001). Both digestibility and metabolizability of energy decreased with increasing dietary SBPS content (P < .01 and P < .001, respectively). Heat production and energy retention were unaffected by the exchange of starch for NSP. However, dietary composition affected energy spent on physical activity (P < .10). Sows were more quiet when dietary NSP content increased. Based on heat production data and apparent digestibility of crude protein, crude fat, and NSP, the estimated net energy value of fermented NSP was 15.2 kJ/g. This relatively high energy value for fermented NSP was only partly related to the lowered energy expenditure for physical activity, 1.7 kJ/g of fermented NSP. This study shows that group-housed sows are capable of using energy from fermented NSP as efficiently as energy from digested starch.

Key Words: Pigs, Polysaccharides, Energy metabolism

268   Effects of increasing concentrations of neutral detergent fiber upon characteristics of performance, nutrient digestibility and intestinal morphology of gilts. J. D. F. Gomes*, R. S. Fukushima, and C. A. Gomide, *Faculdade de Zootecnia e Engenharia de Alimentos da Universidade de Sao Paulo, Brazil*.

Although swine show limited capability to degrade fiber, it is possible to utilize high fiber ingredients in diets for gilts. These animals need to gain moderate weight prior to breeding, and by the time females exhibit their third physiological heat, they have to weigh a minimum of 110 kg and have at least 1.8-2.0 cm of subcutaneous fat. The objective of this research was to assess the effects caused by utilization of 0; 6.6; 13.2 and 19.8 % of neutral detergent fiber (NDF) in the basal diet of gilts. These concentrations of NDF were obtained through inclusion of 0; 10; 20 and 30 % of coast-cross hay (Cynodon dactylon), respectively. This trial was conducted with 20 pure and crossbred Landrace and Large White females with average weight of 52.8 kg and 110 d of age. The experimental design employed was a completely randomized block design with five replications per treatment. Increasing concentration of NDF in the diet of gilts led to a linear response (P < 0.01) on the daily weight gain (0.675; 0.607; 0.525; 0.483 g/d); on the body weight by the onset of the third physiological heat (118.0; 114.0; 102.2; 98.2 kg); on the feed efficiency (3.6; 4.0; 4.7; 5.3); and a quadratic response was observed (P < 0.05) for subcutaneous fat thickness (3.28; 3.34; 2.82; 1.74 cm). However, no difference was found (P > 0.10) on the third physiological heat onset age, which averaged 203 d. Nutrient digestibility was also affected by addition of hay to the basal diet. Dry matter digestibility had a linear response [(P < 0.01) - 76.23; 67.23; 55.83; 55.73 %], as well as, neutral detergent fiber digestibility [(P < 0.05) - 56.63; 44.24; 34.17; 39.12 %]; protein digestibility [(P < 0.05) - 72.16; 64.46; 53.52; 62.74 %] and energy [(P < 0.01) - 71.95; 61.23; 49.21; 53.81 %] had a quadratic effect. There was a trend (P > 0.08) for a linear increase in weight of the small intestine; weight of full cecum, and a quadratic trend for decreased kidney weight. The weight of the empty stomach (0.60; 0.71; 0.74; 0.79 g) and heart (0.30; 0.29; 0.33; 0.35 g) were linearly increased (P < 0.01). These data show that gilts can receive fiber in their diets and have the required body weight and subcutaneous fat thickness by the onset of the third physiological heat.

Key Words: Swine, Neutral detergent fiber, Digestibility

269   Evaluating high oil corn for lactating sows. K. A. Bowers*, B. T. Richert, D. C. Kendall, S. A. DeCamp, K. M. Lemenager, and B. A. Ladd, *Purdue University, West Lafayette, IN*.

One hundred eighteen yorkshire x landrace sows (avg parity of 2.8) were used in a 28d lactation experiment. Mean d2 litter size after adjustment was 10.0 pigs. Dietary treatments were: 1) Normal corn-soy diet formulated to .80% lysine with no supplemental fat, 2) High oil corn equal weight replacement for normal corn in diet 1, .83% lysine, 6.2% total fat; 3) diet 1 with supplemental soybean meal and fat to make it isocaloric and isolysinic to diet 2. Number of sows per treatment were 40, 41, and 37 for diets 1, 2, and 3, respectively. The experiment was conducted from June 1998 through Feb. 1999. Last and tenth rib backfat depth, sow weight, feed intake, and litter weight were measured at d0, 7, 21, and weaning. Blood samples were taken at d21 and milk samples were taken at d2 and 18. Sows were started on diets 2-5 days prior to parturition. There were 3 blocks of sows based on the season of year and were grouped by parity (1, 2-4, 5+) to form 3 lactation age groups. Treatment, parity group, and season were used as independent variables with adjusted litter size and weight at d2, and days of lactation as covariates for statistical analysis. Number weaned was not affected by treatment (avg 9.4, P>.5). Diets 2 and 3 increased avg daily feed intake (ADFI) during week 1 (3.25, 3.76, 3.83 kg, respectively; P<.08), but did not affect overall ADFI (P>.11). Both diets 2 and 3 increased litter weight gain from d2 to wean (P<.06) and litter weaning weight (64.5, 69.7, 70.4 kg; P<.06, respectively). Diets 2 and 3 reduced tenth rib back fat loss from d0 to wean (5.2, 4.2, 3.3 mm; P<.04, respectively). In sows that weaned 10+ pigs, diets 2 and 3 increased litter weight gain from d2 to wean (50.1, 59.4, 57.8 kg; P<.03, respectively) and increased ADFI from d0 to wean (4.33, 4.80, 4.97 kg; P<.07). In conclusion, sows fed high oil corn had equal performance to sows fed normal corn with added fat and protein, and both had greater litter weight gain and lower back fat loss through lactation than the corn-soy control diet.

Key Words: High oil corn, Pigs, Lactation

270   Effects of dietary electrolyte balance in lactating sows. J. M. DeRouchey*, J. D. Hancock, D. J. Lee, C. A. Maloney, J. S. Park, H. Cao, D. W. Dean, and R. H. Hines, *Kansas State University, Manhattan*.

One hundred fifty-three sows (parities one to four) were used to determine the effects of dietary electrolyte balance (Na + K - Cl) on lactation performance. The sows were fed corn-soybean meal-based diets (1.0% lysine, 1.0% valine, .95% Ca, and .80% P) from d 109 of gestation though the 21-d lactation experiment. Dietary electrolyte balances (dEB) were 0,100, 200, 350, and 500 mEq/kg. (A simple corn-soybean meal-based lactation diet would have a dEB of approximately 185 mEq/kg). To achieve the desired dEB, treatment diets had: 1) 1.7% HCl (6 normal) and 1.07% CaCl; 2) 1.0% CaCl; 3) .05% NaHCO₃; 4) 1.29% NaHCO₃; and 5) 2.54% NaHCO₃. Dietary electrolyte balance did not affect daily food intake (P > .17), litter weight gain (P > .15), sow weight change (P > .11), backfat change (P > .14), percentage sows returning to estrus (P > .42), or days to estrus (P > .15). However, urine pH and blood

pH (linear effects, P < .001) decreased and piglet survivability increased (linear effect, P < .02) with decreasing dEB. In conclusion, decreasing dEB of diets fed to lactating sows decreased urine and blood pH and enhanced piglet survivability.

Electrolyte balance, mEq/kg

Item	0	100	200	350	500	SE
Sow wt change, kg	-14.2	-11.1	-10.6	-14.6	-16.5	5
Sow fat change, mm	-3.3	-2.4	-2.6	-2.3	-2.9	.5
Sow ADFI, kg	5.2	5.6	5.5	5.4	5.6	.2
Litter wt gain, kg	44.3	42.7	43.2	42.6	42.2	1.7
Survivability, %	93	91	89	89	88	2
Return to estrus, %	92	91	94	96	93	4
Return to estrus, d	4.6	5.5	4.9	4.3	4.3	.4
Urine pH	4.87	5.01	6.64	7.00	7.70	.2
Blood pH	7.33	7.36	7.39	7.41	7.43	.6

Key Words: Sows, Lactation, Electrolyte Balance

271   Effect of providing sows natural or synthetic vitamin E at two dietary levels over a 5-parity period. D. C. Mahan*[1], Y. Y. Kim[1], and R. L. Stuart[2], [1] *The Ohio State University, Columbus, OH,* [2] *Stuart Products, Inc.*

A study using a total of 48 gilts evaluated the effects of synthetic DL-α-tocopheryl acetate (DL-α-TAc) and natural D-α-tocopheryl acetate (D-α-TAc) with each added at 30 or 60 IU/kg diet and provided from 40 kg body weight through 5-parities (171 farrowings). The study was a RCB design conducted in 2 replicates with sows nested within dietary treatment for a 5-parity period. Sow weights, backfat thickness, litter performance, incidence of MMA were evaluated at each parity. Sows were bled at periodic intervals during gestation and at weaning with the serum analyzed for α-tocopherol. Colostrum, milk collected from the sow, and the serum collected from 3 pigs per litter at weaning, and liver tissue from 5 pigs at weaning in parity 5, were analyzed for α-tocopherol. There was no effect (P < .15) of vitamin E source or level on litter size, or for the various sow weights, feed intakes, or incidences of MMA. Feeding D-α-TAc resulted in higher (P < .01) sow serum, colostrum, and milk α-tocopherol contents at each measurement period, compared with the DL-α-TAC source, and as the dietary vitamin E levels increased. Although sow tissue α-tocopherol tended to be somewhat higher at the end of the 5-parity period when D-α-TAc was fed, there was no significant effect (P > .15) of vitamin E source. There was, however, an increase (P < .01) in sow liver, adipose, lung, and heart α-tocopherol contents when the higher dietary vitamin E level had been fed. Serum and liver α-tocopherol contents were higher (P < .01) in the pigs at weaning when sows had been fed D-α-TAc compared with the DL-α-TAc source. Although the supplemental vitamin E sources were provided on an equivalent IU basis, these results suggest that the biopotency of D-α-TAc was more than the 1.36 value ascribed to it compared to DL-α-TAc.

Key Words: Vitamin E, Reproduction, Pig

272   Performance of starter pigs fed reduced calcium and phosphorus diets with microbial phytase included at different coefficients of variation. B. W. Cousins*[1], M. B. Coelho[1], B. W. Moechnig[2], J. D. Crenshaw[2], and D. P. Holzgraefe[2], [1] *BASF Corporation,* [2] *MoorMan's, Inc.*

A 21-day experiment was conducted to evaluate the effect of dietary microbial phytase (Natuphos) added at the same concentration (300 FTU/kg) but with three different addition rate coefficients of variation (CV) on performance and metacarpal bone measurements in starter pigs (10 kg BW). A total of 96 pigs were allotted by litter, weight and sex to one of four dietary treatments. Treatments consisted of: 1) a basal corn-soybean meal diet (C); 2) as 1 plus phytase added at a low CV (L); 3) as 1 plus phytase added at a medium CV (M); and 4) as 1 plus phytase added at a high CV (H). The basal diet was formulated to contain 0.70% Ca and 0.55% P. All other nutrients were formulated to meet or exceed the requirements (1988 NRC) of 10 kg pigs. To achieve the different CV application rates of phytase, 909 kg batches for each diet were produced and divided into 40 equal portions. Each portion was mixed with different concentrations of phytase, then fed in predetermined sequences during the experiment to create the intended CV. Calculated

cumulative consumption of phytase and %CV, based on analyzed phytase content of the diets and daily measurments of feed disappearance was 320 FTU/kg, 25.9%; 303 FTU/kg, 42.4%; and 287 FTU/kg, 54.7% for the L, M, and H treatments, respectively. Regression analysis of the phytase treatments revealed non-significant linear or quadratic (P$\geq$.10) differences between the L, M, and H CV treatments for gain, feed intake, gain:feed and metacarpal bone measurements. Pigs fed C grew slower, consumed less feed, had reduced feed efficiency, and less energy was required (P$\leq$.05) to break the metacarpal bones than the average of the pigs fed the L, M, and H CV treatments. Pigs fed the H CV application rate tended (P$\geq$.10) to gain slower and have a poorer feed efficiency than the pigs fed the other phytase treatments. The results of this experiment suggest that a CV application rate of phytase up to 25% can be tolerated by 10 kg pigs without adverse effects on performance or metacarpal bone integrity.

Key Words: Pigs, Phytase, Coefficient of Variation

273   Effect of different levels of potato chip scraps on the performance of nursery pigs. S. Rahnema* and R. Borton, *Agricultural Technical Institute, Ohio State University, Wooster, OH.*

One hundred thirty eight pigs (avg. wt 6.94 kg) were used in an experiment to determine the effect of feeding potato chip scraps (PCS) as a source of energy on the performance of nursery pigs. Nursery pigs were blocked by sex and weight and randomly assigned to three treatments in a randomized complete block design experiment. Each treatment consisted of four pens of 11 to 12 pigs each. In treatment one (control), 46 pigs were fed a diet consisting of soybean meal and corn supplemented to meet NRC requirements. In treatments two and three, 15% and 20% of the corn respectively, were replaced with 15% and 20% of PCS. After seven days of adaptation to the pens and diets, a performance trial was conducted over a 42-d period to measure feed intake (FI), total gain (TG), average daily gain (ADG), and gain to feed ratio (G/F) for these pigs. Individual pig weights and pen feed consumption were determined on a weekly basis. Total gain and ADG were not affected by the replacement of corn with PCS. Feed intake was linearly reduced (P < .02) as the level of PCS was increased in the diet. Gain to feed ratio was linearly increased (P < .01) with increasing the level of SPC in the diet. No quadratic effect was noted for any of the parameters that were measured in this study. This experiment demonstrates that PCS can be an effective and even somewhat beneficial in the diet of nursery pigs.

Key Words: Nursery pigs, Potato chips, Performance

274   Effects of chemical hydrogenation of dietary fat on apparent lipid digestibility by finishing swine. L. A. Averette*, M. T. See, and J. Odle, *North Carolina State University, Raleigh, NC.*

Diets high in unsaturated fat result in soft carcass fat depots which may be sub-optimal for subsequent pork processing, especially in lean genotype pigs. Increasing the saturated fatty acid content of added dietary fat (AF) can improve pork quality, provided the fat is adequately digestible. However, saturated fats are not currently available in large volumes or at competitive prices. Therefore, we evaluated chemically hydrogenated fat. In three experiments chromic oxide was added to feed for 7d to measure the apparent digestibility of AF that was fully hydrogenated (FH), partially-hydrogenated (PH) and PH blended with other fat sources. In trial 1, diets containing 5% AF comprised of 100, 66.7, 33.3 or 0% FH (Iodine value, IV = 0) animal fat with the balance contributed by soy oil, were fed to 24 gilts (n = 6/trt). Digestibility decreased linearly (72.6, 61.2, 26.0, and -12.0 $\pm$ 7.4%; P < .0001) as the amount of FH fat in the diet increased, suggesting the FH fat had a digestibility near 0. Trial 2 evaluated (4 x 2 factorial; n = 6/trt) diets containing 5% fat blended to achieve an IV of 20, 30, 40, or 50 compared to PH tallow with identical IV values. Digestibility of diets formulated with PH tallow was greater than those containing blended fat (73.4 vs 67.2 $\pm$ 1.4%; P < .01), particularly at lower IV values (P < .1). In trial three, digestibility was measured in 96 pigs (n = 24/trt) fed 5% choice white grease partially-hydrogenated to an IV of 80, 60, 40, or 20. Decreasing iodine value did not alter digestibility (69.7, 68.2, 69.2, and 66.2 $\pm$ 1.3%; P > .1). Improvements in digestibility were mirrored by improvements in feed efficiency. We speculate that chemical hydrogenation alters the intermolecular distribution of fatty

acids among triacylglycerols, thereby impacting digestibility. These experiments indicate that partial-hydrogenation is superior to blending unsaturated fat with saturated fat sources and that digestibility is not affected by reducing the IV of a partially-hydrogenated fat.

Key Words: Pig, Digestibility, Fat

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275   Adipic acid (AA) increases plasma lysine, but does not reduce lysine requirements in weanling pigs. T. van Kempen*, *North Carolina State University, Raleigh, NC.*

Cerdan et al. (1988) showed that rats dosed with AA had increased liver lysine. This may have been caused by an inhibition of the lysine degradation cascade as AA shows great structural similarity to products of the lysine degradation cascade. Research was undertaken to I) evaluate if AA affected plasma amino acid concentrations in pigs, and to II) evaluate if the requirements for the affected amino acids were reduced. In trial I, 14 individually housed pigs (barrows, 15 kg) were fed either a standard nursery diet, or the same diet fortified with 1% AA. Six days after the start of diet supplementation, plasma samples were obtained for the analysis of free amino acids. The results of this analysis showed that lysine was elevated with 18% (P = .07) and threonine with 15% (P = .17). In trial II, 56 individually housed barrows (9-13 kg) were limit-fed (115 g/kg$^{.75}$) one of the following seven diets: control (supplied 90% of the digestible amino acids based on the NRC, 1998), or this same diet with either lys, thr, or try reduced to 70% of the NRC (1998) with or without AA. Growth performance was monitored over a 15-d period. The results of this trial showed that animals fed the lysine deficient diet had a lower (P < .05) feed efficiency than the controls (0.510 and 0.578, respectively). AA supplementation further reduced feed efficiency (0.475, P < .05 compared to controls, P = .12 compared to the lysine deficient animals). Animals fed the threonine and tryptophan deficient diets had suppressed feed efficiency (0.558 and 0.555, respectively), but this depression was not significant (P = .38 and .32, respectively). Supplementation of these diets with AA further reduced feed efficiency (0.519, P = .12, and 0.524, P = .19, respectively). Surprisingly, it was not feasible to induce threonine and tryptophan deficiency using the above diets. Nevertheless, the data obtained confirm that AA does affect amino acid metabolism, but not such that it reduced the requirement of the amino acid.

Key Words: Lysine, Requirement, Swine

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276   High oil corn in phase feeding programs for nursery pigs and observations on grow-finish performance. R. F. Gilliam*, C. S. Darroch, K. Stalder, A. G. Mathew, and R. L. Wyatt, *University of Tennessee, Knoxville, TN.*

The objective was to determine the effects of using high oil corn (HOC) in a nursery phase feeding program and monitor growth performance through to market. Two groups of 300 crossbred pigs were weaned, segregated by sex and weight into small, medium and heavy groups, and allotted to 12 nursery pens. Pigs received one of two dietary treatments; (1) a transitional phase I diet for 7 d; a corn-based phase II diet for 14 d and a phase III diet (NCIII) for 7 d; (2) a HOC-based phase II diet for 21 d and the NCIII diet for 7 d. BW, ADFI and F/G ratios were measured weekly during the nursery period. Pigs were transferred to a grow/finish barn on d 28, and BW and ultrasound measurements were taken for back fat (BF) and loin eye area (LEA) at the 10th and last ribs four times prior to market. ADG of nursery pigs on the three-phase diet was greater than pigs fed the HOC two-phase diet at d 21 (P = .0034) and 28 (P = .0128). ADG for heavy pigs was greater (P = .0001) than that of medium and light weight pigs, and no treatment x weight group interactions were observed (P = .2043). Pigs fed the three-phase diet had lower F/G ratios than pigs fed the HOC two-phase diet at d 21 (P = .0137) and 28 (P = .0134). LEA for pigs fed the three-phase diet was greater than pigs fed the HOC two-phase diet when measured on d 28 at the 10th (P = .0565) and last rib (P = .0370). There were no effects of dietary treatment on BF. Even though pigs were fed alike in the grow/finish period, ADG of pigs fed the three-phase nursery diet was greater (P = .0106) than that of pigs fed the HOC two-phase nursery diet. Throughout the grow/finish period there was a tendency (P = .0728) for pigs fed the three-phase nursery diet to be leaner than pigs fed the HOC two-phase nursery diet. These results suggest that removal of the transitional phase I diet, and the substitution of HOC for corn in

a phase II diet, does not support maximal BW and lean gains of pigs in the nursery and subsequent grow/finish periods.

Key Words: Nursery pigs, High oil corn, Phase feeding

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277   Potential for identity preserved plasma protein and ProBlend^{TM}-65 in phase 1 off-site nursery diets. C. V. Maxwell*[1], C. S. Wright[1], B. Z. de Rodas[1], M. E. Davis[1], Z. B. Johnson[1], B. R. Dunsford[2], and J. D. Hahn[2], [1]*University of Arkansas, Fayetteville, AR,* [2]*Farmland Industries, Inc., Kansas City, MO.*

An experiment involving 216 weanling barrows (18 ± 2 d of age; Premium Standard) was conducted to determine the efficacy of identity preserved plasma (IPP; plasma protein obtained from Premium Standard pigs) as the source of plasma protein or as the source of plasma used in producing ProBlend^{TM}-65 (PB). At weaning, pigs were blocked based on initial BW and penned in groups of six (six pens per treatment) in an off-site nursery facility. Treatments (TRT) were: 1) a negative control (NC) phase 1 diet containing 19.5% soybean meal (SBM), and devoid of plasma protein or PB, 2) the NC diet with 4.0% IPP and 10% SBM (IPP was added at the expense of SBM on an equal lysine basis), 3) as 2 with identity preserved PB replacing IPP, 4) as 2 with generic PB replacing IPP, 5) as 2 with generic porcine plasma replacing IPP, and 6) as 2 with Appetein replacing IPP. Substitutions in all diets were made on an equal lysine basis at the expense of corn. The diets were equalized in total lysine (1.58%), and lactose (14.7%) content, and formulated to meet the ideal protein ratio. Experimental diets were fed from d 0 to 10; then all pigs were fed common phase 2 (1.4% lys) and phase 3 (1.25% lys) diets for 14 d each. During Phase 1, ADG for TRT 1 to 6 was 166, 247, 249, 240, 272, and 255 g, respectively (NC vs others, P < .01). Gain/feed for TRT 1 to 6 was .38, .53, .52, .50, .56, and .55, respectively (NC vs others, P < .01). During phase 2, pigs previously fed the NC diet had a higher ADG (P < .01) and G/F (P < .01) than those previously fed the plasma based diets. During phase 3 and for the overall study, pigs previously fed identity preserved PB tended to have a higher ADG than those fed generic PB whereas pigs fed generic porcine plasma grew faster than those fed IPP (interaction, P < .1 and P < .08, respectively). Results from this study suggest that any advantage of identity preserved plasma protein over generic plasma protein as the plasma source for nursery diets is minimal.

Key Words: Pigs, Protein Source, Performance

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278   Nutri-Sure$^®$ vs steam rolled oats in starter diets for weanling pigs. G. L. Cromwell, H. J. Monegue*, and M. D. Lindemann, *University of Kentucky, Lexington, KY.*

Steam rolled oats (SRO) are routinely used in starter diets in some herds because of their palatability and perceived protection against diarrhea. Two trials were conducted to assess a nutrient-certified product consisting of cooked breakfast cereal fines (Nutri-Sure$^®$ [NS]; International Ingredient Corp., St. Louis, MO) as an alternative to SRO. Nutri-Sure contains approximately 7% CP, .21% lysine, 3% fat, 2% fiber, and 18% sucrose. In Exp. 1, 96 pigs (8 reps of 4 pigs/pen; 5.9 kg BW, 20.2 d) were fed fortified Phase I diets (1.4% lysine) of mainly corn, soybean meal, 15% dried whey, and 3% dried plasma for 7 d. During Phase II (21 d), lysine and whey were reduced to 1.2 and 7.5%, respectively, and plasma was removed. All diets had 55 mg carbadox and 250 mg Cu/kg. Treatments were (1) basal diet, (2) basal + 10% SRO, and basal + 10% NS. Average daily gain, ADFI, and feed/gain (F/G) for wk 1 were 145, 159, 150 g/d; 213, 236, 209 g/d; and 1.48, 1.51, 1.40, respectively. Over the entire 28-d test, pigs fed NS tended to gain faster and consume more feed (P < .10) than those fed the basal diet(327, 336, 354 g/d; 504, 522, 549 g/d), but F/G was not affected (1.55, 1.57, 1.55). In Exp. 2, 72 pigs in 2 treatment groups (9 reps of 4 pigs/pen; 6.8 kg, 20.6 d) were given a choice of (1) the basal or NS diets and (2) the SRO or NS diets for 28 d. Diets were the same as in Exp. 1. Feeder positions were switched 3 times/wk in each pen. Average daily gain, ADFI, and F/G were not different (P = .20) for the 2 groups (368, 400 g/d; 599, 645 g/d; 1.66, 1.62) but performance tended to favor the SRO-NS group over the basal-NS group. Preference (% of intake) for the NS diet was greater (P < .01) than for the basal diet during wk 1, 2 and 3 (23 vs 77%, 19 vs 82%, 25 vs 75%) and over the entire 4-wk period (33 vs 67%), but not during wk 4 (45 vs 55%). Preference was similar for the SRO vs NS diets during wk 1, 2, 3, 4, (48 vs 52%, 47 vs 53%, 51 vs 49%, 52 vs 48%) and overall (50 vs 50%). These results indicate that Nutri-Sure$^®$ is at

least equal and perhaps superior to steam rolled oats when included at 10% in starter diets for weanling pigs.

Key Words: Pigs, Cereal, Rolled Oats

279   Effect of copper source on performance of weanling pigs. B. Z. de Rodas[1], C. V. Maxwell[1], M. E. Davis*[1], D. C. Brown[1], Z. B. Johnson[1], and T. M. Fakler[2], [1]*University of Arkansas, Fayetteville, AR,* [2]*Zinpro Corp., Eden Prairie, MN.*

An experiment involving 120 pigs (19 d of age; 5.9 kg BW) was conducted to determine the effect of copper source on performance of weanling pigs. Pigs were blocked based on initial BW and penned in groups of five (6 pens/treatment) in a conventional nursery. Treatments (TRT) were: 1) a control diet containing all trace minerals from standard inorganic sources, 2) as 1 with 250 ppm Cu from $CuSO_4$, 3) as 1 with 100 ppm Cu from Availa-Cu copper amino acid complex (CuAA, Zinpro Corp., Eden Prairie, MN), and 4) as 1 with 100 ppm Cu from CuPLEX copper lysine (CuLys; Zinpro Corp.). All diets were fed in the pelleted form in three phases: d 0 to 10 (1.52% lys), 10 to 24 (1.35% lys), and 24 to 38 (1.15% lys). Dietary copper concentrations were maintained throughout the 38 d trial, and copper source replaced corn in the control diet. During d 0 to 24 postweaning (phases 1 and 2 combined), ADG, ADFI, and G:F for TRT 1 to 4 were 315, 384, 360, 370 g/d; 413, 482, 439, 473 g/d; and .76, .80, .82, .79, respectively. Copper supplementation, regardless of Cu source, resulted in improved (P < .05) ADG. Feed intake was greater (P < .05) in pigs receiving $CuSO_4$ and CuLys than in those receiving the control diet. Gain:feed, however, was not affected by dietary treatments. During d 24 to 38 and during the overall experiment, pigs fed $CuSO_4$ or CuLys had greater (P < .1) feed intake than those fed the control diet. Pigs fed the control diet, however, had greater (P < .05) gain:feed than those fed the diets with added Cu during d 24 to 38 postweaning. These data indicate that during the first 24-d postweaning, Cu supplementation, regardless of Cu source, resulted in increases in ADG and ADFI. One hundred parts per million Cu from CuLys or CuAA were as effective as 250 ppm Cu from $CuSO_4$ in improving gain during d 0 to 24 postweaning.

Key Words: Pigs, Copper Source, Performance

280   Evaluating C-Meal^{TM} and Sea Meal R^{TM} as replacements for select menhaden fish meal in nursery pig diets. D. L. Kirkpatrick*[1], C. V. Maxwell[1], B. Z. de Rodas[1], M. E. Davis[1], D. C. Brown[1], Z. B. Johnson[1], and C. R. Hamilton[2], [1]*University of Arkansas, Fayetteville,* [2]*Esteem Products, Inc., Irving, TX.*

Two experiments were conducted to evaluate the potential of C-Meal^{TM}(CM) and Sea Meal R^{TM}(SM) as alternatives to select menhaden fish meal (FM) in nursery diets. C-Meal^{TM} is a blend of beef proteins and SM is a blend of pork proteins. Pigs were blocked by weight and housed in a conventional nursery. In Exp. 1, 96 pigs (6.6 kg BW; 19 d of age) were penned four/pen. Treatment (TRT) 1 consisted of a control diet containing 8% FM, and TRT 2, 3, and 4 were formulated by replacing FM with 8% CM, 8% SM, and 7% SM plus 1% poultry by-product meal (PM), respectively. Experimental diets were fed in two phases: d 0 to 14 (1.50% lys), and d 14 to 28 (1.35% lys), followed by a common phase 3 diet for 14 d. During phase 1, ADG and G:F for TRT 1 to 4 were 342, 351, 349, 344 g/d; and .87, .88, .83, .83, respectively. Pigs fed SM or SM plus PM had lower (P < .05) G:F than those fed FM or CM. During phase 2, G:F was greater (P < .05) in pigs fed FM than in those fed CM or SM plus PM. During phase 3 and overall, ADG, ADFI and G:F were not affected by TRT. In Exp. 2, 144 pigs (5.8 kg BW; 19 d of age) were penned six/pen. Pigs were fed a common phase 1 diet for 7 d, then pens were assigned to one of four phase 2 TRT: 1) a control diet containing 36% soybean meal (SBM) and 2% blood meal, 2) as 1 with 8% FM replacing SBM on an equal lys basis, 3) and 4) as 2 with SM replacing 50 and 100% FM on an equal weight basis, respectively. Phase 2 diets (1.35% lys) were fed from d 7 to 21. During phase 2, ADG for TRT 1 to 4 was 367, 386, 397, 338 g/d, respectively (quadratic effect of increasing SM, P < .1). Gain:feed for TRT 1 to 4 was .72, .79, .76, and .69, respectively (control vs TRT 2, P < .1; linear effect of increasing SM, P < .05). These results indicate that CM can replace 100% FM in phase 1 diets, and SM can replace 50% FM in phase 2 diets containing blood meal without affecting performance.

Key Words: Pigs, Protein Source, Performance

281   Liquid diets accelerate growth of early-weaned pigs and effects are maintained until market weight. J. H. Kim[1], J. Odle*[2], K. N. Heo[2], I. K. Han[1], and R. J. Harrell[2], [1]*Seoul National Univ., Suweon, Korea,* [2]*North Carolina State University, Raleigh.*

Piglets (N=240, 11 d old, 3.93 kg) were allotted to one of four treatments in a 2X2 factorial design to examine the effects of diet physical form and nursery environment during 14 d post-weaning on growth to market weight. During the treatment period, pigs were housed (10/pen) within either a conventional hot nursery (designated C, ambient temp. = 24 C) or a segregated temperature nursery (designated S, ambient temp. = 30 C, with accompanying hot-box hovers maintained at 32 C). Pigs in each environment were fed nutritionally identical diets (>24% CP, 1.97% Lys, and .60 % Met) in either liquid (L) or dry-pellet (D) form. Subsequently, all pigs were fed identical dry diets, and were housed within common grower-finisher facilities (penned by sex, 5/pen). At the end of treatment period (d 14), pigs fed the L diet were 21% heavier than pigs fed the D diet (9.22 vs. 7.60; P<.0001). Similarly, gain, feed intake and gain/feed of liquid-fed pigs were 44%, 18% and 22% greater respectively than observed for pigs fed the D diet (P<.0001). No main effect of environment was observed (P>.10); however, an interaction with diet type was observed during the early-nursery period (P<.01). Pigs fed the L diet showed better performance in the C nursery, while pigs fed the D diet were favored in the S nursery. No differences in growth performance or in ultrasound carcass measurements were detected during the growing-finishing period (P>.10). However, the advantage in body weight of liquid-fed pigs gained during the first 2 wk post-weaning was maintained to the end of the trial (113.85 vs. 110.57; P<.05). Pigs that were fed the early-nursery diet in liquid form reached 110 kg 3.7 d faster than the dry-fed controls (P<0.01). The results suggest that liquid feeding during early life can markedly accelerate piglet growth performance and that the growth advantage is maintained until market weight.

Key Words: Liquid feeding, Nursery environment, Pigs

282   Effects of amino acid substitutions for whey protein concentrate on weanling pig performance. J. Chung*, S. D. Carter, and J. C. Whisenhunt, *Oklahoma State University, Stillwater, OK.*

A total of 120 pigs (21 d, 6.64 kg BW) was used to evaluate the efficacy of replacing whey protein concentrate (WPC, 77% CP) with crystalline amino acids on growth performance and plasma urea nitrogen (PUN) of weanling pigs. Pigs were blocked by BW, sex, and litter and allotted randomly to 5 dietary treatments (4 pens/trt of 6 pigs/pen). Diet 1 (control) consisted of corn, soybean meal, dried whey, plasma protein (3.5%), blood meal (1.5%), and WPC (9.6%). In Diet 2, WPC was replaced with Lys, Thr, Met, Trp, Ile, and Val on an ideal basis. Diet 3 was as Diet 2 with Gly, Glu, and Asp (NEAA) added to approximate NEAA:CP ratio in the control diet. Diets 4 and 5 were as Diet 3 with additions of Trp, Phe, and Tyr (TPT) or Pro, His, and Arg (PHA), respectively, to approximate ratios to lysine in the control diet. Experimental diets were fed during Phase 1 (d 0-14); then all pigs were switched to a common Phase 2 (1.35% Lys) and 3 (1.15% Lys) diet. ADG, ADFI, and G:F for Phase 1 were, respectively: 328, 281, 259, 265, and 266 g; 345, 350, 324, 307, and 311 g; and .951, .807, .800, .860, and .854. Pigs fed the control diet grew faster and were more efficient (P < .01) than pigs fed Diet 2. Addition of NEAA, TPT, or PHA to Diet 2 did not affect (P > .10) growth performance. PUN were determined at the end of Phase 1 and were, respectively: 7.94, 1.18, 4.32, 6.18, and 6.45 mg/dL. PUN were markedly lower (P < .01) for pigs fed Diet 2 as compared with pigs fed the control. Addition of NEAA to Diet 2 increased (P < .01) PUN, but the greatest increase (P < .01) in PUN was observed with addition of either TPT or PHA to Diet 3. Over the entire 42-d period, ADG and G:F did not differ between pigs fed Diet 1 and 2. However, ADG and G:F remained lower for pigs fed NEAA, TPT, and PHA as compared to those fed Diets 1 and 2 during Phase 1. These results suggest that replacement of WPC with an ideal blend of AA reduced pig performance during Phase 1 of the nursery period. Addition of NEAA, TPT, or PHA to an ideal blend of AA did not improve growth performance.

Key Words: Amino acids, Pigs, Growth performance

283   Comparison between wet and dry feeding for group fed first stage pigs. P. G. Lawlor* and P. B. Lynch, *Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland.*

Liquid feed systems for newly weaned pigs have been installed on several pig units in Ireland. The objective of these experiments was to examine the effects of liquid feeding first stage pigs on performance to slaughter. In experiment 1, 24 pens of 16 pigs weighing 8.4 kg were blocked on sex and weight and randomly assigned to 2 treatments (1) pelleted dry and (2) wet feed. Pigs on both treatments were fed 2 kg starter (212 g/kg crude protein, 66 g/kg oil, 19 g/kg crude fibre) and 5 kg link (234 g/kg crude protein, 75 g/kg oil, 19 g/kg, crude fibre) followed by weaner diet to d-27. In experiment 2, 20 pens of 16 pigs weighing 7.8 kg were blocked on sex and weight and randomly assigned to 2 treatments (1) pelleted dry and (2) wet feed. Pigs on both treatments were fed 3 kg starter (227 g/kg crude protein, 92 g/kg oil, 24 g/kg, crude fibre) and 6 kg link (216 g/kg crude protein, 71 g/kg oil, 31 g/kg, crude fibre) followed by weaner diet to d-27. In both experiments liquid feed was prepared daily as a 2 : 1 (water : meal) mix. Standard weaner (213 g/kg crude protein, 34 g/kg oil, 34 g/kg crude fibre) and finisher diets (187 g/kg crude protein, 28 g/kg oil, 37 g/kg, crude fibre) were fed in both experiments. In experiment 1, liquid fed pigs had a poorer average daily gain (ADG) (286 vs 338 g/day, SE 10, P < 0.01) from d 0 to 55 and feed conversion efficiency (FCE) (1.68 vs 1.51, SE 0.02, P < 0.01) from d 0 to 55. Finisher ADG, FCE or carcass quality were not affected by treatment (P > 0.05). In experiment 2, liquid feeding reduced ADG (352 vs 391, SE 6, P < 0.05) from d 0 to 27 and FCE (1.78 vs 1.64, SE 0.02, P < 0.01). It is concluded that liquid feeding first stage pigs reduced ADG and FCE in the initial 27 and 55 days post-weaning respectively.

Key Words: Wet feeding, Post-weaning, Starter

284   Effects of flavor supplementation to diets of weanling pigs on growth performance and feed wastage. E. van Heugten*, *North Carolina State University, Raleigh.*

An experiment was conducted using 168 weanling pigs (17 days old, 5.71 kg initial BW) to evaluate the effect of flavor supplementation on growth performance and feed wastage. Pigs were allotted to 24 pens based on body weight, gender, and litter of origin and received one of four dietary treatments during the first week of the trial: 1) control diet (15% lactose, 1.6% lysine); 2) control diet with flavor; 3) diet with 5.25% chocolate; and 4) diet with 5.25% chocolate and flavor. Pig performance was not affected (P > .35) by chocolate or flavor supplementation. Substantial feed wastage occurred during the first week (8.75%), but it was not affected (P > .35) by dietary treatments. Pigs were then fed a starter I diet (4.1% lactose, 1.4% lysine) for two weeks and a starter II diet (1.25% lysine) for 18 days. Treatments consisted of: 1) control diet; and 2) control diet with flavor. Flavor addition had no effect (P > .12) on pig growth performance during the starter I phase (ADG (g/d), ADFI (corrected for feed wastage, g/d), and G/F were: 385, 468, and 0.82 for the control diet and 383, 472, and 0.81 for the flavor diet), the starter II phase (ADG, ADFI, and G/F were: 613, 920, and 0.67 for the control diet and 611, 940, and 0.65 for the flavor diet), or overall (ADG, ADFI, and G/F were: 513, 722, and 0.71 for the control diet and 512, 735, and 0.70 for the flavor diet). Feed wastage was not affected (P > .80) during the starter I phase (7.2 and 7.0% for the control and flavor diet, respectively), the starter II phase (2.9 and 2.7% for the control and flavor diet, respectively), or overall (4.2 and 4.0% for the control and flavor diet, respectively). The results indicate that feed intake, weanling pig growth, or feed wastage could not be affected by flavor supplementation under these experimental conditions.

Key Words: Flavor, Pigs, Feed Wastage

285   Evaluation of dried fish and porcine solubles as amino acid sources for weanling pigs. S. D. Carter*[1], M. Bauer[2], K. Miller[2], and R. Stuhr[3], [1]*Oklahoma State University, Stillwater,* [2]*North Dakota State University, Fargo,* [3]*Protein Technologies, Inc., West Bend, IA.*

Ninety-six crossbred pigs, initially averaging 6.62 kg, were utilized to determine the efficacy of dried fish solubles (48% CP, 2.26% Lys) and dried porcine solubles (30% CP, 2.95% Lys; Protein Resources, Inc., West Bend, IA) as amino acid sources for weanling pigs. Pigs were blocked by weight and sex and allotted randomly to 3 dietary treatments. Phase 1 diets (1.36% Lys) were, respectively: (1) control diet

consisting of corn, soybean meal, dried whey, spray-dried animal plasma (2.5%), and spray-dried blood meal (2.5%), (2) as 1 with dried fish solubles (8.75%) replacing animal plasma and blood meal, and (3) as 1 with dried porcine solubles (4.5%) replacing animal plasma and blood meal. Phase 2 diets (1.15% Lys) were similar with the exceptions that the control diet did not contain plasma or blood meal and the dried solubles replaced fish meal in the control diet. All diets were formulated to be similar in total amino acid content and metabolizable energy. Phase 1 diets were fed from d 0-14 and Phase 2 diets were fed from d 15-28. Pigs and feeders were weighed on a weekly basis to determine ADG, ADFI, and G:F. ADG, ADFI, and G:F for the 3 treatments during Phase 1 were, respectively: 205, 172, and 178 g; 312, 295, and 292 g; and .657, .585, and .609. ADG and G:F for pigs fed the solubles were reduced slightly, but these differences were not significant (P>.05). Pigs fed the porcine solubles tended to have higher (P<.05) PUN than pigs fed the control or fish solubles. Similar responses were observed during Phase 2, except for PUN which was lower (P<.05) for pigs fed the solubles. For the entire 28-d study, ADG (518, 516, and 494 g) and G:F (.598, .588, and .573) were similar (P>.05) among treatments. These results suggest that dried fish solubles and dried porcine solubles may serve as alternatives to spray-dried plasma and blood meal in Phases 1 and 2 of the nursery period.

Key Words: Weanling pigs, Procine solubles, Fish solubles

286   Amino acid supplementation of wheat-based diets for growing pigs. M. Cervantes*, J. González, N. Torrentera, and S. Espinoza, *Instituto de Ciencias Agrícolas, Universidad Autónoma de Baja California, Calexico, CA.*

Two 28-d experiments were conducted to assess the value of adding crystalline amino acids to wheat-based diets on performance of growing pigs (Hampshire-Yorkshire-Duroc). The wheat (soft winter) analyzed 11.6% CP, .34% lys, .37% thr, .20% met, and .44% ile. In Exp. 1, treatments were: (1) basal diet, wheat, vitamins and minerals (.33% lys, .36% thr), (2) + lys (.76% lys, .36% thr), (3) +lys+thr (.76% lys, .51% thr), (4) +lys+thr+met (.76% lys, .51% thr), (5) control, wheat-soybean meal diet (.76% lys, .60% thr). Each diet was fed to six replications of one pig from 25.5 to 42.6 kg. Gain, feed intake, lys intake, thr intake, and feed/gain were: 295, 490, 831, 759, 674 g/d; 1.52, 1.69, 1.78, 1.79, 1.69 kg/d; 5.9, 13.9, 14.6, 14.7, 13.8 g/d; 5.5, 6.1, 9.1, 9.1, 10.1 g/d; 5.94, 3.48, 2.20, 2.35, 2.49, respectively. Lys addition increased ADG (P<.05), feed intake (P<.07), lys intake, and improved feed/gain (P<.01). Addition of thr, resulted in further increase in daily gain, thr intake, and feed/gain (P<.01); but, met inclusion decreased weight gain, and feed efficiency (P<.01). Pigs fed the control diet grew slower and less efficient than those fed the lys-thr added diet. In Exp. 2, treatments were: (1) basal diet (wheat, lys, vitamins, and minerals), .51% lys, .36% thr, (2) +thr, (3) +thr+ile, (4) +thr+ile+met, and (5) positive control wheat-soybean meal diet (.76% lys, .60% thr). Gain, feed intake, lys intake, thr intake, and feed/gain were: 640, 734, 602, 651, 624 g/d; 1.73, 1.65, 1.81, 1.70, 1.80 kg/d; 13.8, 13.2, 14.5, 13.6, 14.4 g/d; 6.2, 6.5, 9.2, 8.7, 9.2 g/d; 2.73, 2.39, 3.06, 2.70, 2.89, respectively. Addition of thr tended to increase daily gain and improved feed/gain (P<.10). Pigs fed the basal diet added with thr had a higher weight gain and better feed efficiency (P<.05) than those fed the control diet. These data suggest that all the soybean meal can be replaced by crystalline lys and thr in wheat-based diets without affecting the performance of growing pigs.

Key Words: Pigs, Amino acids, Wheat

287   Evaluation of dietary level of cottonseed meal on performance and carcass traits of growing pigs. M. Cervantes*[1], J. González[1], N. Torrentera[1], S. Espinoza[1], and M. Cuca[2], [1]*Instituto de Ciencias Agrícolas, Universidad Autónoma de Baja California, Calexico, CA,* [2]*Colegio de Postgraduados, Montecillo, Mx.*

Two experiments were conducted to evaluate the effect of adding cottonseed meal, at the expenses of soybean meal, to grain sorghum- or wheat-soybean meal diets on performance and carcass traits of finishing pigs (Hampshire-Yorkshire-Duroc). The cottonseed meal analyzed 39.8% CP, 1.81% lys, 1.48% thr, .70% met, .44% ile, 1.28% his, and 1.98% val. In Exp. 1, diets were: (1) basal, wheat-soybean meal, vitamins and minerals (.70% lys), (2), (3), and (4) cottonseed meal replaced soybean meal at 15, 30, and 45%, respectively. Diets 2, 3, and 4 were contained added crystalline lys and thr to equal their levels in Diet 1. Each diet was fed to four replications of two pigs from 52.0 to 95 kg.

Gain, feed intake, and feed/gain, backfat, and loin area were: 873, 809, 869, 812 g/d; 2.38, 2.39, 2.40, 2.50 kg/d; 2.72, 3.11, 2.76, 3.08; 1.98, 1.94, 1.72, 2.22 cm; 27.8, 29.9, 29.8, 29.4 cm2, respectively. The inclusion of cottonseed meal, up to 45% as percentage of the soybean meal, did not affect the daily gain, feed intake, feed/gain, backfat depth, or loin area (P>.10). In Exp. 2, diets were: (1) basal, grain sorghum-soybean meal, vitamins, and minerals (.70% lys), (2), (3), and (4) cottonseed meal replaced soybean meal at 25, 50, and 75%, respectively. Gain, feed intake, and feed/gain were: 928, 972, 899, 898 g/d; 2.89, 3.00, 2.85, 2.80 kg/d; 3.11, 3.09, 3.18, 3.12, respectively. Likewise Exp. 1, daily gain, feed intake, and feed efficiency of finishing pigs were not affected by the inclusion of any level of cottonseed meal, at the expenses of soybean meal, in grain sorghum-soybean meal diets. These data suggest that up to 75% of dietary soybean meal can be replaced by cottonseed meal without affecting the performance of finishing pigs.

Key Words: Pigs, Cottonseed meal, Soybean meal

288   Effect of different levels of potato chip scraps on the performance of growing and finishing pigs. S. Rahnema* and R. Borton, *Agricultural Technical Institute, Ohio State University, Wooster, OH.*

One hundred thirty eight pigs (avg. wt 28.32 kg) were used in an experiment to determine the effect of feeding potato chip scraps (PCS) as a source of energy on the performance of growing and finishing pigs. Pigs were blocked by sex and weight and randomly assigned to three treatments in a randomized complete block design experiment. Each treatment consisted of four pens of 22 to 23 pigs each. In treatment one (control), 45 pigs were fed a diet consisting of soybean meal and corn supplemented to meet NRC requirements. In treatment two and three, 15% and 20% of the corn respectively, was replaced with 15% and 20% of potato chip scraps. After the nursery phase, pigs were moved to growing and finishing pens and a performance trial was conducted over a 91 to 98-d period to measure feed intake (FI), total gain (TG), average daily gain (ADG), and gain to feed ratio (G/F). Individual pig weights and pen feed consumption were determined on a weekly basis. Since the pigs were all finished to the same final weight, total gain was not affected by treatments. However, pigs on the 20% PCS required 7-d longer to reach the final weight. Feed intake was reduced (P < .07) and G/F was increased (P < .01) linearly due to an increase in the level of PCS in the diets. Similarly ADG was increased (P < .01) linearly due to an increase in the percentage of SPC in the diets. This experiment demonstrates that PCS can be effective and even somewhat beneficial in the diet of nursery pigs.

Key Words: Growing-finishing pigs, Potato chips, Performance

289   Study on the optimal lysine:DE ratio for growing pigs in different sexes. W. H. Chang[1], J. D. Kim[1], Z. N. Xuan[1], W. T. Cho[1], I. K. Han[1], and B. J. Chae*[2], [1]*Seoul National University, Suweon, Korea,* [2]*Kangwon National University, Chunchon, Korea.*

This study was conducted to investigate the effects of lysine to digestible energy (DE) ratio on growth performance, nutrient digestibilities and blood urea nitrogen (BUN) for estimating the optimal lysine:DE ratio in grower diet. A total of 138 pigs (LxYxD, 16.78 kg average body weight, 69 barrows and 69 gilts) were randomly allotted into six treatments by a 2x3 factorial design and eighteen cannulated pigs (9 barrows and 9 gilts) were employed in digestive trial to investigate apparent digestibilities and ileal digestibilities of nutrients. Three diets were formulated with a crude protein level of 19%, a DE level of 3.5 Mcal/kg, and three lysine:DE ratios of 3.2 (low, L), 3.5 (middle, M) and 3.8 (high, H) g lysine/Mcal DE per kg diet for both barrows and gilts. Increasing dietary lysine:DE ratio, body weight gain (ADG) of barrows decreased though there was no significant difference observed among treatments (P > .05), however, the tendency in gilts was reverse compared with barrows. For barrows, no significant effects (P > .05) of lysine:DE ratio on feed intake (ADFI) and feed efficiency (G/F) were observed for overall period. For gilts, ADFI was higher during d 36 to 49, while F/G was better during d 0 to 14 (P < .05). For overall period, the optimal G/F was in groups with low and high lysine:DE ratio for barrows and gilts, respectively. The higher apparent digestibilities and apparent ileal digestibilities of nutrients could be achieved when diets provided contained low and high lysine:DE ratios for barrows and gilts, respectively. Data of blood urea nitrogen was negatively related to growth rate. It is concluded that the

optimal lysine:DE ratios were 3.2 and 3.8 g lysine/Mcal DE per kg diet for growing barrows and gilts (16 50 kg of body weight), respectively.

Key Words: Lysine:DE Ratio, Growth Performance, Barrow and Gilt

290   Effects of α-Galactosidase enzyme on ileal digestibility and large intestine fermentation in finishing pigs fed a cereal-soybean-pea diet. F. Baucells*[1], J. Morales[2], J. F. Perez[2], and J. Gasa[2], [1]*Pinsos Baucells, S.A.,* [2]*Universitat Autònoma de Barcelona.*

Ileal digestibility and cecum fermentation were studied in fisnishing pigs after a two months production experiment in which supplementing the diet with α-galatosidase (Biogalactosidase, Quest; 200 Units/kg) improved average daily gain, food:gain conversion ratio and whole tract apparent digestibility. Eighteen crossbred pigs were selected at an avarage live weight of 86 kg. The basal diet contained ground corn, 44%; ground barley, 18%; soybean meal, 10%; peas, 25% and 0.2% chromic oxide as a digestibility marker, either unsupplemented or supplemented with the enzyme. After 14 d of feeding the experimental diets the animals were slaughtered and samples of the ileum and caecum digesta were obtained. Ileal estibility of the DM and different components of the non-starch polysaccharides (NSP), and rectal digestibility of DM and CP were estimated. Concentration of volatile fatty acids (VFA) and purine bases were measured in caecum digesta. The use of the enzyme improved the digestibility in ileum (DM, 633 vs 465 g/kg, P <.05) and rectum (DM, 864 vs 818; and CP, 817 vs 731g/kg, P <.05). Ileal digestibility of NSP-monosaccharides were also higher for galactose, rhamnose, mannose and fucose (P <.05) in the enzyme supplemented diet. Caecum concentrations of VFA (mmol/g) were lower in the enzyme diet for total (121 vs 134, P =.15), butyric (15.5 vs 19.6, P =.09), valeric (1.76 vs 3.12, P <.01) and branched-chain VFA (isovaleric + isobutyric acids, 2.24 vs 3.32, P <.01). Volatile fatty acids profile for the enzyme treatment was also lower (P <.01) for the branched-chain and higher for propionic (P <.05). Concentration of total purine bases in cecum digesta was lower in the enzyme treatment (9.1 vs 13.6 mmol/gDM, P <.001). The results showed that adding α-galatosidase enzyme to cereals-soybean meal-pea diet improves its digestibility and reduces the amount of fermentable substrate arriving to the large intestine in finishing pigs.

Key Words: Pig, Galactosidase, Digestibility

291   Molasses/fat combination as a nutrient source for swine and ducks. S. L. Selin, M. E. Einstein, O. Adeola, and B. G. Harmon, *Purdue University, West Lafayette, IN.*

The study consisted of two separate experiments, a duck metabolizable energy (ME) assay, and a swine grow-finish trial to evaluate the potential utility of a molasses/fat supplement. Thirty-six male White Pekin ducks were assigned based on a randomized complete block design to one of three treatments: (1) feed-deprived; (2) cornstarch; and (3) molasses/fat supplement for the purpose of determining bioavailable energy of the supplement. To assess the affect of the molasses/fat supplement on pig performance, 144, 25 kg pigs (1:1, barrows:gilts) were used. The pigs were allotted to four treatments with six pigs per pen, and six pens per treatment. The four diets were: (1) 16.3% CP, .9% lysine, 3.2 kcal/g ME, corn/SBM diet with 10% corn starch; (2) 16.3% CP, .9% lysine, 3.2 kcal/g ME, corn/SBM diet with 10% molasses/fat supplement; (3) Diet 1 + .17% L-lysine HCl; and (4) Diet 2 + .17% L-lysine HCl. Lysine was reduced by .18% in the finisher diets compared to the grower diets. Pens were switched from grower to finisher diets at an average pig weight of 52 kg. Carcass analysis was performed when an average pig weight of 112 kg was attained. The ME of the molasses/fat supplement was superior to cornstarch (5.91 vs. 4.10 kcal/g) on a dry matter basis. On an as-fed basis, the ME of the molasses/fat supplement compares well to corn (3.47 vs. 3.42 kcal/g). The supplement supported better performance (ADG) in both the grower phase and the total grow/finish phase (P < .05). Gain:feed was similar (P > .05) for the same periods. Throughout the entire study, the molasses/fat supplement increased (P < .05) daily feed intake on both a dry matter and as-fed basis. Carcass data, (loin eye area, backfat, fat free lean index, and carcass yield), were similar (P > .05) across the four treatments. The addition of L-lysine HCl to Diets 3 and 4 did not alter (P > .05) carcass composition or performance. Based on the results of the study, the molasses/fat liquid

supplement can be substituted for up to 10% of the diet and maintain or increase daily gain and feed intake.

Key Words: Molasses/fat product, Pigs, Ducks

292   The effects of expander processing and wheat inclusion levels on performance of grower-finisher pigs. J. V. O' Doherty*, D. Murphy, and S. G. McGlynn, *University College Dublin, Ireland.*

Seventy-two entire male pigs (28 ± 1.0 kg) were used to study the effects of 3 wheat inclusion levels with or without expander processing on grower-finisher pig performance in a 3 x 2 factorial arrangement of treatments. Productive performance and nutrient digestibility (n = 4) were determined in individually fed pigs offered pelleted diets ad libitum containing a high wheat diet (550 g/kg wheat, 62 g/kg soybean meal (SBM), 100 g/kg rape seed meal (RSM), 150 g/kg peas (PS), 100 g/kg wheat feed (WF) and 18 g/kg beef tallow), medium wheat (410 g/kg wheat, 20 g/kg SBM, 125 g/kg RSM, 200 g/kg PS, 150 g/kg WF, 45 g/kg copra meal and 26 g/kg beef tallow) and low wheat (180 g/kg wheat, 125 g/kg RSM, 250 g/kg PS, 177 g/kg WF, 150 g/kg copra meal and 35 g/kg beef tallow). The expanded diets were processed at 105 ^{0} C for 5 seconds at 35 bars. All diets were formulated to have similar concentrations of digestible energy and ideal protein. Starch content of 440, 400 and 310 g/kg and crude fibre content of 48, 58 and 74 g/kg were recorded for the high, medium and low wheat diets, respectively. Neither level of wheat or expansion had an effect (P > .05) on the apparent nutrient digestibility of the diets, however, expansion did tend to decrease the digestibility of DM and energy (P< .01). The reduction in wheat inclusion levels decreased (P < .05) average daily gain (ADG) (0.899 vs 0.887 vs 0.854 kg/day, SE = .014) from 28 kg to slaughter and feed intake (1.62 vs 1.48 vs 1.48 kg/day, SE = 0.028) in the 28 to 55 kg weight range. Expansion had no effect on any growth criteria. The reduction in wheat level decreased (P < .01) kill out proportion (KO) (0.723 vs 0.705 vs 0.710, SE = .0039) and carcass ADG (0.684 vs 0.651 vs 0.641, SE = .011) (P < .05). Expansion decreased (P < .05) KO (0.707 vs 0.718, SE = .0032) and tended to decrease (P < .10) lean meat (543 vs 553 g/kg, SE = 3.81) and carcass ADG (647 vs 670, SE = .0096). In conclusion, decreasing the wheat content of the diet decreased ADG while expansion had no positive effect on growth performance.

Key Words: Pigs, Expanders, Wheat

293   A nutrient database for distiller's dried grains with solubles produced from new ethanol plants in Minnesota and South Dakota. M. H. Whitney*, M. J. Spiehs, and G. C. Shurson, *University of Minnesota, St. Paul, MN.*

A study was conducted to evaluate the nutrient content and variability of distiller's dried grains with solubles (DDGS) originating from new (less than 5 yrs old) ethanol plants in MN and SD. Ten plants (8-MN, 2-SD) participated in the study, submitting a total of 88 samples. Samples of DDGS were collected every two months during 1997 (n=38) and 1998 (n=50) and were sent to the University of Missouri for amino acid analysis, and Iowa Testing Laboratories, Inc., for DM, CP, crude fiber, crude fat, ash, ADF, NDF, Ca, P, K, Mg, S, Na, Zn, Mn, Cu, and Fe analysis. Digestible energy (DE), ME, and NFE levels were also calculated. Means and coefficients of variation for each nutrient among all plants during 1997-98 were: DM (89.3 %, 1.6 %), CP (30.5 %, 5.6 %), crude fat (10.7 %, 11.2 %), crude fiber (8.8 %, 7.9 %), ash (5.7 %, 14.8 %), NFE (44.3 %, 6.0 %), ADF (16.0 %, 15.3 %), NDF (43.2 %, 7.8 %), DE (1796 kcal/kg, 2.1 %), ME (1627 kcal/kg, 2.2 %), Thr (1.13 %, 5.8 %), Val (1.51 %, 6.7 %), Met (0.54 %, 13.3 %), Ile (1.14 %, 8.0 %), Leu (3.58 %, 5.9 %), Phe (1.48 %, 6.3 %), His (0.76 %, 7.8 %), Lys (0.82 %, 18.2 %), Arg (1.18 %, 9.3 %), Trp (0.24 %, 9.8 %), Ca (0.06 %, 57.3 %), and P (0.89 %, 12.2 %), respectively. Among the amino acids analyzed, Lys was the most variable (CV=18.2 %), followed by Met (CV=13.3 %) and Trp (9.8 %). Nutrient levels of MN-SD DDGS were higher in crude fat, NDF, DE, ME, Lys, Met, Thr, and Trp and lower for DM, ADF, Ash, and P than NRC (1998) values. Values differed between year sampled (1997 vs 1998) for Val (1.48 vs 1.52 %) (P < .10); DM (89.63 vs 89.00 %), crude fiber (9.02 vs 8.65 %), His (0.74 vs 0.77 %), and Arg (1.15 vs 1.20 %) (P < .05); and Lys (0.77 vs 0.85 %) (P < .01). These results suggest that gross energy and total lysine, methionine, threonine

and tryptophan levels are higher in DDGS from MN and SD ethanol plants compared to published NRC (1998) values.

Key Words: Distiller's Dried Grains with Solubles, Nutrients

294   Energy, nitrogen, and phosphorus digestibility of growing and finishing swine diets containing distiller's dried grains with solubles. M. J. Spiehs*, G. C. Shurson, and M. H. Whitney, *University of Minnesota, St. Paul, MN.*

Two nutrient balance trials were conducted to determine the digestibility of energy, nitrogen, and phosphorus of Minnesota-South Dakota (MNSD) produced distiller's dried grains with solubles (DDGS) in grower and finisher swine diets. Sixteen pigs weighing 28.6 ± 2.2 kg in Exp. 1, and 16 pigs weighing 84.4 + 6.2 kg in Exp. 2, were randomly assigned to one of four corn-soybean meal based dietary treatments: control (0% DDGS), 10% DDGS, 20% DDGS and 30% DDGS. Total Lys and P levels were constant across dietary treatments within each experiment. Pigs were housed in individual metabolism crates for 10 d and limit fed an average of 1031 g/d and 1767 g/d of their respective experimental diets in Exp.1 and Exp.2, respectively. Urine and feces were collected on d 8 to 10. Feed, feces, and urine were analyzed for N, P, and GE content. Increasing DDGS level in the diet tended to increase GE and N intake in both experiments. Dietary DE and ME were lower (P < .10) for the control diet (3638 and 3611 kcal/kg, respectively) compared to the 10, 20, and 30% DDGS diets (3840 and 3841, 3824 and 3796, 3787 and 3757 kcal/kg, respectively) in Exp.1. In Exp. 2, DE and ME were greater (P < .10) in the 10% DDGS diet (3876 and 3831) compared to 30% DDGS (3628 and 3579). Nitrogen retention (%) did not differ between treatments (P > .10) in both experiments, but N excretion tended to increase with increasing amounts of DDGS in the diet. Feeding 20% DDGS increased % P retention compared to the control and 30% DDGS diets (P < .10) in Exp.1, and feeding the 10% DDGS diet increased (P < .10) % P retention compared to the control diet in Exp. 2. Adding increasing amounts of DDGS to the diet tended to decrease P excretion in both experiments. These results suggest that feeding 10 to 20 % MNSD DDGS will increase dietary DE and ME, improve P retention and reduce P excretion, and maintain N retention while tending to increase N excretion when fed to grow-finish pigs.

Key Words: Pigs, Distiller's dried grains with solubles, Digestibility

295   Effects of two sources of dietary L-carnitine on nitrogen and energy balance in growing pigs. J. W. Frank*[1], B. T. Richert[1], S. A. DeCamp[1], C. Thomas[1], and K. Q. Owen[2], [1]*Purdue University, West Lafayette, IN*, [2]*Lonza, Inc., Fair Lawn, NJ.*

Two experiments were conducted to determine the effects of two sources of dietary L-carnitine on nitrogen and energy balance in growing pigs. For this trial carnifeed® (F; 97 to 103% L-carnitine) and carniking® (K), a 50% L-carnitine product, were used as the supplemental carnitine sources. In the first experiment, 24 barrows (initial BW = 34 kg) were housed in metabolism creates for 14 days and fed one of 3 diets. Pigs were limit fed a .85% lysine diet at $.05 \times BW^{.9}$. Carnitine products were included to provide 50 ppm L-carnitine and replaced cornstarch in the control diet (C). All pigs were fed twice daily and were allowed ad libitum access to water. Pig weights and serum samples were collected on d 0, 7, and 14. Serum samples were analyzed for urea nitrogen concentration and carnitine levels. During the last 4 d of the trial, total fecal, orts, and 10% of urine volume were collected and frozen twice daily. Experiment 2 was identical to experiment 1; however, twelve barrows (4 pigs/treatment) with an initial BW = 23.7 kg received a .95% lysine diet. In addition, serum samples were not analyzed for carnitine levels. In experiments 1 and 2, dietary carnitine did not significantly effect energy or nitrogen utilization in growing pigs (P > .10). In addition, there were no significant differences between the two L-carnitine sources (P > .10). The results for the blood urea nitrogen concentrations showed no significant differences in d 7 or d 14 samples (P > .10). In experiment 1, K and F pigs had greater total (7.48 and 8.02 vs 5.35 μmoles/ml) and free (6.55 and 7.05 vs 4.33 μmoles/ml) L-carnitine concentrations in their serum on d 14 than C pigs (P < .006 and P < .001; respectively). The data from these experiments suggest that L-carnitine supplementation did not affect the energy or nitrogen metabolism of the growing pig. The growing pig absorbed both sources of supplemental L-carnitine with equal efficacy.

Key Words: Carnitine, Nitrogen balance, Pigs

296 Effects of dietary thiamin, folacin, or niacin regimen on growth in high lean pigs. T. R. Lutz*, T. S. Stahly, D. R. Cook, and R. C. Ewan, *Iowa State University, Ames, IA.*

In three separate trials, pigs from a high lean strain were reared via a segregated early weaning scheme (weaned 8 to 14 d of age, physically isolated from other pigs), penned individually and given ad libitum access to a basal diet supplemented with 600% of the NRC estimated requirement for all vitamins except choline and the respective test vitamin. In each trial, pigs were allotted within litter to dietary treatment and fed from 8.5 ± 1.5 to 26 ± 3 kg BW. In trial 1, pigs (10 pens/trt) were fed a pelleted basal diet (2.05 ppm thiamin) supplemented with thiamin equivalent to 0, 130, 260, 390 and 520% of the NRC (1998) estimated requirement for 10 to 20 kg BW pigs. Thiamin regimen did not (P>.10) alter ADG (704, 707, 708, 678, 698 g/d) or gain:feed (744, 725, 766, 724, 761 g/kg). In trial 2, pigs (12 pens/trt) were fed a pelletted basal diet (.52 ppm folacin) supplemented with 0, 100, 200, 300 and 400% of the folacin requirement. Folacin regimen did not (P>.10) alter ADG (657, 655, 668, 634, 670 g/d), gain:feed (806, 821, 795, 816, 817 g/kg) or estimated (via deuterium oxide dilution) accretion rate of body protein (Pa; 114, 113, 118, 112, 118 g/d) or fat (Fa; 66, 68, 58, 59, 58 g/d). In trial 3, pigs (10 pens/trt) were fed a meal basal diet (9.4 ppm available niacin; .175 digestible tryptophan/lysine ratio) supplemented with 0, 120 and 240% of the niacin requirement. Niacin regimen in the presence of minimal tryptophan excess did not (P>.10) alter ADG (694, 661, 688 g/d), gain:feed (716, 711, 719 g/kg), Pa (119, 114, 119 g/d) or Fa (84, 76, 79 g/d). Based on these data, the dietary needs of high lean, high health pigs (8 to 26 kg BW) for thiamin, folacin, and niacin, respectively, are equal to or less than 205, 173 and 75% of the current estimated requirements for 10 to 20 kg BW pigs (NRC, 1998).

Key Words: Thiamin, Folacin, Niacin

297 The influence of crude fibre level and fat supplementation on grower-finisher pig performance. J. V. O'Doherty*, S. G. McGlynn, D. Murphy, and J. J. Callan, *University College Dublin, Ireland.*

Seventy-two entire male pigs (38 ± 1.0 kg) were used to study the effects of increased crude fibre (CF) level in the diet, and maintaining the digestible energy (DE) content of the diet by increased dietary fat inclusion, on pig performance in a 3 x 2 factorial arrangement of treatments. Productive performance and nutrient digestibility (n = 4) were determined in individually fed pigs offered expander processed pelleted diets ad libitum, and containing 3 levels of CF (50, 65 and 80 g/kg) and 2 levels of fat supplementation (25 and 50 g/kg) until slaughter at 100 kg. All diets were formulated to have similar concentrations of DE (3.22 Mcal/kg) and lysine (10 g/kg) and the fat source was a 60:40 blend of tallow and palm oil. There was no CF x fat interaction in any growth criteria. The inclusion of 50 g/kg fat in the diet reduced (P < .05) feed intake (2.28 vs 2.43, SE = .039), average daily gain (ADG) (0.877 vs 0.927, SE = .017) and carcass ADG (0.658 vs 0.700, SE = .011). The increase in dietary CF level linearly decreased (P < .05) feed intake, ADG, carcass ADG and kill out proportion. Carcass characteristics were unaffected by treatments. The increase in dietary CF linearly decreased (P < .05) dietary protein digestibility. There was a (P < .01) CF x fat interaction (P < .01 in dry matter (DM), oil and energy digestibility. The increase in CF level linearly decreased (P < .05) the DM, energy and oil digestibility while the inclusion of 50 g/kg fat decreased (P < .01) DM and energy digestibility and increased (P < .05) oil digestibility. However, the inclusion of 50 g/kg fat in the diet reduced (P < .01) DM and energy digestibility of the diets at the 50 g/kg and 65 g/kg CF level, however, fat inclusion level had no effect at 80 g/kg CF. The inclusion of 50 g/kg fat in the diet increased (P < .01) oil digestibility at the 50 g/kg and 65 g/kg CF levels, however, fat inclusion had no effect at the 80 g/kg CF inclusion. In conclusion, increasing both the CF level and supplementary fat had a negative effect on pig growth performance and nutrient digestibility.

Key Words: Pig, Fiber, Fat

298 Effects of adding wheat midds to low crude protein, amino acid supplemented diets for finishing pigs. J. A. Shriver*, S. D. Carter, B. W. Senne, and L. A. Pettey, *Oklahoma State University, Stillwater, OK.*

Ninety-six pigs, initially weighing 28 kg, were utilized to evaluate the effects of adding wheat midds to low crude protein, amino acid (LPAA)

supplemented diets on growth performance, carcass traits, and plasma urea nitrogen (PUN) of finishing pigs. Pigs were blocked by BW, sex, and litter and allotted randomly to 4 dietary treatments (6 reps of 4 pigs/pen). Dietary treatments were: (1) fortified corn-soybean meal control, (2) as 1 with CP lowered by 4 percentage units and supplemented with Lys, Thr, Met, and Trp, (3) as 2 plus 10% wheat midds, and (4) as 2 with 20% wheat midds. Wheat midds (.64% Lys) were added to the LPAA diets at the expense of corn and soybean meal. Lysine HCl was added to make all diets isolysinic, and Thr, Met, and Trp were added to Diets 2-4 on an ideal basis. Diet 1 was formulated to 18, 16, and 14% CP (.95, .80, and .65% Lys) for 28-54, 55-83, and 82-111 kg, respectively. Diets 2-4 were formulated to 14, 12, and 11% CP for the three phases, respectively. ADG and G:F were, respectively: .75, .70, .72, and .74 kg; and .302, .305, .306, and .309. Lowering CP and adding AA reduced (P < .10) ADG, but addition of 10 or 20% wheat midds did not affect growth rate. Lowering CP and adding AA or the addition of wheat midds to LPAA had no effect (P > .10) on G:F. At 111 kg, pigs were killed to determine carcass traits. LMA, 10th fat depth, and % lean were, respectively: 46.5, 41.6, 43.3, and 41.4 cm2; 2.24, 2.07, 2.40, and 2.22 cm; and 53.4, 52.8, 51.9, and 52.1%. Pigs fed the LPAA diets had smaller (P < .10) LMA, but 10th rib fat depth and % lean were not affected (P > .10) by diet. Pigs were bled at the end of each phase for determination of PUN. Reducing CP and adding AA reduced (P < .01) PUN, but addition of wheat midds did not affect (P > .10) PUN. These data suggest that reducing CP by 4 percentage units and adding AA reduces growth rate of finishing pigs; however, the addition of 10 or 20% wheat midds to a LPAA diet had little effect on growth performance, carcass traits, or plasma urea nitrogen.

Key Words: Pigs, Amino acids, Wheat midds

299 Effect of wheat quality and quantity in the diet on the growth performance of finisher pigs. P. B. Lynch[1] and P. G. Lawlor*[1], [1]*Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland.*

There has been increased interest in formulating diets with high inclusion levels of wheat. The objective of these experiments was to examine the effect of wheat quality and quantity in the diet on finisher pig performance. In experiment 1, 72 pigs of c. 38 kg were blocked on sex and weight and randomly assigned to 3 wheat- soya diets formulated with (1) high quality (HQ), (2) good quality (GQ), and (3) poor quality wheat (PQ). HQ, GQ and PQ had hectolitre weights of 74.4 g, 73.3 g and 67.0 g respectively and their yeast and mold count was 4.5 x 104, 38 x 104, and 65 x 104 /g respectively. In experiment 2, 12 pens of 3 pigs (c. 35 kg) were blocked on sex and weight and randomly assigned to 3 dietary treatments with different levels of wheat (1) 700 g/kg , (2) 500 g/kg, and (3) 300 g/kg. All diets were formulated to 11.2 g/kg lysine and 13.6 MJ/kg and fed dry as a 5 mm pellets. In experiment 1 carcass ADG was 611, 554 and 597 g/day (s.e. 16, p < 0.05) for HQ, GQ and PQ fed pigs respectively. Carcass FCE was 3.48, 3.87 and 3.86 (s.e. 0.08, p < 0.01) and P2 fat depth was 13.4, 11.0 and 12.3 mm (s.e. 0.7, p < 0.05) for HQ, GQ and PQ fed pigs respectively. In experiment 2 treatment had no significant effect on DFI, ADG or FCE (p > 0.05). P2 Fat depth was 13.5, 11.7, and 11.1 mm (s.e. 0.7, p < 0.05) for treatments 1, 2 and 3 respectively. It is concluded that ADG and FCE can be improved by selecting higher quality wheat. Pigs fed low quality wheat can in some cases maintain a good ADG by increasing their intake. P2 fat depth increases as wheat inclusion in the diet increases from 300 g/kg to 700 g/ kg.

Key Words: Wheat, Finishing pigs, Quality

300 Effects of dietary tannic acid on feed intake, daily gain, and salivary glands of young pigs. J. A. Ford, Jr.*[1], I. Osaka[2], and W. L. Hurley[1], [1]*University of Illinois at Urbana-Champaign,* [2]*Hokkaido-Shintoku Animal Science Institute, Hokkaido, Japan.*

Dietary tannins adversely affect protein digestibility. Objectives of the current study were to determine the effects of dietary tannic acid on feed intake, daily gain, and salivary gland weights of young pigs. Twenty-four barrows (PIC C-22 X PIC 346), at about five weeks of age and 10 kg body weight (BW), were randomly placed into one of six groups (N = 4 per group). Groups were fed a standard growing diet (corn-soybean mix with added minerals and vitamins) containing added tannic acid (TA) at 0, .125, .25, .5, 1.0, or 2.0 %. Barrows were placed in individual pens

for a seven-day pretreatment period, followed by five days of receiving dietary treatment. Feed intake and body weights were recorded daily. Salivary glands were collected at slaughter on d 13, and weights of the parotid and submandibular glands recorded. Total intake of TA for the dietary treatment period was 0, 6.8, 10.5, 23.9, 46.2, and 87.2 g for the 0, .125, .25, .5, 1.0 and 2.0 % added TA groups, respectively. Regression analysis showed that the rate of increase of feed intake for the dietary treatment period declined as intake of TA increased (P = .02). No significant differences in average daily gain were observed during the 5 d dietary treatment period. Parotid gland weights increased as dietary TA increased (P = .003). Parotid gland weights of pigs in the 0 % and 2.0 % added TA groups were 12.9 ± 4.2 g and 59.8 ± 7.5 g, respectively. When expressed as a percentage of BW the parotid gland weights increased as dietary TA increased (P = .003). Parotid gland weights were $.09 \pm .02$ % and $.38 \pm .03$ % of BW for the 0 % and 2.0 % added TA groups, respectively. In contrast, no significant differences in weights of submandibular glands were observed. Increased dietary intake of TA did not affect average daily gain or submandibular gland weight, but resulted in a significant increase in parotid gland weight. The pig parotid gland is specifically sensitive to the level of dietary tannin.

Key Words: Barrows, Tannic Acid, Salivary Glands

301   Effects of sorghum starch type, endosperm hardness, and processing technologies on growth performance of broiler chicks and nutrient digestibility in finishing pigs. H. Cao*, J. D. Hancock, B. W. Senne, J. M. Jiang, R. H. Hines, and K. C. Behnke, *Kansas State University, Mahattan KS.*

Two experiments were conducted to determine the effects of sorghum genotypes and processing technologies on growth of chicks and nutrient digestibility in pigs. Six sorghums were grouped into soft (851111), medium (279 & PL-1), hard (Segolane and 475), and waxy (XFG739) categories. Energy requirements were less to grind and steam flake Segolane than the other sorghums. Also, waxy sorghum required the less energy to steam flake than the other sorghums. In a 21-d growth assay with 600 (average initial BW of 90 g) broiler chicks, the sorghums were coarsely ground to 1,000 mm, finely ground to 450 mm, steam-flaked at $70°C$, and extruded at $110°C$. The processed grains were added to diets that were sorghum-soybean meal-based and formulated to 1.32% lysine. Grinding improved ADG (P < .01) and gain/feed (P < .04) compared to thermal processing, but thermal processing gave better retention of DM, N, and GE (P < .03). Also, retention of nutrients was greater with fine grinding vs coarse grinding (P < .05) and extrusion vs steam flaking (P < .08). No sorghum genotype effects were observed for growth performance, but chicks fed soft sorghum had greater (P < .01) nutrient retention than chicks fed the medium and hard endosperm sorghums. There were sorghum genotype x processing method interactions, with gain/feed for chicks fed the medium and hard genotypes responding more to fine grinding (vs coarse grinding) than did chicks fed the soft sorghum (P < .05). Also, GE retention of the waxy sorghum responded more to fine grinding (vs coarse grinding) and less to extrusion (vs steam flaking) than the other sorghums (P < .04). When ground to a single particle size (550 mm) and fed to finishing pigs (average initial BW of 64.5 kg), digestibility of DM (P < .01) and GE (P < .07) were less for waxy sorghums than the other genotypes. Also, the hard sorghums were more digestible (P < .06) than the medium hardness sorghums. In conclusion, retention of DM and GE were greater in finishing pigs fed hard vs soft sorghums but the opposite was true in broiler chicks. Furthermore, the interactions observed in the chick growth assay suggested that specific genotype x processing method combinations must be identified to yield sorghum-based diets of optimal nutritional value.

Key Words: Sorghum processing, Chick, Pig

302   The effects of dietary feather meal concentration on growth performance, feed intake, and carcass characteristics. K.-W. Ssu*, M. C. Brumm, P. S. Miller, and H.-Y. Chen, [1] *University of Nebraska, Lincoln, NE.*

Thirty-six individually penned crossbred barrows and gilts were used in a finishing experiment (initial wt = 58.6 kg) with 6 replications to determine the effects of dietary feather meal (FM) additions on ADG, ADFI, and carcass characteristics. The experiment was a 2 (10 and 20%, FM) × 2 (60 and 75 kg starting weight (SW) that FM feeding was initiated) factorial treatment design with control barrow (CB) and gilt (CG) groups fed no FM. Diets for CB were formulated to contain .59

and .49 true ileal digestible lysine and CG and FM diets were formulated to contain .68 and .57 true ileal digestible lysine from 60 to 86 and 86 to 110 kg, respectively. There was no difference in ADG (P > .1) among treatment groups. Barrows fed 20% FM from 75 kg had decreased ADFI similar to that of CG (2.75 vs 2.72 kg, P > .1). Barrows consumed less feed the first week after the 20% FM diets was initiated and gradually increased thereafter. However, barrows fed 20% FM diet consumed less feed than CB. Feed intake was affected (P > .1) in pigs fed 10% FM diets compared to CB. Control gilts had improved feed efficiency and lean gain compared to CB (3.01 vs 3.35 and 302 vs 234 g/d, P < .05). Barrows fed 20% FM from 75 kg tended to have reduced backfat depth vs CB (23.0 vs 27.2 mm, P < .1). Barrows fed 20% FM from 75 kg had carcass lean percentages similar to CG (48.6 vs 49.7 %, P > .1) and greater than CB (48.6 vs 45.7 %, P < .05). Feather meal increased plasma urea concentrations (PUC) of the FM groups compared to CB and CG one week after FM treatment was initiated (P < .05). For the last two weeks before slaughter, barrows fed 20% FM from 75 kg tended to have greater PUC than pigs fed 20% FM from 60 kg (69.0 vs 62.5, w7; 63.6 vs 56.1 mg/100mL, w7, P < .1). Feeding 20% FM to barrows from 75 kg decreased ADFI, backfat depth, and improved carcass lean percentage.

Key Words: Barrows, Feather meal, Feed intake

303   Varying Ratios of Insoluble:Soluble Fiber in Soybean Hulls Affect Nutrient Digestibilities by Ileal Cannulated Dogs. T. M. Burkhalter*, N. R. Merchen, A. R. Patil, L. L. Bauer, S. M. Murray, and G. C. Fahey, Jr., *University of Illinois, Urbana.*

An experiment was conducted to evaluate the effects of soybean hulls (SH) containing varying ratios of insoluble:soluble fiber on ileal and total tract nutrient digestibilities by dogs. Six ileal-cannulated dogs were fed seven diets in a 6 x 7 Youden square arrangement. The seven diets included five SH-containing diets with insoluble:soluble fiber ratios of 1.9, 2.7, 3.2, 5.2, or 7.2 and two control diets containing either beet pulp (BP) as a fiber source or 0% supplemental fiber. Diets contained poultry by-product meal (44.5% of DM), brewer's rice (36.1% of DM in the 0% fiber diet), and poultry fat (15.7% of DM) as the main ingredients. There was a substitution of 7.5% BP and SH for brewer's rice in the BP and SH-containing diets. Ileal digestibilities of DM, OM, CP, total dietary fiber, fat, and GE were lower (P < .05) for dogs fed diets containing supplemental fiber (avg. 65.1, 71.6, 65.2, -17.5, 93.1, and 76.5%, respectively) compared to dogs fed the 0% fiber diet (79.3, 84.2, 74.4, 16.7, 95.6, and 86.2%, respectively). Fiber inclusion had a modest negative effect (P < .05) on total tract DM, OM, fat, and GE digestibilities (avg. 72.3, 79.3, 92.6, and 81.7%, respectively) compared to the 0% fiber diet (78.5, 85.7, 94.1, and 86.1%, respectively). Dogs fed the diet containing BP had higher (P < .05) total tract digestibilities of OM, CP, and GE (82.1, 76.2, and 83.7%, respectively) compared with dogs fed diets containing SH (avg. 78.8, 72.3, and 81.3%, respectively). Ileal digestibilities of DM and OM by dogs fed the SH treatments responded quadratically (P < .05) to insoluble:soluble fiber ratio, with digestibility coefficients decreasing as the insoluble:soluble fiber ratio approached 3.2. Highest ileal digestibilities were observed for treatments with insoluble:soluble fiber ratios of 1.9 and 7.2. The ratio of insoluble:soluble fiber in SH affects DM and OM digestibilities at the ileum, indicating that optimization of this ratio is desirable.

Key Words: Dog, Soybean hulls, Fiber

304   Soybean hulls as an energy source for weanling horses. E. A. Ott* and J. Kivipelto, *University of Florida, Gainesville, FL.*

Soybean hulls have been used as a feed ingredient for horses for many years. However, they have generally been used as a fiber source. The NRC (1989) gives soybean hulls an energy value of 1.88 Mcal/kg DM, which is comparable to a medium quality grass hay. Recent evidence suggests that soybean hulls have a higher energy value than assigned. Two feeding trials were conducted to evaluate the energy value of soybean hulls by using them to replace oats in a concentrate for weanling horses. In *Exp. 1*, sixteen Thoroughbred and Quarter Horse foals were weaned at 112 d of age and started on the experiment at 145.2 days of age. The foals were assigned at random within breed and gender subgroups to either the oats or soybean hull based concentrate. The

soybean hulls replaced oats at 25% of the concentrate. The concentrates were fed individually to appetite for two, 1.5 hr feeding periods daily. C. bermudagrass (*Cynodon dactylon*) hay (12.8% CP) was group fed at 1.0 kg/100 kg BW daily. Weights and measurements of the foals were made at 14 d intervals for 112 d and the foals were radiographed for bone mineral content at the start and completion of the study. *Exp. 2* used thirteen weanlings starting at 143.8 d of age, and was identical to *Exp.1* except for the source of the hay. In *Exp.1*, no differences in feed or nutrient intake, weight gain or body measurement gains were detected (P > .05) except for body length gain which was greater for the foals on the oat based concentrate (P = .04). The foals gained .73 and .70 kg/d on the oat and soybean hull concentrates, respectively. In *Exp. 2*, the protein content of the hay (7.0% CP) was lower than the previous year, resulting in a protein intake below NRC (1989) recommendations. No differences in weight, withers height, or body length gains were detected (P > .05), but heart girth (P = .01) and hip height gain (P = .04) were both lower for the soybean hull fed foals. The foals gained .74 and .61 kg/d for the oat and soybean hull based concentrates, respectively. Bone mineral deposition was not different between groups (P > .05). Results suggest that soybean hulls have an energy value for horses that is more similar to oats than medium quality grass hay. At protein intakes below requirements, soybean hulls do not appear to be as valuable to the foal as oats.

Key Words: Soybean hulls, Horses, Weanlings

305   Ontogeny of L-threonine transport into porcine jejunal brush border membrane vesicles. Ming Z. Fan*[1], Layi Adeola[2], and Eli K. Asem[2], [1]*University of Guelph, Guelph, Ontario, Canada,* [2]*Purdue University, West Lafayette, Indiana.*

Luminal L-threonine is transcellularly transported across enterocyte brush border membrane (BBM) via Na-dependent B^o- and Na-independent L-system transporters. We examined the postnatal ontogenesis of BBM threonine uptake kinetics in developing pigs at the ages of 8, 28, 35 and 70 days. Initial threonine uptake rates in BBM vesicles were measured by fast filtration (22°C, L-[3-^{3}H]threonine plus non-labelled L-threonine, ranging from 0.03 to 2.0 mM). The initial uptake of threonine into BBM vesicles was kinetically partitioned into the components of Na-dependent, Na-independent and diffusional uptake. For Na-dependent component, the maximal uptake rate (Jmax, pmol/mg.s) and transporter affinity (Km, mM) were: Jmax/Km, 6.5±1.0/1.94±0.81 (8-day); 24.5±3.7/0.83±0.28 (28-day); 61.3±8.4/0.62±0.21 (35-day); 33.2±3.8/0.41±0.18 (70-day). For Na-independent component, the maximal uptake rate (Jmax, pmol/mg.s) and transporter affinity (km, mM) were: Jmax/Km, 4.8 ± 1.3/1.68 ± 0.80 (8-day); 14.0 ± 2.0/0.64 ± 0.22 (28-day); 12.9 ± 1.9/0.64 ± 0.23 (35-day); 18.8 ± 2.4/0.62 ± 0.26 (70-day). The apparent permeability coefficients (Kdiff, pmol.L/mg.mmol.s) were: 0.74 ± 0.15 (8-day); 2.54 ± 0.29 (28-day); 3.31 ± 0.29 (35-day); 7.55 ± 0.42 (70-day). In conclusion, kinetics of BBM threonine uptake displayed postnatal developmental changes in the pig.

Key Words: L-Threonine, Transport, Pigs

306   The use of steered ileo-cecal valve cannulated pigs in nutrition research. J. S. Radcliffe*, R. S. Pleasant, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Collection of ileal digesta to evaluate amino acid digestibilities has become increasingly desirable in swine nutrition research. Recently, Mroz et al. (J. Anim. Sci. 74:403-412) developed a method for placing a steered ileo-cecal valve (SICV) cannula into pigs which allows for total collection of ileal digesta and normal flow of digesta during non-collection periods. This technique was modified and used with 46 cross-bred barrows across four trials. Changes include: incising through the muscle layers in the laparotomy site instead of griding through them, use of a heparinized saline lavage, a stylette in place of a guide ring, and fixing the outer cannula barrel in place with a hose clamp. The current technique involves a right flank laparotomy, parallel and distal to the last rib, with the pigs under general anesthesia. The inner ring (2.0 mm thick, 35.0 mm i.d.) is introduced into the ileal lumen through an enterotomy proximal to the attachment of the ileo-cecal band. The string attached to the inner ring is threaded through the ileum and ileo-cecal valve into the cecum using a silastic stylette which encases the string. Next, the outer ring (2.0 mm thick, 34 mm o.d.) is fixed in

placed around the ileum, distal to the inner ring and just proximal to the ileo-cecal valve. The inner cannula barrel (barrel: 120 mm length, 25 mm i.d., 32 mm o.d.; flange: 70 mm o.d.) is introduced into the cecal lumen via an enterotomy through the taenia coli and secured in place with a series of purse string sutures. The inner cannula barrel is exteriorized through a stab wound distal to the intial laparotomy site where it is plugged using a cylindrical stopper (24 mm o.d., 60 mm length) and held in place by the outer cannula barrel (barrel: 43 mm length, 33 mm i.d., 41 mm o.d.; flange: 80 mm o.d.). These changes led to less post-surgical complications, and less adhesions seen upon necropsy at the end of each experiment. Based on the four trials, this technique has proven to be a reliable technique for collecting and evaluating ileal digesta.

Key Words: Pigs, Cannula, Ileum

307   The rat as a model for the assessment of ileal amino acid digestibility of fishmeal for pigs. L. Gutiérrez*, L. García, F. Vázquez, D. Mendoza, R. Ramos, and J. Vega, *Centro de Investigacion en Alimentacion y Desarrollo, A. C., Hermosillo, Sonora, México.*

The use of the laboratory rat as a model animal for the determination of apparent ileal amino acid (AA) digestibility in the growing pig, using the slaughter method, was evaluated. Twenty male Sprague-Dawley rats (190 g body weight) were allotted into two groups and housed individually in stainless steel wire-bottomed cages in a room maintained at 25°C with a 12 h light/dark cycle. Six male hybrid pigs (30 kg body weight) were also housed individually in open pens without bedding material at 25°C. Rats and pigs were fed diets containing fish meal as the sole protein source. Chromic oxide was included in the diets as an indigestible marker. Ileal contents from the terminal 20 cm of ileum were collected after slaughter of the rats and pigs. Ileal and diets samples were analyzed for chromium by atomic absorption and for AAs by liquid chromatography to calculate digestibility. Mean apparent ileal AA digestibility for rats and pigs were, respectively: ASP 0.67, 0.81; GLU 0.64, 0.82; SER 0.95, 0.77; HIS 0.73, 0.76; GLY 0.62, 0.64; THR 0.88, 0.84; ARG 0.92, 0.71; ALA 0.73, 0.77; TYR 0.92, 0.71; MET 0.81, 0.83; VAL 0.64, 0.82; ISO 0.63, 0.88; LEU 0.75, 0.87; LYS 0.88, 0.91. The data were subjected to a one-way analysis of variance and differences between means were examined using a t-student test. There were no differences for HIS, GLY, THR, ALA, MET and LYS, showing that interspecies comparisons made under defined conditions indicated close agreement between rats and pigs for apparent ileal digestibility for those AAs. It is concluded that the growing rat is a satisfactory model for determining ileal digestibility for some AAs in fish meal in the growing pig.

Key Words: Amino acid, Ileal digestibility, Pig

308   Fermentability of selected fibers by dog and cat fecal microflora. U. A. Jamikorn*[1], D. L. Harmon[1], D. J. Davenport[2], L. B. Deffenbaugh[2], and K. L. Gross[2], [1]*Dept. of Animal Sciences, University of Kentucky, Lexington, KY,* [2]*Hill's Pet Nutrition, Topeka, KS.*

Fermentability of selected fibers; beet pulp, cellulose, oat fiber I (OFI), oat fiber II (OFII), peanut hulls, pectin, isolated soy fiber (ISF), and soymill run (SMR) were evaluated using batch culture fermentations with inoculum prepared from dog or cat feces. Feces from three dogs or three cats were pooled within species and diluted 1:10 (wt:vol) in clostridial glycerin-salt solution for use as microbial inoculum. Fermentations were conducted in 50-mL test tubes containing 300 mg substrate, 29 mL buffered medium and 1 mL of the inoculum. After a 24-h incubation at 39°C, a 1 mL aliquot was removed for VFA analysis and 4 volumes of ethanol were added to precipitate soluble fibers to determine organic matter disappearance (OMD). Fiber fermentability, as determined from total VFA production by dog fecal microflora (FM), was; pectin > ISF > beet pulp > SMR > peanut hulls > others. Fiber fermentability, as determined from total VFA production by cat FM was; SMR = ISF > others. Propionate and butyrate production by dog FM were greatest (P < .05) for pectin (7.3, and 15.3 mmol, respectively). Acetate production by dog FM was greatest (P < .05) for ISF (16.7 mmol). Acetate, propionate, and butyrate production by cat FM were greatest (P < .05) for SMR (3.3, 0.5, and 0.9, mmol, respectively). When expressed as mmol/g OM fermented, in vitro fermentation of cellulose by dog FM resulted in the greatest (P < .05) acetate production (731.1)

and OFII yielded the greatest (P < .05) propionate and butyrate production (272.3 and 264.2, respectively). In vitro fermentation of SMR by cat FM yielded the greatest production of acetate, propionate, and butyrate (53.4, 8.4, and 14.1 mmol/g OM fermented, respectively). Because of the critical role of VFA in maintaining gut health, VFA production may be a better indicator of fermentability. Over estimations occur for OMD, probably the result of fibrous substrates containing large amounts of soluble carbohydrates.

Key Words: Digestion, Fermentation, Fiber

309   Dietary restrictions and growth performance and carcass traits of pigs selected for lean growth efficiency. L. I. Chiba*, D. L. Kuhlers, L. T. Frobish, S. B. Jungst, E. J. Huff-Lonergan, S. M. Lonergan, and B. L. Anderson, *Auburn University, AL.*

Thirty-two select-line (SL) and 32 control-line (CL) Duroc pigs weighing 20 kg were used to assess the effect of dietary amino acid (AA) restrictions during the grower (G) phase and AA content of finisher (F) diets on growth performance and carcass traits. Pens containing two gilts or castrated males were randomly assigned within the genotype to two G (.421 and .765 g lysine/MJ DE) and two F (.421 and .612 g lysine/MJ DE) corn-soybean meal diets in a 2 x 2 x 2 factorial arrangement of treatments. At 50 kg, blood samples were collected for blood urea nitrogen (BUN) analysis, and ultrasound backfat (UBF) was measured before diet change. At 112 kg, blood samples were collected again before slaughter. Pigs were allowed ad libitum access to feed and water. Genotype had no effect on growth rate during the G or F phase, but to optimize overall growth, the SL pigs should be offered the high-AA G diet (genotype x G diet, P < .05). The SL pigs had better carcass traits (P < .05) and utilized AA more efficiently for lean accretion than the CL pigs, indicated by lower BUN (P = .07). Pigs fed the high-AA G diet grew faster and more efficiently during the G phase and had lower UBF than those fed the low-AA diet (P < .01). Pigs fed the low-AA G and F diet sequence and high-AA G and F diet sequence grew faster and more efficiently during the F and G-F phase than those fed other diet combinations (G x F, P < .01), but they had inferior carcass traits (G x F, P = .07), indicating that improved growth performance was a result of an increased rate of fat rather than lean accretion rate. There was no evidence of compensatory weight gain during the F phase for pigs subjected to AA restrictions during the G phase, but they had a similar lean accretion rate compared to those fed adequately. Therefore, it is possible that the compensatory response of lean tissue growth may have occurred at the expense of fat tissue growth.

Key Words: Pigs, Genotype, Amino acid restrictions

310   Effects of inclusion levels of vitamin and mineral premixes on growth performance, pork stability, and nutrient digestibility in finishing pigs. B. J. Chae[1], S. C. Choi*[1], W. T. Cho[2], and I. K. Han[2], [1]*Kangwon National University, Chunchon, Korea,* [2]*Seoul National University, Suweon, Korea.*

A total of 120 finishing pigs (LxYxD, average initial body weight of 50 kg) were employed for a 7-week feeding trial to determine the effect of inclusion levels of vitamin and mineral premixes on growth performance, pork stability, and nutrient digestibility in finishing pigs. Vitamin and mineral premixes were separately made by the NRC (1998) requirements at the inclusion level of .1%, respectively, in the diet. Treatments were 100% (Control), 150%, 200%, and 250% of NRC (1998) requirements. The average daily gain and feed conversion were higher (P < .05) in pigs fed the diet containing vitamin and mineral premixes at the inclusion level of 200% than others except the 250% group, but feed intake was reduced (P < .05) when pigs fed the diet vitamin and mineral premixes at the inclusion level of 250% as compared to other groups. There was a trend toward improving pork stability as the inclusion levels of vitamin and mineral premixes were increased during storage. Thiobarbituric acid reactive substance (TBARS) and peroxide values (POV) were lower (P < .05) in the pork (*M. trapezius cevicalis*) from pigs receiving vitamin and mineral premixes at the inclusion levels of 200 and 250% than control when sealed and stored (1°C) for a 2-week period. The digestibility of calcium was improved (P < .05) in diets containing vitamin and mineral premixes 200 and 250% as compared to vitamin and mineral premixes 100 and 150% groups. In conclusion, it would appear that inclusion of vitamin and mineral premixes at the level of 200% of NRC (1998) requirements gave positive effects on growth performance and pork stability in finishing pigs.

Key Words: Vitamin and Mineral Premix, Growth, Pork Stability

311   Broiler meat containing fishy aromatics after sea clam viscera was withdrawn from the diet. J. E. Wohlt*, C. A. Graybush, and P. K. Zajac, *Rutgers-The State University of New Jersey, New Brunswick, NJ.*

In previous studies, broiler growth was not decreased when dried sea clam viscera (SCV) replaced soybean meal (SBM), but feeding certain dietary levels of SCV resulted in fishy aromatics being detected in breast (5.0% SCV) and thigh (2.5% and 5.0% SCV) meat. Withdrawing SCV from the diet 3 wk prior to marketing birds may eliminate fishy aromatics in meat. Thus 72 day old male broiler chicks were assigned randomly to 4 dietary treatments (6 birds/cage, 3 cages/treatment): 1) commercial diet, 2) research diet (RD)+SBM, 3) RD+2.5% SCV, 4) RD+2.5% SCV withdrawn after 3 wk. Diets contained 21% CP wk 1 to 3 and 19% CP wk 4 to 6. SCV replaced SBM in the RD. Twelve birds (1 bird/cage, 3 birds/treatment) were sacrificed and breast and thigh meats evaluated for 4 aromatic flavor spectra: chicken complex (boiled chicken), sweet white (white meat), gamey dark (dark and gamey meats), and liver/bile/fishy (fish or mollusk meats and/or organs) using a 15 point intensity scale (0=none to 15=very strong). Treatment had no effect on average daily gain or feed to gain: 42.8, 38.4, 42.5, 40.2, g/d; 1.87, 1.92, 1.85, 1.92 for birds fed diets 1 to 4. Aromatics for sweet white meat were higher (P< .05) in breast than thigh meat (5.6 vs. 3.4), but not affected by diet. Aromatics for gamey dark were higher (P<.05) in thigh then breast meat (3.9 vs. 1.4), again diet having no effect. Thigh meat from birds fed 2.5%SCV or having SCV withdrawn from the diet had high (P<.05) liver/bile/fishy aromatics than thigh meat of birds fed the commercial or RD containing SBM (1.1 and 1.5 vs. 0.3 and 0.4). Even though SCV was withdrawn for 3 wk, wk 4 to 6 representing one-half the growth period, this period was insufficient to prevent detectable fishy aromatics in thigh meat. Rapid growth of broilers in combination with minimal turnover of protein and water in thigh meat may result in the retention of fishy aromatics. Lower dietary levels of SCV must be tested in future studies.

Key Words: Clam viscera, Broiler, Meat aromatics

312   Effects of feeding cane molasses at two levels of crude protein in finishing diets on growth performance, carcass traits and pork quality. L. R. Loeza*, D. H. Beermann, K. R. Roneker, X. G. Lei, and R. W. Blake, *Cornell University, Ithaca, NY.*

Corn-soybean diets were formulated to contain a constant lysine:crude protein ratio and an ideal protein amino acid pattern at 12% or 14% crude protein (CP). Lysine content averaged 6.5% of CP. Fifty cross-bred barrows and gilts (Large White x Landrace x Duroc or Hampshire) weighing 37 ± 1.1 kg were randomly assigned to one of four treatment groups or an initial comparative slaughter group. Equal numbers of barrows and gilts were fed ad libitum diets containing 0 or 20% cane molasses (CM) and 12 or 14% crude protein (2 x 2 factorial arrangement) until they reached 95 kg live weight. Feeding molasses increased intake from 2.33 to 2.86 kg/d when diets contained 12% CP but had no effect when diets contained 14% CP (P<.016 for interaction). Similarly, ADG was increased from .72 to .82 kg/d (P<.01) when diets contained 12% CP, but had no effect when diets contained 14% CP (.83 vs .87 kg/d). Feeding CM had no effect on carcass weight, dressing percentage, degree of muscling, backfat thickness, or individual muscle weights of the ham and loin. Hot carcass weights, degree of muscling and ham weights were less (P<.047) with 12% vs 14% CP. Loin eye area and backfat thickness were not affected by the CP level or CM. Total muscle accretion rates in the ham and loin were 16% greater (P<.01) when 14% CP was fed, but neither level of CP nor addition of CM altered adipose tissue accretion rates in the ham or loin. Longissimus color ratings were lower (lighter) with the 12% CP level, but marbling and firmness were not altered. Results demonstrate that feeding up to 20% molasses in finishing diets formulated to achieve an ideal protein amino acid composition of the diet has no detrimental effect on pork carcass composition or quality.

Key Words: Cane Molasses, Growth, Pork Quality

313   Utilization of blood-derived products in pig nutrition. P. Medel*[1], D. Torrallardona[2], L. Llaurado[2], and G. G. Mateos[1], [1]*Universidad Politécnica de Madrid, Spain,* [2]*IRTA-Mas Bova, Tarragona, Spain.*

Two trials were conducted to study the effect of inclusion, and the ileal amino acid digestibility of two blood-derived meal sources in pig diets. In trial one (T1), one hundred twenty male piglets weaned at 20 d of age and weighing an average 5.7 kg were blocked by litter and body weight and used in a 28 d performance trial. From 0 to 14 d the piglets were divided in 3 groups (eight replicates of five piglets each). The only difference among treatments in this phase was the source of blood-derived meal used: 5% of spray dried animal plasma (SDP), 5% of a high quality spray-dried blood meal (HQBM, Blosol A92, DAKA a.m.b.a.), or a 50% mixture of both. From 14 to 28 d of trial each of the 3 pre-starter treatments were divided into two groups that received a diet with 5% of fish meal dried at low temperature (FMLT, 999, Esbjerg Fiskeindustri), or 5% of a regular blood meal (BM, DAKA a.m.b.a.), respectively. In trial two (T2), six males (46.3 kg) were surgically modified with an end to end ileo-rectal anastomosis and ileal digestibility of amino acids was measured for the HQBM and BM samples. The experimental products were mixed with a basal protein-free diet to obtain feeds with 18.7 and 19.5% crude protein for the HQBM and BM diets, respectively. Each diet was tested in all the animals using a 2 d quantitative collection period preceeded by a 5 d adaptation period. In T1, no differences among treatments were detected from 0 to 14 d for any of the traits studied. From 14 to 28 d, diets containing BM allowed the same growth rate (495 vs 485 g/d, P > .10), but poorer feed conversion (1.29 vs 1.35, P = .10) than FMLT diets. The ileal digestibilities of all the amino acids except for isoleucine were greater for HQBM than for BM (P < .05). The digestibility coefficients for lysine, threonine, methionine, cystine, and tryptophan were 99.4, 99.2, 99.3, 98.7, 95.7 for HQBM, and 98.3, 97.8, 98.5, 96.0, 91.9 for BM, respectively. It is concluded that both HQBM and BM can be used succesfully in pig feeds, although feed conversion tended to be impaired when BM was used in substitution of FMLT.

Key Words: Blood meal, Pigs

314   Perfect Pro® **as a source of protein for weanling pigs.** A. C. Guzik*, L. L. Southern, and T. D. Bidner, .

Three experiments were conducted to evaluate the use of Perfect Pro® (PP) as a source of protein. In each experiment, treatments were replicated with four (Exp. 1 and 2) or seven (Exp. 3) pens of three to five pigs each. Each experiment lasted from three to four weeks for the combined Phase I (1.5% Lys in Exp. 1 and 2, 1.6% Lys in Exp. 3) and Phase II (1.3% Lys) periods. In Exp. 1 (6.7 kg and 23 d of age) and 2 (6.1 kg and 22 d of age), pigs were fed one of three Phase I diets: 1) basal (B) diet containing corn, SBM, whey, fish meal, and blood cells (AP-301 G), 2) B + 4% spray dried porcine plasma (SDPP), or 3) B + 2% SDPP+2% PP. In Phase II, the dietary groups from Phase I were divided into two subsequent groups. One group received a diet containing corn, SBM, whey, fish meal, and 2% blood cells, and the second group received this same diet with 2% PP, resulting in six treatments for the Phase II and overall periods. In Exp. 1, ADG and ADFI were increased (P<.10) during Phase I in pigs fed 4% SDPP or 2% SDPP+2% PP. Gain:feed (GF) was not affected (P>.10) during Phase I. In Phase II, the 2% PP addition did not affect ADG, ADFI, or GF. Also, Phase I diets did not affect (P>.10) growth performance during Phase II. Overall, ADG (P<.10) and ADFI (P<.04) were increased in pigs fed 2% SDPP+2% PP during Phase I. In Exp. 2, ADG and GF were increased in pigs fed 2% SDPP+2% PP during Phase I. During Phase II, ADFI was increased in pigs fed 2% SDPP+2% PP relative to those fed the basal diet (P<.005) or the diet containing 4% SDPP (P<.01) in Phase I. Also in Phase II, GF was increased in pigs fed 2% SDPP+2% PP (P<.03) relative to those fed 4% SDPP. Overall, ADG and GF were not affected (P>.10) by diet, but ADFI was increased in pigs fed 2% SDPP+2% PP (P<.03) relative to the basal diet. In Exp. 3, all pigs (5.7 kg and 17 d of age) were fed a Phase I diet containing 2% SDPP+2% PP. In Phase II, ADG, ADFI, and GF were not affected (P>.10) by the addition of 2% PP relative to 2% blood cells. Overall, pigs fed 2% SDPP+2% PP have equal performance to those fed 4% SDPP.

Key Words: Pigs, Protein Sources, Growth

315   Effects of water soluble globulin on the performance of weanling pigs. B. S. Borg*, J. M. Campbell, L. E. Russell, D. U. Thomson, and E. M. Weaver, *American Protein Corporation, Ames, IA.*

Three-hundred weanling pigs (5.0 kg initial weight, 14-21 d of age) were used in a 28 d experiment to evaluate the effects of a water soluble globulin protein (WSGP). Pigs were blocked by sex and initial weight and randomly allotted to two experimental treatments with 25 pigs/pen and 6 replications/treatment. Experimental treatments included a typical pelleted 3-phase nursery program with and without WSGP. Total lysine content of diets offered was 1.65, 1.30 and 1.20% for phases one, two and three, respectively. Spray-dried animal plasma was included at a level of 4% in the phase one diet. Pigs were fed the various diets for 7, 14 and 7 days for phase one, two and three, respectively. WSGP was supplied through the water source for 14 d using a commercially available proportional dispenser. Compared to d 0-7, the concentration delivered was reduced by 50% during d 7-14. During the initial 7 d, pigs receiving WSGP had improved (P<.001) average daily gain (ADG), average daily feed intake (ADFI) and gain/feed (G/F) compared to the controls. Relative improvements in each measure were 65, 33 and 27% for ADG (0.130 vs 0.215 kg), ADFI (0.137 vs 0.182 kg) and G/F (0.94 vs 1.19). From d 7-14, ADG (0.227 vs 0.318 kg), ADFI (0.304 vs 0.373) and G/F (0.74 vs 0.86) was improved (P<.02) for pigs receiving WSGP compared to controls. Overall (d 0-28) WSGP improved performance (P<.01), ADG, ADFI and G/F was 0.300 kg, 0.398 kg, 0.76; and 0.350 kg, 0.438 kg, 0.80 for control and WSGP pigs, respectively. These results suggest the WSGP improves performance from d 0-14 and the enhancement in performance is maintained through 28 d postweaning.

Key Words: Globulin protein, weanling pigs, liquid-feeding

316   Use of spray dried plasma in combination with different types of milk proteins in diets for piglets. P. Medel[1], F. Baucells[2], J. C. de Blas[1], and G. G. Mateos*[1], [1]*Universidad Politecnica de Madrid, Spain,* [2]*Pinsos Baucells, Barcelona, Spain.*

A trial was conducted to evaluate the influence of milk protein source (casein vs serum proteins) and spray dried animal plasma (SDP) supplementation (0% inclusion vs 4% of either APC-920 or Proglobulin) on performance of piglets weaned at 21-d. A total of 180 male piglets (21-d and 5.4 kg of average body weight) were used in a 2 x 3 factorial experiment with 6 replicates of five piglets per treatment. The experimental diets were formulated to be isonutritive (2500 kcal/kg NE, 21.6% crude protein, 1.54% total lysine, and 10.3% lactose) and were offered ad libitum for 20-d. Afterwards, all the replicates were fed a common starter diet containing 2435 kcal/kg NE, 21% crude protein and 1.28% total lysine. Spray dried animal plasma supplementation improved growth at 10 (187 vs 154 g/d; P = .01) and at 20-d of trial (346 vs 312 g/d; P < .01). The effect was mostly due to an increase in feed consumption (191 vs 162 g/d, P = .02, and 379 vs 346 g/d, P = .09, from 0 to 10, and from 0 to 20-d, respectively). Feed conversion was not modified by SDP addition. Diets that included casein as the main milk protein source showed better feed conversion than diets based on serum protein at 10 (1.01 vs 1.11 g/g; P = .10) and at 20-d (1.08 vs 1.13 g/g; P = .14) of trial. A significant interaction between milk protein source and SDP suplementation was observed for average daily gain, but not for feed conversion; the addition of SDP improved growth more in piglets fed milk serum proteins than in piglets fed casein (P = .03). No differences were detected between SDP sources for any of the parameters studied. It is concluded that SDP addition improves growth of piglets mostly due to an increase of feed consumption and that casein diets tended to decrease feed conversion with respect to serum milk protein diets during the first 20-d after weaning. The addition of SDP resulted in better performance when serum vs casein protein was used.

Key Words: Milk protein, Spray dried plasma, Piglets

317   Effects of increasing pellet conditioning temperature of diets containing spray-dried animal plasma on weanling pig performance. M. U. Steidinger*[1], R. D. Goodband[1], M. D. Tokach[1], J. L Nelssen[1], L. J. McKinney[1], J. C. Woodworth[1], B. S. Borg[2], and J. M. Campbell[2], [1]*Kansas State University,* [2]*American Protein Corp. Ames, IA.*

Two hundred fifty-two weanling pigs (6.0 ± 1.3 kg and 21 ± 3 d of age; PIC) were used in a 14 d growth assay to determine the effects of

increasing pellet conditioning temperature on pig growth performance. Experimental treatments consisted of a corn-soybean meal control diet (1.4% lysine and 15% dried whey) with no spray-dried animal plasma (SDAP) and fed in a meal form, or the control diet with 5% SDAP replacing soybean meal on a equal lysine basis also fed in a meal form. Additional treatments were the 5% SDAP diet pelleted (3.97 mm diameter) at conditioning temperatures of 60, 66, 71, or 77°C. Corresponding pellet exit temperatures were 68, 74, 77, and 80°C. The pelleted diets were conditioned with a ten second retention time and then pelleted using a Master Model HD 1000 series California Pellet Mill equipped with a 31.8 mm effective thickness die. Pigs were blocked by initial weight and allotted randomly to each of six dietary treatments with six pigs/pen and seven replications/treatment. From d 0 to 14 after weaning, pigs fed diets containing SDAP had greater (P<.001) ADG, G/F, and (P<.08) ADFI than pigs fed the control diet. No differences in performance were observed among pigs fed the meal diet containing SDAP and the mean of pigs fed the pelleted diets. Increasing pellet conditioning temperature up to 77°C did not adversely affect performance. These results suggest that conditioning temperatures up to 77°C do not adversely affect growth performance of pigs fed diets containing 5% SDAP from d 0 to 14 after weaning.

Key Words: Weanling Pigs, Spray-dried Animal Plasma, Pellet Conditioning Temperature

318   Effects of weaning diet on pig performance and intestinal morphology. K. J. Touchette*[1], R. L. Matteri[2], C. J. Dyer[2], J. A. Carroll[2], and G. L. Allee[1], [1]*University of Missouri-Columbia,* [2]*Animal Physiology Research Unit, ARS, USDA.*

We evaluated the effect of feeding liquid versus dry diets after weaning on pig performance and intestinal morphology. At 14 d of age, 32 pigs (4.67±.06 kg) were assigned to 1 of 4 treatments in a RCBD: 1) cross-fostered to another sow (SOW); 2) weaned to a dry diet with 7% spray-dried plasma (SDP); 3) weaned to a dry diet with no SDP; 4) weaned to a liquid milk replacer (MR) diet. The 0 and 7% SDP diets contained 30% lactose and exceeded NRC (1998) recommendations for other nutrients. All pigs were killed after 4 d, and intestinal samples collected at 3 equidistant sites from the proximal jejunum to the distal ileum to measure villus heights, crypt depths and villus:crypt ratio (VCR). The stomach, heart, kidney, and liver were weighed. The final weight of pigs fed milk replacer were similar to the pigs cross-fostered to another sow (6.03 vs 5.83 kg). There was no difference between the pigs fed either 0 or 7% SDP (4.61 vs 4.59 kg), with both groups weighing less than either group on a liquid diet (P ≤ .001). The villi for pigs fed either liquid diet were taller (P ≤ .001) than pigs fed either dry diet. The crypt depth of the most distal section for the pigs that remained on the sow was reduced compared to all other crypt depth measurements (P ≤ .001). The pigs fed either dry diet had a lower VCR than the pigs on a liquid diet (P ≤ .001), and the most distal section for the pigs that remained on the sow had a higher VCR than all other VCR measurements (P ≤ .01). Organ weights are shown below. This study shows that pigs weaned to a liquid milk replacer perform similar to pigs kept on a sow, while pigs weaned to a dry diet have reduced performance. There were also differences in intestinal morphology which may be related to pig performance.

Organ	SOW	0% SDP	7% SDP	MR	SEM
Heart[1]	9.87[a]	9.40[ab]	8.82[b]	10.06[a]	.035
Kidney[1]	10.85[a]	9.68[a]	9.90[a]	13.47[b]	.655
Stomach[1]	8.15[ab]	8.64[a]	7.98[ab]	7.77[b]	.238
Liver[1]	44.98[a]	41.94[a]	42.48[a]	57.29[b]	1.48

[1]g/kg$^{.75}$BW, [a,b]P < .05

Key Words: Weaned pigs, Liquid diet, Intestinal morphology

319   Effect of source and level of dietary lysine on growth performance of 11 to 22 kg pigs. E. L. Hansen*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, J. C. Woodworth, P. R. O'Quinn, M. De La Llata, and M. U. Steidinger, *Kansas State University.*

Three hundred-twenty PIC (C22 X 355 barrow and gilt) nursery pigs (10.89 kg) were used to compare the effects of increasing dietary lysine from L-Lysine HCl (L-LYS) or Peptide Plus^{TM} (PP). Peptide Plus is a hydrolyzed bovine muscle protein source. L-LYS was added at .1595,

.3185 and .4775% or PP at 2.39, 4.78, and 7.16% to a basal corn-soybean meal diet (0.90% lysine; negative control, NEG) to achieve diets with 1.025, 1.15 and 1.275% total LYS, respectively. A positive control (POS) diet was formulated to 1.275% LYS with corn and soybean meal. Ideal ratios of other amino acids were maintained in all diets with synthetic amino acid additions. All diets were formulated to maintain similar dietary Ca, P, Na, Cl and ME. There were eight replications of the eight treatments with five pigs/pen. Data were analyzed as a randomized complete block design with seven single df contrast comparisons; POS vs NEG, POS vs other 1.275% LYS, L-LYS linear, L-LYS quadratic, PP linear, PP quadratic and L-LYS vs PP. For the 19-d study period, ADG increased linearly (P < .001) with increasing dietary LYS. Feed intake tended to decrease linearly (P = .12) and G/F increased (P < .01) with increasing PP. Increasing dietary LYS with L-LYS resulted in linear (P < .001) and quadratic (P = .011) improvements in G/F. Pigs fed diets containing L-LYS vs PP had increased ADG (P < .05) and G/F (P<.001). Pigs fed the POS diet had decreased (P < .05) ADFI and increased (P < .001) G/F compared to pigs fed the other 1.275% LYS diets. These data suggest that PP is less bio-available than L-LYS and that high levels of synthetic amino acids or PP do not promote the same degree of feed utilization as soybean meal.

	NEG	L-LYSINE HCl			PEPTIDE PLUS			POS	
Lyisne,%	.90	1.025	1.15	1.275	1.025	1.15	1.275	1.275	SEM
ADG,g/d	538	563	599	613	566	558	592	611	10.08
G/F	.557	.590	.652	.644	.591	.597	.631	.683	.008

Key Words: Lysine, Peptide Plus, Pigs

320   Effects of free fatty acids in choice white grease on growth performance of nursery pigs. J. M. DeRouchey*, J. D. Hancock, C. A. Maloney, H. Cao, D. J. Lee, J. S. Park, D. W. Dean, and R. H. Hines, *Kansas State Unversity, Manhattan, KS.*

A total of 120 crossbred barrows and gilts (average initial BW of 6.2 kg) were used to determine the effects of free fatty acids (FFA) in choice white grease (CWG) on growth performances of nursery pigs. The pigs were blocked by weight and allotted to pens based on sex and ancestry for the 33-d growth assay. The pigs (five per pen) were housed in an environmentally controlled room and fed diets formulated to 1.7% lysine for d 0 to 5, 1.55% lysine for d 5 to 19, and 1.40% lysine for d 19 to 33. Treatments were a corn-soybean meal-based control with no added fat, 6% CWG, and 6% CWG that had been heated at 35 °C and treated with 1872, 1,1752 and 2,248 lipase units/g of fat. The FFA concentrations in the CWG were increased from 1.8% to 18.3, 35.4 and 53.3% with increasing lipase concentrations. As for pig growth, those fed the control diet (no added fat) had the same ADG (P < .30) but lower gain/feed (P < .04) than pigs fed diets with added fat. There were no effects of FFA concentration on ADG or gain/feed (P < .36) and ADFI increased as FFA concentration was increased (linear effect, P < .04). In conclusion, our data suggest that concentrations of FFAs up to 53.3% in CWG do not adversely affect growth performance of nursery pigs.

		Free Fatty Acids, %				
Item	Control	1.8	18.3	35.4	53.3	SE
ADG, g	473	489	487	475	494	11
ADFI, g	737	687	712	718	716	9
G/F, g/kg	642	712	684	662	690	18

Key Words: Pigs, Free fatty acids, Fat quality

321   Influence of different vegetable oils on the exocrine pancreatic secretion in piglets. S. Jakob*[1], R. Zabielski[2], S. G. Pierzynowski[3,5], M. Sorhede Winzell[4], C. Rippe[4], L. Evilevitch[3], M. Kuria[3], and R. Mosenthin[1], [1]*Inst. Anim. Nutr., Hohenheim Univ., Germany,* [2]*Dept. Anim. Physiol., Warsaw Agricultural Univ., Poland,* [3]*Dept. Anim. Physiol., Lund Univ., Sweden,* [4]*Dept. Cell and Molecular Biol., Lund University, Sweden,* [5]*R&D Gramineer Int. AB, Lund, Sweden.*

The influence of intraduodenal (id) application of vegetable oils on the spontaneous reaction of the exocrine pancreas of piglets has not yet been studied. Six growing pigs (BW 13.3 kg) were prepared with a pancreatic duct catheter and a duodenal re-entrant T-cannula. The animals were fed twice daily (10.00 and 16.00 h), a commercial weaner diet at a level of 2% of BW. Beginning with the morning feeding, olive oil, coconut oil

or saline as a control were loaded id via the duodenal cannula over a period of 1 h according to a 3 x 2 Latin square design. The amount of each oil loaded corresponded to 0.1% of BW. Pancreatic juice was collected over a period of 4 h, beginning 1 h preprandially (09.00) till 3 h postprandially (13.00). The volume of secretion was determined in 30 min intervals, an aliquot for analyses was obtained and the remainder was re-infused into the duodenum. In addition to volume of secretion, total lipase activities were estimated. Data were analyzed using repeated measures ANOVA. No time effect (P $\geq$ 0.2) with respect to the volume of secretion was observed for the saline and the coconut oil treatment, whereas a time effect (P $\leq$ 0.03) was recorded for the olive oil treatment. The volume of pancreatic juice secreted for the olive oil decreased (P $\leq$ 0.04) over the time compared to the coconut oil treatment. Lipase activities were affected over the time by id loading of olive oil (P $\leq$ 0.01), coconut oil (P $\leq$ 0.01) and saline (P $\leq$ 0.02), respectively. No differences (P $\geq$ 0.2) between the slopes of the curves for the saline and coconut oil treatments were obtained, but an increase for the olive oil compared to saline (P $\leq$ 0.05) and coconut oil (P $\leq$ 0.04) treatments was determined. It is suggested that under prandial conditions, the exocrine pancreas responds differently in its spontaneous secretion to different vegetable oils.

Key Words: Pancreatic secretion, Fat, Pig

322   Effects of rancidity in choice white grease on growth performance in nursery pigs. J. M. DeRouchey*, J. D. Hancock, C. A. Maloney, J. S. Park, D. J. Lee, H. Cao, D. W. Dean, and R. H. Hines, *Kansas State University, Manhattan, KS*.

A total of 150 crossbred barrows, boars, and gilts (average initial BW of 6.8 kg) were used to determine the effects of rancidity in choice white grease (CWG) on growth performance in nursery pigs. The pigs were blocked by weight and allotted to pens based on sex and ancestry for the 35-d growth assay. The pigs (five per pen) were housed in an environmentally controlled room and fed diets formulated to 1.7% lysine for d 0 to 7, 1.55% lysine for d 7 to 21, and 1.40% lysine for d 21 to 35. Treatments were a corn-soybean meal-based control with no added fat, 6% CWG, and 6% CWG heated at 80°C with O_2 gas bubbled through it for 5, 7, 9, and 11 d. Peroxide values for the CWG increased with 0, 5, and 7 d oxidation (i.e. peroxide values of .8, 40, and 105 mEq/kg, respectively), but decreased to 1 mEq/kg as the peroxides decomposed with 9 and 11 d of oxidation. As for growth performance of the pigs, ADG was not affected (P $>$ .91) but gain/feed was less for pigs fed the control diet with no added fat (P $<$ .04). Average daily gain (linear effect, P $<$ .01) and ADFI (linear effect, P $<$ .001) decreased as fat became more rancid, but gain/feed was not affected (P $>$ .16). In conclusion, our data suggest that as fat is oxidized (especially to peroxide values greater than 40 mEq/kg), ADG and ADFI in nursery pigs will decrease.

		Days of oxidation					
Item	Control	0	5	7	9	11	SE
ADG, g	506	525	526	501	508	478	12
ADFI, g	747	749	735	690	682	680	15
G/F, g/kg	677	701	716	726	745	703	16

Key Words: Pigs, Rancidity, Fat quality

323   Barley processing in poultry and piglet diets: A comparative study. M. García*[1], P. Medel[1], R. Lázaro[1], C. Pineiro[2], and G. G. Mateos[1], [1]*Universidad Politecnica de Madrid, Spain,* [2]*Proinserga S.A., Spain*.

Two trials were conducted to evaluate and compare the influence of hydrothermal processing (HP) of barley on performance and fecal digestibility of broilers and piglets when included at 50% of the diet. Trial 1 (T1) was conducted with broilers from 1 to 28-d of age and Trial 2 (T2) with weaned piglets from 21 to 49-d of age. In both trials the experimental design was completely randomized with three barley treatments: raw (R), micronized (M) or expanded (E). Each treament was replicated six times and the experimental unit was a cage with 15 male chicks or 5 male piglets, respectively. In T1, HP of barley improved feed intake (33.7 vs 31.9 g/d; P = .11) and average daily gain (24.2 vs 22.1 g; P $<$ .05) but did not influence feed conversion at 14-d. From 14 to 28-d, growth of broilers was impaired by HP of barley (60.9 vs 63.7 g/d; P = .06) and as a result weight gain from 0 to 28 d was not modified (42.7 vs 43.1 g; P = .69). At 28-d, HP of barley increased the apparent fecal

digestibility of energy (75.3 vs 74%; P = .09) and of organic matter (74.3 vs 73.2; P = .12). In T2, HP of barley improved daily gain (232 vs 209 g/d; P = .07) and tended to increase feed intake (228 vs 210 g/d; P = .21) but did not modify feed conversion during the first 14-d. Heat processing did not influence performance of piglets from 14 to 28-d (average daily gain of 492 vs 470 g/d; P = .42, for treated and raw barley, respectively) or fecal digestibility of energy at 28-d (79.3 vs 76.6 %; P = .22) but tended to increase the fecal digestibility of organic matter (81.7 vs 78.9%; P = .14). No differences were found in T1 or T2 between M and E barley diets for any of the parameters studied. It is concluded that HP of barley improved performance in both chickens and piglets in the first stages of life (0 to 14-d after hatch or weaning, respectively) and tended to increase nutrient digestibility at 28-d. However, HP did not influence performance of piglets beyond 14 d of weaning and, in fact, reduced that of broilers from 14 to 28-d of age.

Key Words: Barley processing, Piglets, Broilers

324   Effects of Hemicell® addition to nursery diets on growth performance of weanling pigs. L. A. Pettey*, S. D. Carter, B. W. Senne, and J. A. Shriver, *Oklahoma State University, Stillwater*.

Two experiments were conducted to evaluate the effects of Hemicell® (B-mannanase; Chem-Gen Corp., Gaithersburg, MD) addition to nursery diets on growth performance of weanling pigs. In Exp. 1, 156 pigs (20 d, 6.27 kg BW) were allotted by BW, sex, and litter to 4 dietary treatments (6 reps/trt, 6-7 pigs/pen). Treatments were a factorial arrangement of diet complexity (complex vs simple) and Hemicell® addition (0 vs .05%). Complex diets used in Phase (P) 1 (1.50% Lys) and 2 (1.30% Lys) were fortified corn-soybean meal-dried whey based with plasma while simple diets were corn-soybean meal based. During P3, pigs were fed simple corn-soybean meal diets (1.10% Lys). Pigs were fed in 3 dietary phases (P1, d 0-14; P2, d 14-28; and P3, d 28-42). Pigs fed complex diets gained faster and were more efficient (P$<$.05) during P1 than pigs fed simple diets. Hemicell® had no effect on growth performance during P1. However, for P2 and P3 combined, Hemicell® increased (P$<$.01) G:F. For the 42-d period, G:F was improved (P$<$.10) for pigs fed complex diets (.632 vs .615) and for those fed Hemicell® (.636 vs .611). There were no diet complexity x Hemicell® interactions. In Exp. 2, 117 pigs (44 d, 13.62 kg BW) were allotted by BW, sex, and litter to 3 dietary treatments (10 reps/trt of 3-4 pigs/pen) in P3 (21 d) of the nursery period. Diets (1.20% Lys) were: (1) simple corn-soybean meal-based control, (2) as 1 + soybean oil to increase ME by 100 kcal/kg, and (3) as 1 + Hemicell® (.05%). Calculated ME of the 3 diets were: 3,296, 3,396, and 3,296 kcal/kg. Pigs were fed a common diet in P1 & P2 prior to the experiment. Over the entire 21-d period, ADG and G:F for the 3 diets were: 543, 553, and 559 g; and .568, .587, and .594, respectively. Pigs fed diets with added soybean oil or Hemicell® had greater G:F (P$<$.01) than pigs fed the control diet; however, ADG and G:F were similar for pigs fed soybean oil or Hemicell®. These results suggest that Hemicell® improves growth performance of weanling pigs during the latter phase of the nursery period.

Key Words: Enzyme, Weanling pigs, Growth performance

325   Supplemental NaCl or KCl added to weanling pig diets containing naturally high Na and Cl contents. D. C. Mahan*, S. D. Carter, G. M. Hill, and J. L. Nelssen, *NCR-42 Committee on Swine Nutrition*.

Previous results had demonstrated a growth and feed efficiency response when supplemental chloride (Cl) was added to diets containing dried whey or spray dried plasma protein. These feed ingredients contain naturally high levels of Na and Cl. The reported studies had not used these ingredients in combination, suggesting that a composite use of several components with naturally high contents of these nutrients may give different results. A regional study involving 4 stations (KS, MI, OH, OK) evaluated the effects of adding Cl from NaCl or KCl to diets containing feed ingredients naturally high in Na or Cl. The basal diet during Phase 1 (0 to 14 d postweaning) used a mixture of corn-soybean meal-fishmeal but with added spray dried plasma protein (7.0%) and dried whey (25%), and was formulated to a 1.50% lysine level. During Phase 2 the basal diet was formulated using a mixture of corn-soybean meal-fishmeal but with added spray dried blood cells (3.5%) and dried

whey (20%). Supplemental NaCl or KCl was added to provide an additional .12 or .24% Cl from both Cl sources. Other nutrients met or exceeded NRC (1988) standards. The study was conducted in a RCB design and involved 305 weanling pigs in 11 replicates. Each station conducted a minimum of 2 replicates and weaning age between stations ranged from 8 to 24 d of age. The basal diets were analyzed for Na, K, and Cl and averaged .46, 1.20, .65% and .25, 1.11, .48% for these nutrients for Phase 1 and 2, respectively. There was no (P > .15) gain, feed intake or feed efficiency response for the 0 to 14 d, or 15 to 35 d postweaning periods when either form of Cl was added to the basal diets. These results suggest that the basal diet contained adequate Na, K, and Cl to meet the pigs requirement for these nutrients, and there was no need to further supplement the postweaning diets when the basal diets exceeded the current NRC (1998) estimated requirements for these nutrients.

Key Words: Chloride, Sodium, Pig

326   Effect of boron supplementation on bone characteristics and plasma mineral concentrations in young pigs. T. A. Armstrong*, J. W. Spears, and L. F. Stikeleather, *North Carolina State University, Raleigh, NC.*

The objectives of these studies were to determine the effects of dietary boron (B) on performance, plasma mineral concentrations, and bone characteristics of weanling pigs. In Exp.1, 48 crossbred weanling pigs were blocked by weight, randomly assigned to one of 12 pens, and pens were randomly assigned to one of 3 treatments: 1) control (20.3% CP corn-soybean meal basal diet, 1.25% Lys, 3970 kcal/kg DE); 2) basal diet + 5 mg B/kg diet; and 3) 15 mg B/kg diet. Boron was supplemented as sodium borate (11.3% B). In Exp. 2, 48 crossbred weanling pigs were blocked by weight, randomly assigned to one of 12 pens, and pens were randomly assigned to the same dietary treatments as described in Exp. 1. However, the basal diet in Exp. 2 was a 15% CP semi-purified diet (1.28% Lys, 3561 kcal/kg DE). The diets in Exp. 1 and 2 were fed for 40-d. On d 40, blood samples were obtained for plasma mineral analysis and plasma alkaline phosphatase activity (ALP). Right and left femurs were removed from 8 pigs per treatment on d 40 for the determination of bone weight (g), length (mm), and bone breaking strength (kg . mm). In Exp. 1, there was no effect (P > .10) of B supplementation or level on animal performance. Weight and length of femurs were decreased (P < .10) by supplemental B; however, there was no difference (P > .10) in femur breaking strength. In Exp. 2, there was no difference (P > .10) in ADG or ADFI, but gain:feed was improved (P < .05) by the addition of 5 mg B/kg diet. Weight and length of femurs were not different (P > .10) between treatments, but 5 mg B/kg diet increased (P < .05) bone breaking strength of femurs. In Exp. 1 and 2, there was no effect (P > .10) of B on plasma Ca, Mg, P, or ALP. These data indicate that the addition of 5 mg B/kg diet as sodium borate to semi-purified diets improved gain:feed and increased breaking strength of femurs in weanling pigs.

Key Words: Boron, Bone, Pigs

327   Food-grade sorghum in diets for finishing pigs. D. W. Dean*, J. D. Hancock, C. A. Maloney, J. M. DeRouchey, D. J. Lee, J. S. Park, H. Cao, A. Natchanok, and R. H. Hines, *Kansas State University, Manhattan, KS.*

A total of 160 crossbred barrows and gilts (10 pigs per pen) were used to determine the effects of food grade sorghum in diets for finishing pigs. The pigs (47.7 kg average initial BW) were blocked by weight and alloted to pens based on sex and ancestry. The pigs were housed in a modified open front finishing barn with floors that were half slatted and half solid concrete. Each pen had a two-hole self feeder and nipple waterer to allow ad libitum access to feed and water. Treatments were a bronze-pericarp control (Pioneer 8500) and three food-grade (white seed/tan plant) sorghums (NC+7W97, Cargill 888Y, and Jowar 1) ground through a 1.6 mm screen to a mean particle size of approximately 600 microns. Diets were sorghum-soy-based and formulated to .9% lysine for d 0 to 46 and .75% lysine from d 46 to 73. The food-grade sorghums were added to the diets on a wt:wt basis in place of the bronze sorghum. Average daily gain, ADFI, and gain/feed were not affected by treatment from d 0 to 46 (P > .69), d 46 to 73 (P > .79), and overall (P > .68). Also, dressing percentage, last rib fat thickness, and depth, color, marbling, firmness, and final pH of the longissimus muscle

were not affected by treatment (P > .19). Thus, our results suggest that these varieties of grain sorghum were similar in feeding value.

Item	Pioneer 8500	NC+ 7W97	Cargill 888Y	Jowar 1	SE
ADG, g	990	970	990	980	20
ADFI, kg	3.06	3.06	3.10	3.10	.07
G/F, g/kg	324	317	320	316	4
Backfat, mm	22.1	20.5	21.5	22.0	.7
Color	4.1	4.1	4.1	4.1	.1
Marbling	2.4	2.3	2.2	2.4	.1
Final pH	5.41	5.35	5.38	5.37	.02

Key Words: Sorghum, Food-grade, Pig

328   Nitrogen metabolism of growing gilts fed standard corn-soybean meal diets or low-protein diets supplemented with crystalline amino acids. J. L. Figueroa*, A. J. Lewis, P. S. Miller, and S. R. Gomez, *University of Nebraska, Lincoln, NE.*

To investigate why lean growth rates of pigs fed low-protein diets supplemented with crystalline amino acids (AA; lysine, threonine, tryptophan, methionine) are lower than those of pigs fed standard corn-soybean meal diets, a N balance experiment was conducted. Twelve gilts (initial weight 41 kg) were fitted with urinary catheters and fed six different diets in a modified Latin Square design (two squares and three, 7-d periods). Diets were as follows: 1) 18% CP, 2) 14% CP + AA, 3) 16% CP, 4) 12% CP + AA, 5) 14% CP, 6) 10% CP + AA. The AA were added to provide the same amounts, on a total basis, as those in the intact protein diets that were 4% CP higher (i.e., Diet 2 was equivalent to Diet 1, etc.). Gilts were allowed ad libitum access to feed and water. There were no differences among treatments (P > .30) for ADG (.74 kg), ADFI (1.54 kg), or ADG/ADFI (.47). Nitrogen retention (g/d) decreased (P < .01) in both the standard diets (27.1, 24.5, 21.0) and the AA-supplemented diets (21.5, 19.2, 15.8) as CP decreased and was consistently lower (P < .01) in the AA-supplemented diets. Nitrogen retention (% of N intake) tended to be greater for AA-supplemented diets, but differences were not significant. Apparent N digestibility was greater (P < .01) in standard diets than in AA-supplemented diets (87.7 vs 85.1%). There were no differences among treatments (P > .30) in BV (68.2% for standard vs 70.9% for AA-supplemented). Thus, at AA concentrations from deficient to excess, low-protein, AA-supplemented diets failed to achieve the same N retention as equivalent corn-soybean meal diets. These data suggest that dietary factors other than amino acid concentrations account for the reduction in lean growth observed in pigs fed low-protein, AA-supplemented diets.

Key Words: Pigs, Nitrogen Balance, Amino Acids

329   Effect of low protein diets on energy utilization in growing pigs. L. Le Bellego[1], J. van Milgen*[1], M. Rademacher[2], S. Van Cauwenberghe[3], and J. Noblet[1], [1]*INRA, Saint-Gilles, France,* [2]*Degussa, Hanau, Germany,* [3]*Eurolysine, Paris, France.*

Twenty two (Large White x Landrace) x Piétrain castrated males of 65 kg body weight, were used to study the effect of reducing the crude protein (CP) content of the diet on the utilization of energy in growing pigs kept under thermoneutral conditions (24°C). Four protein levels ranging from 18.9% (CP1) to 16.7, 14.6 and 12.3% (CP4) were tested by replacing soybean protein by corn starch; industrial amino acids were added to maintain an optimal and balanced amino acid supply. All diets provided .578 g/MJ ME of digestible lysine and pigs were fed at about 2.63 MJ/day/kg BW$^{.60}$ of ME. After adaptation to diets and experimental conditions, excreta were collected for 8-d with heat production (HP; indirect calorimetry), feeding behavior and physical activity measured over the last 4-d; the fasting heat production (FHP) was also measured over a subsequent 2-d period. The thermic effect of feed (TEF), FHP and HP due to physical activity (AHP) were calculated. Pigs performance and nitrogen balance were not affected by reduction of the dietary CP level and nitrogen excretion was linearly reduced (minus 58% between CP1 and CP4). The average FHP (0.797 MJ/day/kg BW$^{.60}$ at zero physical activity) and AHP (0.214 MJ/day/kg BW$^{.60}$) were not affected by the treatment. When adjusted for zero activity and the same average ME intake (2.4 MJ/day/kg BW$^{.60}$), HP was lower (P<.01) when CP level was reduced and represented 53.3% and 49.2% of ME intake,

for CP1 and CP4 respectively. This lower HP was mainly due to a reduction of TEF (P<.03) which corresponded to 19.9 and 15.8% of ME intake for CP1 and CP4, respectively. The reduced HP for identical ME intake resulted in a greater quantity of retained energy with lower CP diets. It is concluded that the reduction of the CP content in pig diets with essential amino acids levels kept optimal allows to reduce the quantity of nitrogen excreted, but is also accompanied by a more efficient utilization of energy. In situations where performance is limited by ME intake, a greater efficiency of resources can be obtained.

Key Words: Growing Pigs, Dietary Protein, Heat Production

330   Effects of increasing lysine:calorie ratio and dietary fat addition on growth performance and carcass characteristics of gilts from 27 to 120 kg. M. De La Llata*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan, KS.*

A total of 1,200 gilts (PIC C22 x 337) with an initial weight of 27 kg were used in a 120 d growth trial to determine the effect of lysine:calorie ratio and dietary fat (choice white grease) addition on growth performance and carcass characteristics. Pigs were allotted to one of 8 dietary treatments in a completely randomized design with 25 pigs/pen and 6 pens/treatment. The corn soybean meal-based diets were arranged in a 2 x 4 factorial with two levels of added dietary fat (0 and 6%) and four lysine:calorie ratios in each phase. The four phases were 27 to 45, 45 to 75, 75 to 100, and 100 to 120 kg. Lysine:calorie ratios (g lysine/Mcal ME) were 2.96, 3.26, 3.56 and 3.86 in phase 1, 2.25, 2.50, 2.75 and 3.0 in phase 2, 1.64, 1.84, 2.04 and 2.24 in phase 3, and 1.12, 1.32, 1.52 and 1.72 in phase 4. No interactions occurred between lysine:calorie ratio and dietary fat except for ADFI in phase 1 (P < .06) and 3 (P < .08). During every phase, ADG and feed efficiency (G/F) linearly increased (P < .01) with increasing lysine:calorie ratio. However, for the overall experiment, the greatest response was observed in gilts fed the third lysine:calorie ratio (quadratic, P < .05). Increasing added dietary fat increased (P < .03) ADG during phase 1 and 2. Increasing added dietary fat from 0 to 6% decreased (P < .01) ADFI in all phases and increased (P < .01) G/F in phases 1, 2, 3, and overall. Fat depth decreased linearly (P < .01), and loin depth, percent lean and fat free lean index (FFLI) increased linearly(P < .01) with increasing lysine:calorie ratio. Fat addition to the diet numerically increased (P < .17) fat depth and decreased (P < .12) FFLI. The results from this experiment indicate that the addition of 6% dietary fat decreases feed intake and increases G/F, and that the third lysine:calorie ratio regimen used was appropriate to maximize growth performance of gilts in a commercial finishing environment.

Key Words: Fat, Lysine:calorie ratio, Gilts

331   Effects of increasing lysine:calorie ratio and dietary fat addition on growth performance and carcass characteristics of barrows from 34 to 120 kg. M. De La Llata*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan, KS.*

A total of 1,200 barrows (PIC C22 x 337) with an initial weight of 34 kg were used in a 120 d growth trial to determine the effect of lysine:calorie ratio and dietary fat (choice white grease) addition on growth performance and carcass characteristics. Pigs were allotted to one of 8 dietary treatments in a completely randomized design with 25 pigs/pen and 6 pens/treatment. The corn soybean meal-based diets were arranged in a 2 x 4 factorial with two levels of added dietary fat (0 and 6%) and four lysine:calorie ratios in each phase. The four phases were 34 to 60, 60 to 80, 80 to 100, and 100 to 120 kg. Lysine:calorie ratios (g lysine/Mcal ME) were 2.41, 2.71, 3.01 and 3.31 in phase 1, 1.75, 2.0, 2.25 and 3.5 in phase 2, 1.38, 1.58, 1.78 and 1.98 in phase 3, and 1.02, 1.22, 1.42 and 1.62 in phase 4. No interactions occurred between lysine:calorie ratio and dietary fat except for ADFI in phase 3 (P < .09). During every phase and for the overall trial, ADG and feed efficiency (G/F) increased linearly (P < .02) with increasing lysine:calorie ratios. However, the greatest response occurred when increasing lysine:calorie ratio to the third level in each phase, with a smaller further increase at the highest level. Increasing lysine:calorie ratio did not influence ADFI for any phase. Increasing added dietary fat from 0 to 6% decreased ADFI and increased G/F (P < .01) in all phases, while ADG was increased during phase 1 (P < .06), 2 (P < .11), and overall (P < .04). Fat depth decreased linearly (P < .01), and loin depth, percent lean and

fat free lean index (FFLI) increased linearly(P < .01) with increasing lysine:calorie ratio. Dietary fat addition increased (P < .08) fat depth and decreased (P < .08) FFLI. These results indicate that the addition of 6% dietary fat decreases feed intake and increases G/F, and that the fourth lysine:calorie ratio regimen used was most appropriate to obtain the best performance of barrows in this experiment.

Key Words: Fat, Lysine:calorie ratio, Barrows

332   Effects of increasing neutral detergent fiber (NDF) on the performance and carcass characteristics of growing-finishing swine. J. D. F. Gomes*[1], P. J. A. Sobral[1], R. S. Fukushima[1], C. G. Lima[1], A. C. A. Fagundes[2], L. W. O. Souza[2], S. M. Putrino[1], C. E. Utyiama[1], C. Grossklaus[1], and L. L. Oetting[1], [1]*Faculdade de Zootecnia e Engenharia de Alimentos da Universidade de Sao Paulo, Brazil,* [2]*Faculdade de Medicina Veterinária e Zootecnia da Universidade de Sao Paulo, Brazil.*

Despite high utilization of the dietary fiber fraction in ruminant animals, swine can show positive responses when fed diets containing this alternative source of energy. The utilization of fibrous food for swine may control possible problems with stress caused by housing and excessive feed. Furthermore, adding fiber to the diet may allow better control of carcass standards, resulting in adequate weight gain to lean meat yield. Thus, it is possible to ensure reduction in the backfat, a positive aspect very important to the actual market. This study was conducted to evaluate the effects caused by inclusion of neutral detergent fiber (NDF), through the utilization of Tifton hay as the source of dietary fiber, on performance and carcass characteristics of growing-finishing swine (73-150 d). The experimental design employed was a completely randomized block with 20 male and 20 female crossbred (Large White x Landrace) pigs. Daily feed consumption (DC), daily weight gain (DG), and feed/gain (FG), hot carcass yield (HC), cool carcass yield (CC), lean carcass yield (LC), loin area (LA), and backfat(BF) were measured. Data were analyzed using GLM procedure (SAS®). The results showed no differences (P > 0.17) between experimental treatments relative to DC, DG, and FG. In relation to carcass characteristics, no differences were observed (P > 0.20) between treatments, although was occurred reduction in HC, CC and BF of animals fed with 10% of hay grass (8% NDF). The utilization of the low NDF (8%) diet, did not promote alterations in performance and carcass characteristics of growing-finishing swine. These results indicate that inclusion of fiber in the ration does not alter the development and, thus, performance and carcass characteristics.

Key Words: Neutral detergent fiber, Performance, Carcass characteristics

333   The effects of Hemicell® on digestibilities of minerals, energy, and amino acids in pigs fitted with steered ileo-cecal valve cannulas and fed a low and high protein corn-soybean meal diet. J. S. Radcliffe, B. C. Robbins*, J. P. Rice, R. S. Pleasant, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Twelve crossbred barrows (BW = 44 kg), fitted with steered ileo-cecal valve (SICV) cannulas, were used to investigate the effects of Hemicell® (β-mannanase) on the apparent total tract digestibilities (ATTD) of energy, Ca, P, DM, and the apparent ileal digestibilities (AID) of Ca, P, DM and amino acids. All diets were corn-soybean meal-based. Diets 1 and 3 contained 12% and 16% CP, respectively. Diets 2 and 4 contained 12% and 16% CP, respectively, and were supplemented with Hemicell® at a level of .50% of the diet. Calcium and P levels were .54% and .45% for the low CP diets and .53% and .45% for the high CP diets, respectively. Pigs were randomly allotted to one of the four dietary treatments in 3 blocks of a 4 x 4 Latin square. Pigs were individually housed in metabolic pens (1.2m x 1.2m). Water was supplied ad libitum, and feed was given at a level of 9% of the pigs metabolic BW (BW$^{.75}$)/d. Each 2-wk period consisted of a 7-d adjustment, a 3-d total collection, a 12-h ileal digesta collection, a 3-d readjustment, and a second 12-h ileal digesta collection. There were no interactive effects of Hemicell® and CP level; therefore, only main effects are reported. Increasing the level of CP in the diet from 12 to 16% improved (P < .001), ADG, G:F, and the AID of DM, Ca, P, N and all amino acids measured. In addition, the ATTD of P (P < .01) was increased while there was no effect (P > .1) on ATTD of Ca, energy, or DM. The addition of Hemicell® to the diet increased AID of DM (P < .001) and ATTD of energy (P < .05).

Although, numerical means favored Hemicell®, differences were not significant (P > .10) for AID of Ca, P, and amino acids or ATTD of Ca, P, and DM. Based on the results of this study, Hemicell® may be a useful feed additive for increasing the energy availability in a corn-soybean meal-based diet fed to pigs.

Key Words: Pigs, Energy digestibility, β-mannanase

334   Circadian fluctuation in heat production and physical activity in group-housed pigs influenced by fermentable carbohydrates. J. W. Schrama*[1] and G. C. M. Bakker[2], [1]Animal Health and Reproduction Group, Wageningen Agricultural University, [2]TNO Nutrition and Food Research Inst., Dep. of Anim Nutr. and Physiol., Wageningen, The Netherlands.

This study assessed effects of fermentation and bulkiness of dietary carbohydrates on fluctuation in heat production and physical activity. Eight clusters of 14 group-housed pigs were fed one of four diets, in a 2×2 factorial design. Factors included 1) level of gastro-intestinal fermentation and 2) dietary volume. Contrasts in fermentation were created by exchanging gelatinized maize starch with raw potato starch on a volume basis. Dietary volume was altered by adding 15% milled wheat straw to the diets. Amounts of other dietary ingredients fed to the pigs were similar. Heat production (H) was measured every 9 min during a 14-d experimental period. Mean daily H related to activity (Hact) was 17.6% lower for the potato starch diet compared to the maize starch diet (P < .01). Gastro-intestinal fermentation did not affect average daily total H (Htot) and H corrected for activity (Hcor). Daily pattern in Htot differed between potato and maize starch diets. Hourly means of Htot ranged from 533 to 871 kJ.kg$^{-.75}$.d^{-1} and from 492 to 944 kJ.kg$^{-.75}$.d^{-1} for the potato and maize starch diets, respectively. The larger within day variation in Htot was partly due to the increased activity for pigs fed the maize diet during the light period of the day. The within day variation in Hcor was reduced when the gastro-intestinal fermentation was stimulated. Dietary volume (addition of milled straw) did not affect mean daily values or daily patterns in Htot, Hact and Hcor. In conclusion, the effect of non-starch polysaccharides on activity of group-housed pigs is related to stimulated gastro-intestinal fermentation, and not the dietary volume of fiber-rich diets. Furthermore, fermented carbohydrates compared to digested carbohydrates reduce within day variation in metabolism, which is likely related to a more gradual absorption of nutrients.

Key Words: Pigs, Behaviour, Heat production

335   Postprandial blood pH and acid base balance in pigs as affected by dietary cation-anion difference. Y. Dersjant-Li[1], M. Verstegen*[1], A. Jansman[2], J. Verreth[1], J. Schrama[1], and H. Schulze[3], [1]Wageningen Institute of Animal Science, Wageningen, The Netherlands, [2]TNO-Nutrition and Food Research Institute, Wageningen, The Netherlands, [3] Finnfeeds International Ltd., Marlborough, Wiltshire, United Kingdom.

An experiment was conducted to test the effect of dietary cation-anion differences (CAD, $Na^+ + K^+ - Cl^-$; meq/kg) on postprandial blood pH changes and acid base balance in pigs. Four pigs with a mean body weight of about 40 kg were surgically fitted with catheters in the carotid artery. Two dietary CAD levels (-200 and 200 meq/kg) were tested by using a cross over experimental design, that consisted of two periods, each of one wk duration. Two pigs were assigned to one of two experimental diets in each period. Feed was provided in pelleted form at a rate equivalent to 2.6 times the maintenance requirement for energy in two meals per d. Water was freely available. In each period, blood samples were taken on two days (d 5 and 7), at 0, 0.5, 1, 1.5, 2, 2.5, 3, 4, 6 and 9 h after feeding through catheters. Blood pH, HCO_3^-, base excess (BE), Na^+, and K^+ were measured immediately after sampling using an acid-base meter (HP iSTAT WR052) with EG6+ cartridges. Plasma Cl^- content was measured using a chloride meter (PCLM digital chloride meter). Blood pH was lowered (P < .0001) at -200 CAD (7.39) compared to 200 CAD (7.46). Base excess (3.15 mmol/L) and HCO_3^- (27.5 mmol/L) were also at a lower concentration in the blood in the -200 CAD group compared to the 200 CAD group (8.61 and 32.3 mmol/L, respectively). Plasma Cl^- and blood K^+ concentrations were higher (P < .01) for the CAD -200 group compared to CAD 200. However, Na^+ concentration in the blood was not influenced by dietary CAD. Arterial blood pH remained constant after feeding in both CAD groups. Dietary CAD significantly influenced postprandial plasma Cl^-, and blood Na^+

and K^+ concentrations. However, pigs maintained a constant CAD level (electrolyte balance) in the blood after feeding. In conclusion, dietary CAD changed blood pH and acid-base buffer system in pigs while maintaining a constant postprandial blood pH and electrolyte balance.

Key Words: Pigs, Blood pH, Acid-base balance

336   Effect of tannin-rich quebracho extract on ileal endogenous amino acid losses in pigs. C. A. Steendam*, S. Tamminga, and M. W. A. Verstegen, Wageningen Institute of Animal Sciences (WIAS), Wageningen, The Netherlands.

The effect of added dietary quebracho extract (QE, Schinopsis spp.) on endogenous nitrogen (N) and amino acid (AA) losses in pigs was measured using the peptide alimentation ultrafiltration technique. Quebracho contains relative high levels of condensed tannins and serves as a model for tannins in pig feeds. The control diet based on maize starch (521 g/kg) contained enzyme hydrolyzed casein (180 g/kg; MW < 5 kDa) as the sole N source and Cr_2O_3 (1 g/kg) as digestibility marker. Addition of QE (12% catechin equivalents, 65% total phenols) to the control diet at 4% of feed intake resulted in the quebracho diet. Control diet and quebracho diet were tested in a cross-over design with 12 crossbred castrated male pigs (15-25 kg BW). Pigs were housed individually and fed a mash feed (water/feed = 2.5 vol/wt) at 2.4 times their energy requirement for maintenance. Feeding times were 8.00 h and 20.00 h. Animals were fitted with a post valve T-caecum cannula for collection of ileal digesta. After a 7-day adaptation period, digesta was collected between feedings on days 8, 9 and 10. Collection bags were changed hourly and digesta was frozen at -20°C. Thawed digesta was pooled per animal, analyzed for DM, freeze-dried and analyzed for N and Cr. After resuspending in water, it was subjected to centrifugation (7,000 g, 5°C) followed by ultrafiltration (MW cut off 10 kDa, 20°C). The precipitate + retentate (> 10 kDa), considered to be the endogenous fraction, was analyzed for DM, N, and AA. Adding QE to the diet increased the endogenous N flow (> 10 kDa) from 1.65 ± 0.07 to 5.8 ± 0.09 g /kg dry matter intake (DMI; P < .001). Endogenous AA flows (g/kg DMI) were all increased by QE (P < .001), but AA pattern (g AA per 160 g N) of the endogenous fraction was changed. The most obvious changes caused by QE, were an increase in proline (75 ± 5.0 vs 128 ± 6.1; P < .001), glycine (41 ± 0.5 vs 60 ± 0.6; P < .001) and arginine content (30 ± 0.8 vs 46 ± 1.0; P < .001) and a decrease in glutamate (205 ± 6.0 vs 140 ± 7.3; P < .001) and serine content (119 ± 2.2 vs 87 ± 2.7; P < .001). It is concluded that dietary quebracho extract increases the ileal endogenous N flow and that the amino acid pattern of ileal endogenous N losses is not constant, but depends on composition of the diet.

Key Words: Pigs, Endogenous amino acids, Tannins

337   Effects of sorghum ergot in diets for nursery pigs. D. W. Dean*[1], R. H. Hines[1], J. D. Hancock[1], G. A. Kennedy[1], J. K. Porter[2], C. A. Maloney[1], J. M. DeRouchey[1], D. J. Lee[1], J. S. Park[1], and H. Cao[1], [1]Kansas State University, Manhattan, KS, [2]R.B. Russell Agricultural Research Center, Athens GA.

Two experiments were conducted to determine the effects of ergot contaminated sorghum grain in diets for nursery pigs. All pigs, in both experiments, were fed the same complex starter diet (1.7% lysine) for 7 d and then changed to the experimental sorghum-based diets. In Exp. 1, 48 crossbred barrows and gilts (4.8 kg average initial BW) were blocked by weight and alloted to pens based on sex and ancestry. The pigs were fed diets with normal sorghum or ergot infected sorghum in the 32-day growth assay. The sorghums were analyzed for ergot alkaloids and found to have none and 1.2 ppm dihydroergosine for the normal and contaminated sorghums, respectively. When fed to pigs, overall ADG (P < .003) and ADFI (P < .001) were reduced by the diet with ergot infected sorghum. However, gain/feed was improved (P < .02) for pigs fed the diet with ergot. In Exp. 2, 48 crossbred barrows and gilts (average initial BWof 4.9 kg) were used in a 28-day growth assay. Treatments were: 1) normal sorghum; 2) 50% normal:50% ergot infected sorghum (.6 ppm dihydroergosine); and 3) ergot infected sorghum (1.2 ppm dihydroergosine). Average daily gain and ADFI decreased (linear effects, P < .02) as contaminated grain in the diets was increased from none to 100%. Gain/feed was not affected (P > .6) by ergot contamination of the sorghum. In conclusion, our results suggest that ergot infected grain sorghum (with levels as low as .6 ppm dihydroergosine) will markedly decrease feed intake and growth in nursery pigs.

Item	Normal Sorghum	50% normal 50% ergot	Ergot infected sorghum	SE	P <
Exp. 1					
ADG, g	557	–	462	10	.003
ADFI, g	842	–	658	15	.001
Gain/feed, g/kg	662	–	702	7	.02
Exp. 2					
ADG, g	491	464	409	13	.005
ADFI,g	748	705	615	30	.02
Gain/feed, g/kg	656	658	665	14	.63

Key Words: Sorghum, Ergot, Pig

338   The effects of antibiotic regimens on fecal shedding patterns and bacterial resistance in pigs infected with *Salmonella typhimurium*. P. D. Ebner* and A. G. Mathew, *University of Tennessee, Knoxville, TN.*

An experiment was conducted to determine effects of antibiotic regimens on fecal shedding and antibiotic resistance in pigs infected with *Salmonella typhimurium*. Fifty 50-d-old pigs were inoculated with *Salmonella typhimurium*, blocked by litter, and assigned to one of four treatments including: 1) IM injection of ceftiofur sodium for three days followed by inclusion of oxytetracycline (OTC) (110 ppm of feed), 2) apramycin (165 ppm of feed) for 14 d followed by OTC (110 ppm), 3) carbadox (55 ppm) followed by OTC (110 ppm), and 4) no antibiotics (control). Pigs were housed in a common room; however, direct contact between pigs of different treatment groups was not possible. Fecal samples were collected by rectal swab, pre-inoculation, 48 and 72 h post-inoculation, and at weekly intervals, until pigs reached approximately 110 kg BW. Salmonella isolates were analyzed for resistance to ceftiofur sodium, apramycin, carbadox, and OTC on days 2, 5, 7, 21, 42, and 70 post-inoculation. Reduced shedding (P < .05) was observed in pigs receiving the apramycin/OTC treatment when compared to the control; however, no differences were observed between antibacterial treatments and no antibiotic treatment increased shedding. The percentage of resistant isolates increased with time within every treatment (Treatment x Time interaction, P < .05). Resistance to individual antibiotics also increased with time in every treatment (Antibiotic x Time interaction, P < .05). The percentage of isolates resistant to carbadox was significantly greater (P < .05) in pigs receiving the carbadox/OTC treatment compared to other antibiotic treatments; however, this was the only Antibiotic x Treatment interaction observed. These data indicate the antibiotics tested do not increase shedding of *Salmonella typhimurium*; however, resistance to those antibiotics increases over time following treatment dose.

Key Words: Pigs, Salmonella typhimurium, Antibiotics

339   Inhibitory/stimulatory effect of organic acids on intestinal microflora. A. Piva*[1], G. Biagi[1], E. Meola[1], J. B. Luchansky[2], and P. P. Gatta[1], [1]*University of Bologna, Italy,* [2]*University of Wisconsin, Madison, WI.*

The use of organic acids in monogastric diets has become a common practice despite the variable outcomes. Very little is known about the effect of organic acids on the host microflora. We investigated the effect of several organic acids in swine *in vitro* fermentation. Cecal inoculum was collected from pigs within 20 minutes from slaughter and the fermentation was carried out in a batch culture system that allowed quadruplicate observations per treatment at time 0, 4, 8, and 24 h after the incubation commenced. Gas production was recorded hourly and the data were fitted by the Gompertz bacterial growth model (r2 > 0.98). Organic acids were used at 60, 120, and 240 mmol/L, in fermentation vessels with pH adjusted to 6.5-6.7. Compared to control diet, formic acid (FA) decreased cumulative gas production (VF) by 29% and 55% at 120 and 240 mmol/L, respectively (P < .05). Acetic acid (AA) showed no effect on VF. Propionic acid (PA) decreased VF by 24% and 48% at 120 and 240 mmol/L, respectively (P < .05). Lactic acid (LA) increased VF by 19%, 59%, and 24% at 60, 120, and 240 mmol/L, respectively (P < .05). Maximum rate of gas production was modified by FA by -50% and -61% at 120, and 240 mmol/L, by AA by -38% at 240 mmol/L, by PA by +27%, and -44% at 60, and 240 mmol/L, and by LA by +127%, +210% and +56% at 60, 120, and 240 mmol/l, respectively (P < .05). Ammonia concentration (mmol/L) after 8 h fermentation,

was restrained by 29% by LA at 60 mmol/L. The other acids, beside FA at 60 and LA at 120 mmol/L, resulted in an increase at 8 h. Samples collected from fermentation vessels at 8 h were plated on Violet Red Bile Agar and Rogosa Agar showing no difference in colony forming units. Organic acids seemed to have different degrees of inhibition of swine cecal microflora delaying and reducing the gas production curve. PA and FA gave the most promising indications for an effective control of cecal microflora. Interestingly, LA resulted in a stimulatory effect on microflora as suggested by gas and ammonia data.

Key Words: Additive, Acidifier, Pig

340   Proximal pH changes in the porcine stomach in response to buffers in the water supply. K. D. Ange*, J. H. Eisemann, R. A. Argenzio, and A. T. Blikslager, *North Carolina State University, Raleigh, NC.*

The objective was to measure the pH of the proximal region of the porcine stomach to determine whether buffers added to the water supply could decrease acidity in order to reduce the incidence of pars esophageal ulceration. Four barrows (25 ± 2 kg) had gastric cannulas surgically implanted into the proximal region of the stomach. Pigs were placed on a finely ground and pelleted corn-soybean meal diet (398 ± 2.35 microns) prior to surgery and fed ad libitum. The experimental design was a Latin Square. Water treatments included: water (control), 200 mOsm sodium bicarbonate, 250 mOsm sodium bicarbonate, and 250 mono/disodium phosphate. Pigs were given a 4-d adjustment period and pH sampling began on the morning of the d 5 and continued for 24 h under normal feeding conditions. Feed was removed and measurements were continued for 16 h. Buffered water raised the pH of the proximal region of the stomach when compared to the control during the entire sampling period (P < .0001). Average pH while consuming the 250 mOsm $NaHCO_3$ buffer was 4.63 ± .11 (n = 4), 4.86 ± .11 (n = 4) for the 200 mOsm $NaHCO_3$, 4.59 ± .14 (n = 3) for the 250 mOsm mono/diphosphate buffer, and 3.65 ± .11 (n = 4) for the water control. Buffers also raised the pH of the proximal region of the stomach for both the fed phase (P < .0001) and the fasting phase (P<.01) of the trial when they were analyzed separately. Drinking water disappearance was measured during the buffer adjustment period. The water disappearance rates when pigs were given the $NaHCO_3$ were higher than the water control (P < .01). Average daily drinking water disappearance for the 250 mOsm $NaHCO_3$ was 13.77 ± .74 liters, 13.56 ± .74 liters for the 200 mOsm $NaHCO_3$, 10.33 ± .95 liters for the phosphate buffer and 9.13 ± .74 liters for the water control. Therefore, the pH of the proximal region of the stomach was increased by adding buffers to the water supply although addition of the bicarbonate buffers resulted in increased drinking water disappearance by the pig.

Key Words: Buffer, pH, Water

341   Potential role of pancreatic enzymes in the formation of pars esophageal ulcers in growing pigs. T. Parr*[1], V. M. Gabert[1], D. B. Anderson[2], and M. Ellis[1], [1]*University of Illinois, Urbana, IL,* [2]*Eli Lilly, Greenfield, IN.*

The present study was carried out to determine the impact of fasting on the incidence of pars esophageal ulcers and the composition of stomach contents in growing swine. Control animals (fed) were left in the nursery facility with ad libitum access to feed and water, while treated animals (fasted) were mixed with unfamiliar pigs, moved to a growing facility and not allowed access to feed. Ad libitum water was available. After 24 hours, pigs from both groups were euthanized. Stomachs were weighed and pH was measured from the cardiac and pyloric regions of the stomach, as well as the small intestine. Stomach contents were collected from the same location, and enzyme activities were determined. Ulcer scores were assigned to all pig stomachs. Fasting pigs decreased (P<.001) full stomach weights and increased ulcer scores (P<.0001) compared to fed pigs, 1.37 and 0.2, respectively. No pH difference was found (P>.05) between fed (3.9) and fasted (3.3) pigs. Trypsin activity was higher in the cardiac region of fed pigs (0.41 U/g of gastric digesta) vs. fasted pigs (0.18 U/g) and in the pyloric region of fasted pigs (0.29 U/g) as compared to fed pigs (0.06 U/g). Chymotrypsin activity was low in the cardiac and pyloric regions (0.01 U/g) of the stomach in fed pigs, however, it tended to be higher (P<.10) in the cardiac and pyloric regions of the stomachs in fasted pigs, 0.16 U/g and 0.19 U/g, respectively. The level of pepsin was lower in the cardiac (102.9 μg/g) and pyloric (94.2μ g/g) regions of the stomachs in fed pigs, but was higher (P<.01) in the

cardiac region (357.9 μg/g) of fasted pigs and tended to be higher in the pyloric region (465.8 μg/g) of the fasted pigs. There were no significant differences in trypsin, chymotrypsin or pepsin levels in the duodenum between treatments. The results indicate that pancreatic enzymes reflux into the stomach and are active despite the low gastric pH. Therefore, the autodigestive properties of pancreatic enzymes could contribute to ulceration of the pars esophagea.

Key Words: Pigs, Ulcers, Chymotrypsin

342   Effect of Aureomycin® chlortetracycline (CTC) in grower and finisher diets vs. Tylan® or BMD® on performance, health, carcass parameters, meat quality characterisits and probability of having lightweight pigs, in lean genotype, high health swine. G. Gourley*[1], J. Deen[2], and T. Wolff[3], [1]*Swine Graphics Enterprises, Webster City, IA,* [2]*North Carolina State University, Raleigh, NC,* [3]*Roche Vitamins Inc., St. Charles, MO.*

The objective of this study was to compare the effects of two CTC programs (CTC 110 mg/kg in grower diets followed by 55 mg/kg in finisher diets, fed to market ($\geq$ 122 kg BW), or followed by zinc bacitracin (Baciferm) 27.5 mg/kg starting 2 wk before market), vs. Tylan 44 mg/kg in grower, followed by 22 mg/kg in finisher, vs. BMD 33 mg/kg in grower and finisher. Single-sourced pigs (n = 1000), averaging 24 kg BW, were randomized by weight and sex to 40 pens (25 pigs/pen). Pigs were fed corn-soy meal diets in a five-phase feeding program, with gilts fed diets ranging from 1% to .64% lysine, and lysine levels of barrows diets ranged from 1% to .55%. Pigs fed 110 mg/kg CTC in grower diets were heavier (P $<$ .01) than all of the other treatment groups. Pigs fed 110 mg/kg CTC in grower diets had higher ADG (P $<$ .01) and ADFI (P $<$ .05) vs. all other treatment groups. Overall, comparison of within-pen CV showed a trend (P $<$ .1) toward reduced variability for the CTC-only group vs. non-medicated pigs. The CTC treatments reduced (P $<$ .01) the odds of having lightweight pigs ($<$ .77 kg ADG) by 48% and 42% vs. non-medicated controls, while the Tylan and BMD reductions (25% and 4%, respectively) were not significant. Morbidity and mortality were minimal and were not different between treatment groups. None of the treatments impacted (P $>$ .05) carcass characteristics nor meat quality. In summary, CTC fed at low levels in grower-finisher diets positively impacted performance and reduced (P $<$ .01) the probability of having slow-growing pigs vs. non-medicated controls, while Tylan or BMD did not.

Treatment	Nonmed	CTC	CTC/Bac	Tylan	BMD	CV
Grow-Fin						
ADG (kg)	.85[b]	.91[a]	.90[a]	.88[ab]	.87[b]	2.7
ADFI (kg)	2.20[b]	2.34[a]	2.35[a]	2.25[ab]	2.25[ab]	3.5
F/G	2.58	2.57	2.59	2.55	2.60	2.0

[ab]Means with uncommon superscripts differ, (P$<$.05)

Key Words: CTC, Tylan, BMD

343   The effect of various factors on the analytical procedures for L-gulonolactone oxidase activity in swine liver. S. Ching*, D. C. Mahan, R. Moreau, and K. Dabrowski, *The Ohio State University, Columbus, OH.*

The vitamin C requirement in swine has been evaluated using various biological methods (immune response, performance, and tissue ascorbic acid concentration), but none have used liver L-gulonolactone oxidase (GLO) activity. L-gulonolactone oxidase is the key enzyme of vitamin C biosynthesis present in the liver of the pig. This study was conducted to establish analytical procedures for evaluating the activity of GLO in the liver. The effect of substrate (L-gulonolactone) levels, storage time,

antioxidant (glutathione, GSH) levels, tissue sample to buffer ratio, and sampling locations in the liver on GLO activity were analyzed. Five pigs for each variable were killed and the liver collected and frozen (-80°C). The substrate levels evaluated were 0, 33, 66, 100, and 132 mM. Enzyme activity increased quadratically (P $<$.01) as substrate levels increased and plateaued at 100 mM of gulonolactone. The GSH was added at 0, 16, 33, 50, and 66 mM, but GLO activity was not affected (P $>$.15). Enzyme activity was analyzed after 0, 7, 15, and 30 d of storage. No difference (P $>$.15) was found for the different storage durations. There was no difference (P $>$.15) in enzyme activity when analyzed from five different locations of the liver. The ratio of liver sample (g) to buffer (ml), including deoxycholate as a detergent for GLO extraction, was 1:1, 1:2, 1:4, 1:8, and 1:16. Enzyme activity increased quadratically (P $<$.01) as the ratio decreased. The absorbance scan of ascorbic acid from multi-wavelength spectrophotometry was not stable when the ratio of 1:8 or 1:16 was used. These results suggest that for measuring GLO activity in pig liver, the optimal level of gulonolactone and GSH should be 100 and 50 mM, respectively. The suitable liver sample to buffer ratio was 1 g of liver to 4 ml of buffer. GLO activity can be analyzed within 30 d of storage without loss of activity and with similar results at the various liver locations.

Key Words: Pig, Gulonolactone oxidase, Ascorbic acid

344   Comparison of the performance of, hematology and serum chemistry of rabbits fed supplementary antibiotics or copper or yeast or Leuceana leucocephala. A. A. Onifade, D. O. Adejumo, E. O. Onipede, R. I. Obiyan, A. O. Abu, O. T. F. Abanikannda, G. M. Babatunde, and A. Abubakar, *University of Ibadan, Ibadan, Nigeria.*

A comparison of four nutrition-based strategies to improve rabbit performance and health was the objective of this study. Two antibiotics: Tylosin or Neoterramycin at 100 mg/kg; Copper sulfate at 125 or 250 mg/kg; Yeast as *Saccharomyces cerevisiae* (YeaSacc[1026®]) at 1.5 or 3.0 g/kg, and a forage named *Leuceana leucocephala* served fresh at 50 g/day were added to experimental diets for rabbits. The control diet contained neither antibiotic nor forage supplement, and each diet was fed *ad libitum* to ten individually caged rabbits for 56 days. Performance of rabbits was determined weekly, while hematology and blood chemistry were determined terminally using conventional clinical procedures. The results showed that all the rabbits fed the supplements had superior (P $<$ .05) growth rate, feed intake and feed conversion to the control group. The erythrocytes and hematocrit were highest(P $<$ .05) in rabbits fed 3.0 g/kg yeast and 250 mg/kg Cu, while Leucocytes were highest (P $<$ .05) on Neoterramycin and Cu-based diets and lowest (P $<$ .05) on *Leuceana*-supplemented diet. Activities of alkaline phosphatase, aspartate and alanine aminotransferases were highest (P $<$ .05) in the control rabbits whereas feeding antibiotic- and Cu-based diets resulted into lower (P $<$ .05) values for these enzymes than yeast-supplemented diets. Total protein and albumin were highest (P $<$ .05) in rabbits fed supplemental Cu and yeast while antibiotics and Leuceana caused moderately higher (P $<$ .05) level than the control. Serum cholesterol was lowest (P $<$ .05) in rabbits fed 3.0 g/kg yeast and highest (P $<$ .05) in the control group. Serum Ca^{2+} concentration was highest (P $<$ .05) in the control rabbits but generally comparable (P $>$ .05) on other treatments. Fasting glucose was highest (P $<$ .05) in rabbits fed 250 mg/kg Cu and the control diets while rabbits fed supplemental Leucaena and Neoterramycin had the least (P $<$ .05) concentration. These data suggest that all the supplements have growth promoting effects in rabbit and differently modulate the blood chemistry; however, feeding supplemental yeast or *Leuceana* forage are highly recommended since both are neither chemicals nor antibiotics.

Key Words: Rabbit, Performance and Blood Chemistry, Feed Additives

PASTURES & FORAGES

345   Supplementation strategies for beef cattle consuming low-quality forages in the western US: An executive sumary of a WCC 104 publication. T. DelCurto*, *Eastern Oregon Agricultural Research Center, Oregon State University, Union.*

Beef cattle production in the Western US faces numerous regional challenges. Arid rangelands with limited forage production, as well as, seasonal and yearly extremes in forage quality create the need for supple-

mentation programs that are dynamic and regionally specific. Likewise, some areas consist of cool season forage bases and(or) high elevation rangelands characterized by significant winter precipitation (snow accumulation) which, as a result, necessitates heavy reliance on harvested forage during the winter. The economic future of western beef producers may relate to the ability to reduce winter feed costs with the use of low-quality roughages such as bi-product straws, and dormant,

stockpiled forages. Winter management strategies, in turn, often blend optimal production with low-input, economically sustainable strategies that may differ from other regions of North America. Our Western Coordinating Committee (WCC 104) endeavored to create a publication that defined supplementation of low-quality roughages in the context of western beef production systems. This publication, like many others, focuses on protein, energy, and protein form issues. Additionally, this publication includes discussions of general supplementation concepts (matching production expectations with the resources available), strategies for supplementat delivery, supplementation of vitamins and minerals, comparisons of hand-fed versus self-fed supplements, and supplementation concepts within economically sustainable framework. While most authors conducted general reviews within their topic areas, emphasis was placed on regional research and, more specifically, research specific to western beef production systems.

Key Words: Beef cattle, Low-quality roughages, Supplementation

346   Forage quality and animal performance in beef heifers grazing stockpiled fescue as influenced by supplemental whole cottonseed (WCS). M. H. Poore*, M. E. Scott, S. P. Morgan, and J. T. Green, *North Carolina State University, Raleigh, NC.*

An 83-d trial was conducted to determine changes in quality of stockpiled fescue and to evaluate performance of beef heifers. Thirty-six heifers (initial wt 265 kg, initial body condition score 5.0) were assigned to six groups. Each group was randomly assigned to a 2.4 ha infected fescue pasture which had received 76 kg/ha N on Sept 1. An estimated 4499 kg/ha of forage was available when the trial started Dec 3, 1997. The heifers were strip-grazed with daily forage allocation and had access to a mineral mix. Groups were rotated among pastures weekly to control for pasture differences. Three groups were fed daily .33% of body weight as WCS (.87 kg DM/head, 24.4% CP) with a small amount of concentrate (.16 kg DM/head, 15.8% CP) to aid WCS consumption. Quality of forage to be grazed the next week was determined in each pasture by taking grab samples above the 5 cm target grazing height. Forage samples were separated at two week intervals to determine proportions and composition of green and brown tissue. Shrunk ADG (.56 kg/d vs .46 kg/d; P<.06) and final body condition score (5.4 vs 5.0; P<.03) was higher for supplemented heifers. Blood urea N tended to be lower for unsupplemented heifers (7.8 vs 9.7 mg/dl; P<.10) at d 27, but did not differ at d 55 (9.2 mg/dl) and d 87 (12.2 mg/dl). Forage averaged 16.8% CP, 82.0% in vitro true organic matter digestibility (IVTOMD) and 25.9% ADF. Each component showed quadratic effects (P<.01) over time, with CP and IVTOMD being lowest Feb 3 (13.8 and 77.8%, respectively) and ADF highest on both Jan 13 and 27 (28.5%). Brown tissue averaged 10.3% CP, 63.9% IVTOMD and 35.7% ADF and did not vary over time. Green tissue averaged 90.5% IVTOMD and 22.1% ADF with no effect of time. CP in green tissue showed a quadratic effect (P<.01) with an average of 20.4% and a minimum of 17.9% on Dec 30. Forage quality was higher and varied less over the winter than anticipated. Heifers responded to supplementation, but performance was lower than expected based on forage quality.

Key Words: Stockpiled fescue, Supplementation, Whole cottonseed

347   Effects of corn and decreasing levels of soybean meal on intake and digestion of prairie hay by beef steers. T. N. Bodine*[1], H. T. Purvis II[1], and C. J. Ackerman[1], [1]*Oklahoma Agricultural Experiment Station, Stillwater.*

An 8 x 8 latin square experiment with 2 x 4 factorial arrangement of treatments was designed to determine the effects of supplemental corn fed with decreasing amounts of SBM on intake and digestion of prairie hay. A Corn+SBM supplement was fed in a preliminary trial to determine hay intake and OM digestibility (HOMD) to be used in formulating diets. Eight ruminally cannulated steers (318 kg) were fed ad lib prairie hay with 0% (NOCRN) or .75% (CORN) BW cracked corn, each with four incrementally decreasing levels of supplemental DIP (1.3, 1.0, 0.7, 0.4 g DIP/kg BW). Diets were formulated by balancing total diet DIP to TDN for the CORN+1.3 diet and decreasing supplemental g DIP/kg BW for the remaining CORN treatments. The NOCRN supplements contained equal g DIP/kg BW as each respective CORN supplement. Supplement DM intake was equalized within NOCRN (1.22 kg/(steer*day)) or CORN (3.27 kg/(steer*day)) treatments with cottonseed hulls. Decreasing DIP in CORN treatments resulted in a linear (P

< .01) decrease in hay OM intake (HOMI; 5.25, 5.31, 5.03, 4.05 kg/d) with a quadratic (P < .01) response (6.75, 6.55, 6.27, 3.71 kg/d) in NOCRN treatments. Feeding CORN+0.4 increased (P < .01) HOMI (4.05 vs 3.71 kg/d) over NOCRN+0.4. A cubic (P < .01) response to decreasing DIP was observed in HOMD (49.3, 41.9, 45.8, 29.5%) in CORN supplements while no trend (P > .49) was found in NOCRN treatments (55.1, 56.2, 54.5, 58.0%). Supplementation with CORN+0.4 depressed (P < .01) HOMD (29.5 vs 58.0%) compared to NOCRN+0.4. Decreasing DIP resulted in a linear (P < .01) decrease in total digestible OMI (TDOMI; 5.51, 4.92, 4.89, 3.70 kg/d) in CORN treatments with a quadratic (P < .01) effect (4.75, 4.55, 4.14, 2.66 kg/d) in NOCRN treatments. Supplementation with CORN+0.4 increased (P < .01) TDOMI (3.70 vs 2.66 kg/d) compared to NOCRN+0.4. Balancing total diet DIP to TDN appeared to overcome negative associative effects typically found when low-quality forages are supplemented with large quantities of low-protein, high-starch feeds.

Key Words: Protein, Starch, Fiber digestion

348   Undegraded intake protein supplementation of steers on native Sandhills range. C. B. Wilson*[1], T. J. Klopfenstein[1], and D. C. Adams[2], [1]*University of Nebraska, Lincoln, NE,* [2]*University of Nebraska WCREC, North Platte, NE.*

A trial was conducted to evaluate the effects of undegraded intake protein (UIP) supplementation on pasture gains of compensating yearling steers and summer born calves. Upland sandhills range consisting of a mixture of warm and cool season species was utilized in 1998 (June1 to September 8). Forty-eight yearling steers (339 kg) were used in a completely randomized design with a 4 × 2 factorial treatment arrangement. Yearlings were wintered at four rates of gain, .68 (Fast), .2 (Slow) and, .45 kg/d (Slow/Fast and Fast/Slow). Thirty-two summer born (June-July 1997) calves (235 kg) were also utilized. All steers and summer born calves were assigned to one of two summer treatments: supplemented or unsupplemented control. The supplement supplied .2 kg of UIP per d attained by feeding 1.3 kg of supplement 3 d/wk. Supplement consisted of 78.5% treated soybean meal, 18.5% feather meal, and 3% molasses (DM basis). Biweekly forage samples contained on average (DM basis) 10.5% crude protein and 1.95% UIP (%DM). UIP supplementation significantly improved pasture gains in supplemented steers over unsupplemented controls (.15 kg/d; P < .05). Fast had a response of .22 kg/d to supplementation while Slow had a response of .15 kg/d. However, the interaction was not significant (P = .60). Summer born calves showed a positive response to the supplement (.15 kg/d; P = .0001) compared to unsupplemented summer born calves. Feedlot data showed no significant effect of summer treatment on DMI however feedlot average daily gain was significantly higher (P = .06) for unsupplemented cattle. There was also a trend (P = .17) for increased gain/feed for unsupplemented cattle. Carcass data showed no significant effects on fat, marbling or yield grade (P > .1) across summer treatment. Overall, UIP supplementation was an effective way to improve summer gains on pasture but the improved gains were not maintained in the feedlot.

Key Words: Undegraded intake protein, Compensatory gain, Calves

349   First limiting nutrient for nursing calves grazing native range in southeastern North Dakota. T. W. Loy*, G. P. Lardy, J. S. Caton, and M. L. Bauer, *North Dakota State Universtiy, Fargo.*

Thirty-two spring-born, crossbred calves (average initial wt=169 ± 9.42 kg) were used in a randomized complete block design to evaluate the first limiting nutrient of nursing calves during the summer grazing season. Calves were blocked by sex, stratified by weight and parity, and assigned to one of four treatments: Control (no supplement); Energy (100% soy hulls; 385g/d); DIP (68% soy hulls, 32% SBM; 375g/d); or DIP+UIP (80% sulfite liquor-treated soybean meal, 16% feather meal, 4% blood meal; 375g/d). Supplements were formulated to be similar in ME and the DIP and DIP+UIP supplied equal amounts of degradable protein. Supplemented calves were fed individually and refusals were collected following each feeding. Weight gain, fecal output and milk intake (MI) were measured in July, August and September. Forage intake was estimated during each period by 6-d total fecal collection with 4 steers per treatment. Six ruminally-fistulated yearling heifers were used to collect extrusa samples, which were analyzed for CP, NDF, ADF and IVOMD. MI was measured using the 12-hour weigh-suckle-weigh technique. Two-day weights were taken to determine weight gain. GLM

procedure of SAS was used to determine treatment effects. Orthogonal contrasts were used to compare Control vs. supplemented calves; Energy vs. protein-supplemented; and DIP vs. DIP+UIP. MI tended to differ between treatments ($P = .11$) and supplemented calves had higher MI than Control calves ($P = .02$). Total forage intake (OM kg/d) differed between Energy calves and those on protein treatments ($P = .03$). Forage intake as a percentage of body weight was affected by treatment ($P = .06$). Control calves had higher intakes compared to those receiving supplement ($P = .07$) as did Energy calves vs. protein-supplemented calves ($P = .05$). Supplemented calves gained faster than Control calves over the entire trial ($P = .05$). Based on this data, energy appeared to be the first limiting nutrient for weight gain by nursing calves grazing native range in eastern North Dakota.

Key Words: Nursing calves, Supplementation

350   Effects of bypass methionine on the performance of growing cattle fed bermudagrass hay supplemented with molasses-based supplements. D. I. Hopkins[1], W. E. Kunkle*[1], A. C. Hammond[2], D. B. Bates[1], and B. A. Reiling[1], [1]University of Florida, Gainesville, [2]USDA, ARS, Brooksville, FL.

This research investigated whether performance responses to protein supplements could be explained by total sulfur amino acids in bypass (UIP) protein. Supplements were formulated to provide 1, 2, 3, 4, or 5 g/d of total sulfur amino acids (TSAA, methionine plus cystine) in the UIP from either blood-feather meal (BFM, 50:50), corn gluten meal (CGM) or a rumen protected methionine (MET, Smartamine M'). These were compared to a control supplement. Supplements contained 84% fortified (urea, minerals, vitamins) sugarcane molasses and 16% corn. Corn was replaced with the respective protein source in the supplements. Fourteen pens (6 head/pen) of crossbred steers and 14 pens of crossbred heifers were assigned to the 16 treatments in 1996-97. Fifteen pens (5 head/pen) of crossbred steers and 15 pens of crossbred heifers were assigned to the 16 treatments in 1997-98. Calves averaged 240 kg and body condition score 5 at the start of the trials. Bermudagrass hay was offered ad libitum and molasses slurries were limit fed at 2.7 kg/d (fed twice each week) to growing cattle during the 105- to 120-day trials (December to March). Animal data were averaged for each pen which was the experimental unit and data for each experimental variable was regressed on TSAA level. Cattle gains increased linearly ($P < .01$) as bypass TSAA level was increased from 0 to 5 g/d. Each gram of bypass TSAA increased gain 27g/d. All sources of methionine gave similar ($P = .53$) results suggesting that TSAA concentration of BFM and CGM supplements was the limiting nutrient that was improving performance. Quantity and source of bypass TSAA did not affect dry matter intake ($P > .10$) which averaged 5.8 kg/d. Gain/feed was improved .0036 units (linear, $P = .03$) for each gram of bypass TSAA up to the 5 g/d and all sources of bypass TSAA gave similar results ($P = .39$). Cattle fed BFM and CGM supplements had increased BUN (11.6 to 16.3 mg/dl) as the bypass TSAA level and total nitrogen intake increased, but cattle fed increasing levels of MET supplement had similar BUN (11.3 mg/dl) and total nitrogen intake. This research suggests that TSAA concentration in supplemental UIP is an important factor for growing cattle fed forage based diets.

Key Words: Supplementation, Methionine, Molasses

351   Nitrogen metabolism in pregnant mares fed grass hays containing different concentrations of protein. J. Boyer*[1], N. Cymbaluk[2], B. Kyle[2], D. Brown[1], and H. Hintz[1], [1]Cornell University, Ithaca, NY, [2]Linwood Ranch, Carberry, Manitoba.

A study was conducted to determine the protein intake needed to maintain nitrogen balance in pregnant mares. Twenty pregnant mares (12 of light horse breeding, average body weight, 600 kg and 8 of draft horse breeding, average body weight, 800 kg) were fed either early cut (mid July) or late cut (early August) mixed, mostly timothy, grass hay at a rate of about 2% of body weight. In addition, all horses received oats at 1.8 kg/day. These diets were fed for 145 days starting in November when the mares were about 4-1/2 months pregnant. Balance studies were conducted in December and February. Feces and urine were collected for five days. The early cut hay, late cut hay and oats contained 11.3, 7.1, and 13.6% crude protein respectively (DM basis). The resulting early cut hay and oat diet provided 11.7% protein and the late cut hay and oat diet provided 8.1% protein (DM basis). Minitab was used to fit a general least squares means model to partition variance

among period, hay, breeding and experimental error from a 2 x 2 x 2 arrangement of treatments. No significant effects were found due to breed of horse or collection period. The apparent digestibility of protein in the early cut hay diet was greater (P<.001) than for late cut hay diet (63.7% vs 51.7%). Nitrogen retention was positive in both groups, but greater (P<.001) for horses fed early cut hay (29 g of N/day vs. 15 g N/day for late cut hay). Nitrogen retention was greater in mares fed the diet containing 11.7% protein, but the mares fed the 8.1% protein diet were in positive nitrogen retention. Both groups had healthy foals of normal weight. When protein is provided by grass hay and oats (high fiber diet), it appears that the protein requirement for pregnant mares may be less than the 10% protein suggested by NRC.

Key Words: Horse, Nitrogen balance, Hay maturity

352   Effect of nitrogen fertilization, harvest date, and species on protein fractions of warm-season grasses. C. R. Johnson*, B. A. Reiling, P. Mislevy, and M. B. Hall, University of Florida, Gainesville, FL.

A split-plot study was designed to analyze the effect of fertilization and harvest date on protein fractions of Cynodon dactylon (L) (BER) and Cynodon nlemfuensis Vanderyst var. nlemfuensis (STAR). The main plot was species and it was randomized to 4 complete blocks. Split plots were the fertilization (FERT) treatments (0, 39, 79, 118, 157 kg N/ha). Plots (n=40) were established in 1996 and harvests conducted every 4 weeks, beginning June 1997 (HARV 1-5). Fertilizer was applied after each harvest. Fresh forage samples were force air-dried at 60°C and ground to pass through a 1mm screen. Dependent variables were total nitrogen (N) and protein fractions as presented in 1996 National Research Council Nutrient Requirements of Beef Cattle (A, B_1, B_2, B_3, C). All protein fractions are reported as a percentage of total N. Fertilizer linearly increased (P<.01) total N of BER and STAR. As a percentage of DM, BER and STAR had 1.6, 1.7, 2.1, 2.4, 2.8 and STAR had 1.6, 1.9, 2.2, 2.7, 3.0 ± .5% N for FERT 0, 39, 79, 118 and 157, respectively. In both species, a linear increase (P<.01) was observed for effect of FERT on A. Means for A at FERT 0 was 28.8%, FERT 79 was 32.1% and FERT 157 was 38.6% (P<.01). Fertilization had no effect on B_1, but later HARV decreased (P<.01) B_1 from 8.6% (HARV 2) to 5.3% ± .5 (HARV 5). Mean values for B_2 (24.7 and 24.0% ± .5 for BER and STAR, respectively) were unaffected (P>.05) by specie, HARV or FERT. Fertilization caused a linear decrease in B_3 (34.2, 30.2, 28.9, 26.8 and 25.0 ± .8% for FERT 0, 39, 79, 118 and 157, respectively; P<.01) across species. High levels of FERT also decreased (P<.01) C. For FERT 0, 39, 79 and 118, there was no difference (P<.01) in C, however FERT 157 decreased C by .7 and .3 percentage units for BER and STAR, respectively (P<.01). In conclusion, STAR had more total N and B_1 than BER, but less B_3. There was no difference between species for B_2 and C. Fertilization increased A, whereas all other fractions tended to decrease linearly due to FERT.

Key Words: Protein fractions, Forage, Fertilization

353   Chemical composition and ruminal degradability of processed alfalfa products. A. F. Mustafa, D. A. Christensen, and J. J. McKinnon, University of Saskatchewan, Saskatoon.

A study was conducted to determine effects of processing on chemical composition and ruminal degradability of three alfalfa products. These included dehydrated (dehy) pellets, sun cured pellets, and cubes. Results of the chemical analysis showed that sun cured pellets had the highest (P < .05) NDF and ADF and total carbohydrate levels followed by cubes, and dehy pellets, respectively. Crude protein (CP) content was highest (P < .05) for dehy pellets (20.4%), intermediate for sun cured pellets (16.0%), and lowest for cubes (15.3%). Intermediately degradable CP was the main protein fraction in the three products and was higher (P < .05) in cubes than in dehy and sun cured pellets. Estimated net energy of lactation was highest (P < .05) in dehy pellets (1.41 Mcal/kg), intermediate in cubes (1.25 Mcal/kg) and lowest in sun cured pellets (1.23 Mcal/kg). Results of the in situ trial indicated that dehy pellets had higher (P < .05) ruminal protein degradability than sun cured pellets and cubes. The estimated rumen escape protein value for dehy pellets, sun cured pellets and cubes were 36.1, 42.0, and 49.8%, respectively. It was concluded that alfalfa products used in this study varied in their chemical composition and ruminal degradability. The

results also suggest that the dehydration process failed to increase the rumen escape protein value of dehy alfalfa pellets.

Key Words: Alfalfa, Processing, Rumen degradability

354   Social behavior of grazing beef cattle: implications for management. B. F. Sowell*, J. C. Mosley, and J. G. P. Bowman, *Montana State University, Bozeman, MT.*

The purpose of this paper is to explore the social structure and behavior of grazing beef cattle and apply that knowledge to management problems. Cattle herds are composed of stable, social subgroups. These subgroups form strong, long-term social bonds which influence home range use. Selective culling is one management strategy which may be used to alter subgroup composition and home range fidelity. This technique could improve cattle distribution and reduce damage to riparian areas. Herding is another technique which can improve habitat use by altering home range fidelity. Grazing distribution is often a learned response. Management strategies which alter the social composition and structure of cattle subgroups can affect habitat use. If a particular subgroup has desirable range use patterns, replacement heifers should not be introduced from outside subgroups. Cattle form social hierarchies which can present a number of feeding problems. Older, heavier, more dominant animals may consume a greater proportion of supplement than smaller, less dominant animals. Sorting cattle into similar age groups with similar physiological demands can improve intake variation between individuals. Variation in individual supplement consumption may be reduced by changing delivery methods. Management of grazing cattle is an exercise in behavior modification. The more we understand about these behaviors and how they are acquired, the more readily they can be manipulated to enhance management.

Key Words: Selective culling, Subgroups, Social hierarchies

355   Grazing time and assessment for beef cows on pasture using GPS. M. C. Udal, L. W. Turner, B. T. Larson, L. J. Driedger*, and S. A. Shearer, *University of Kentucky, Lexington, KY.*

Global Positioning Systems (GPS) can be used to assess animal behavior and grazing patterns. Collars with GPS receivers tracked beef cows in summer on continuously grazed fescue. Animal activity (grazing, standing, lying) was determined by two dual-axis motion sensors in GPS collars that record "up-down" and "side to side" movements of head and neck. Minimum time between two logged events (pulses) is 0.5 s. Events counted per sensor per time period indicate relative activity. Seven GPS_2000 collared cows were placed in a 6 ha pasture. GPS fixes were taken every 5 minutes for 7 days, and the activity sampling window was set for the 4 minutes between fixes. Cows were observed on 4 occasions of up to 8 consecutive hours to validate motion sensor counts to specific activity (standing, grazing, lying). Counts from activity sensors were summed for the 4 minutes between the 5 minute GPS fix intervals. Data were analyzed for differences between collars and activity periods. A counter sum cutoff was determined that classified activity of cows, and validated observed data. Visual observations documented 135 active (grazing) periods and 1196 inactive (standing or lying) periods of 5 minutes each. Sensor values were different between collars (P < .003). Observed grazing and non-active sensor count means for all cows indicated the activity classification means were different (P < .0001). The system correctly classified grazing (94.8%), and inactive (91.2%) data records (91.7% of total records). The GIS database visualized inactive points and grazing locations. Grazing locations were well spaced and distributed. Inactive points were clustered near water, or in favored resting places. Predicted grazing time mean values were 32.9% per day. Four of five collars estimated grazing time within 1.3% of the mean. One collar produced an estimate of 1/3 less grazing time, which could result from sensor variablilty, animal differences, or collar attachment differences. This technique shows promise for assessing grazing behavior of cows on pasture.

Key Words: Grazing, Beef cattle, GPS

356   Beef cow-calf production from pastures containing hay-type or grazing tolerant alfalfa hybrids grazed by season-long or complementary stocking. M. L. Hermann* and J. R. Russell, *Iowa State University, Ames, IA.*

To evaluate forage production, legume persistence, and cow-calf production from pastures containing hay-type and grazing tolerant alfalfa hybrids and grazed by different stocking systems, six 2.02-ha pastures were seeded in 1997 with 'Barton' smooth bromegrass, a mixture of 'Affinity' alfalfa (a hay-type hybrid) and 'Barton' smooth bromegrass, or a mixture of 'Amerigraze' alfalfa (a grazing tolerant hybrid) and 'Barton' smooth bromegrass to be grazed season long. Four 2.02-ha pastures to be used for complementary grazing were divided into 1.21 ha seeded with 'Barton' smooth bromegrass and .81 ha seeded with 'Affinity' or 'Amerigraze' alfalfa and 'Barton' smooth bromegrass. In 1998, each pasture was divided into ten paddocks and rotationally strip-stocked with crossbred cows at 1.98 cow-calf units/ha for 120 d beginning on May 18. On June 1, hay was harvested from 40% of each pasture. Cows grazed paddocks in the remaining 60% of each pasture for the first 44 d and 100% of each pasture on d 45 to 120. Daily forage allowance was calculated from the live mass estimated with a falling plane meter (1.2 kg/m^2) and assuming that DMI of each cow-calf pair was 3.5% of cow's BW and grazing efficiency was 50%. Total and live forage masses were greater (P<.05) in May and September from all alfalfa pastures than the season-long smooth bromegrass pastures and from season-long alfalfa pastures than pastures using alfalfa for complementary grazing. Proportions of 'Affinity' and 'Amerigraze' alfalfa in pasture live DM decreased 55 and 70% in pastures grazed season long and 42 and 60% in pastures using alfalfa for complementary grazing (Hybrid, P<.05; Grazing system, P<.05). Calf daily gain (kg/d) and seasonal BW production (kg/ha) were not affected (P>.10) by the presence of alfalfa, alfalfa hybrid, or grazing system. Total animal (cow and calf) production was greater (P<.05) in pastures containing alfalfa than smooth bromegrass and greater (P<.10) in alfalfa pastures grazed season long than those grazed by the complementary system.

Key Words: Beef cattle, Alfalfa, Grazing

357   Performance and nutrient utilization of steers consuming kenaf, pearl millet, or bermudagrass. B. J. Rude, B. S. Baldwin, K. C. Hanson*, and D. L. Trammell, III, *Mississippi State University, Starkville, MS.*

Kenaf is gaining in popularity as a fiber crop in the southeastern U. S. During the vegetative phase nutrients from kenaf may be utilized for cattle growth. To determine animal performance, 72 steers (214 ± 65 kg) were allotted to one of three forages: kenaf (K); pearl millet (M); or bermudagrass (B) and allowed to graze for 56 days. During the first 28 days, steers grazing M gained faster (P < .01; .90 kg/d) than those grazing K (.71 kg/d) but slower than steers grazing B (1.05 kg/d). During the 2nd 28 d, steers grazing B gained slower (P < .05; .24 kg/d) than those grazing K or M (.62 and .70 kg/d; respectively). Total gain for steers grazing M was faster (P < .05; .80 kg/d) than those grazing B or K (.65 and .67 kg/d; respectively). To determine nutrient utilization, 12 steers were divided into the same three forage groups and fed green chop while housed in metabolism crates. Dry matter intake differed (P < .05) between K, B, and M (1.07, 2.05, and 2.63 % of BW; respectively). Apparent digestibility of DM (60, 68, and 76 %) and OM (62, 73, and 80 %) were different (P < .05) for B, K, and M; respectively. Apparent digestibility of NDF, ADF and hemicellulose was less (P < .05) for kenaf (43, 32, 59 %; respectively) than for B and M (69 and 78 %, 69 and 73 %, 68 and 83 %; respectively). Apparent digestibility of protein was less (P < .05) in steers consuming B (58 %) than for those consuming K or M (78 and 77 %; respectively). Apparent digestibility of energy was least (P < .05) for B (66 %) and greatest for M (79 %) with K being intermediate (71 %). More (P < .05) protein was retained in steers consuming M (320 g/d) compared to those consuming B or K (78 and 107 g/d; respectively). Energy retained by steers was different (P < .05) for B, K, and M (9.6, 5.2, and 16.3 kcal/d; respectively). Steers grazing K did not perform as well as those grazing M. This may be due to steers utilizing protein and energy more efficiently when grazing M compared to K.

Key Words: Kenaf Grazing, Nutrient Utilization, Beef Cattle

358   Management influences on gaseous energy losses from grazing beef cattle. K. C. Olson*[1], J. A. Walker[2], B. R. Bowman[1], C. E. Foley[1], C. A. Stonecipher[1], and D. G. Eddington[1], [1]*Utah State University, Logan, UT,* [2]*South Dakota State University, Pierre, SD.*

Management practices that reduce methane emissions contribute to improved energetic efficiency by ruminants. Methane reductions also contribute to reduced greenhouse gas loading. The objective was to evaluate management methods to decrease methane emissions from grazing beef cattle by improving production efficiency. Animal performance, nutrient utilization, and methane emissions were measured in 3 experiments to evaluate relative sensitivity of methane responses to different types of management practices including cattle, grazing, or forage management. To evaluate cattle management, cows and calves from an accelerated slaughter program were compared to contemporaries in a normal feeding program. Calves were compared from weaning to slaughter. Methane emissions per day were similar, but total methane emitted from weaning to slaughter was reduced ($P = .0009$) by 57% because accelerated steers were slaughtered about 90 d sooner. Genetically superior cows used to produce accelerated calves were compared to control cows throughout the annual production cycle. Methane emitted per cow was similar ($P > .05$) but methane emitted per unit of calf gain was less for superior cows because of faster gain by the calves. To evaluate grazing management, a stocking rate trial was conducted using 4 rates to evaluate the effect on cows and calves on irrigated pastures during the growing season. Increased stocking rate decreased animal performance and nutrient intake, and tended to increase methane emitted per unit of cow or calf gain. To evaluate forage management, a grazing trial was conducted using pregnant, non-lactating beef cows during the fall and lactating beef cows in the spring to compare 4 improved grasses seeded on range and native range. Methane emissions varied among grass species and grazing season. For example, native range provided the lowest methane in fall, but was among the highest in spring. Methane emission reduction was more sensitive to manipulation of animal than forage or grazing management.

Key Words: Beef Cattle, Grazing, Methane

359   Relationships between in vitro gas production and in vivo digestibility and intake of tropical feeds by cattle. E. Zerbini* and S. Fernandez-Rivera, *International Livestock Research Institute - ICRISAT, Patancheru, India; - ICRISAT, Sadore, Niger.*

The objective was to determine the relationship between in vitro gas production (G) and in vivo digestibility and intake of tropical feeds by cattle. Eight feeds from semiarid India including rice straw (2), millet straw (2), sorghum straw (2), groundnut hay (1) and natural pasture grass (1); and five feeds from Niger including natural pasture straw (4) and cow pea hay (1) were evaluated. In vivo digestibility and intake was carried out with F1 Friesian x Sahiwal bulls (263.7 kg BW) in India and with Indigenous Zebu steers (278.9 kg BW) in Niger. Mean and range (g/kg DM) of selected parameters measured in feeds were: OM, 901.1, 837 to 956; N, 8.4, 2.4 to 24.6; NDF, 639.5, 396.1 to 736.8; ADF, 474.7, 291.5 to 552.3; Lignin, 85.8, 35.5 to 157; digestible dry matter (DMD), 520.4, 345.7 to 636.6; digestible organic matter (OMD), 548.2, 370.7 to 681.7; dry matter intake/kg $BW^{.75}$ (DMI), 68.1, 35.3 to 97.2; organic matter intake/kg $BW^{.75}$ (OMI), 61.3, 31.5 to 89.0; and digestible organic matter intake/kg $BW^{.75}$ (DOMI), 33.6, 15.1 to 55.9. Mean G at 48 hours incubation (G48) was 30.8 (22.9 to 40.7) ml/200 mg DM. G48 was highly correlated with N (r = .77, P < .01), NDF (r = -.76, P < .01), ADF (r = -.83, P < .001), but not with Lignin (r = .13, P = .67). Regression of DMD and OMD on G48 were: DMD = 342.7 + 5.73 G48 (r^2 = .187, P = .16) and OMD = 375.8 + 5.56 G48 (r^2 = .146, P = .22). Stepwise multiple regression using PROC REG of SAS resulted in the following relationships: DMD = 402 + 7.84 G48 - 1.54 Lignin (r^2 = .86, P < .001); OMD = 445 + 8.04 G48 - 1.81 Lignin (r^2 = .91, P < .001); DMI = -13.62 + 2.62 G48 (r^2 = .71, P < .001); OMI = -18.73 + 2.56 G48 (r^2 = .76, P < .001); DOMI = -18.0 + 1.95 G48 - .11 Lignin (r^2 = .90, P < .001). G48 alone explained only 15% of the variation in feed OMD, while Lignin added to the model explained 61% of that variation. However, G48 alone explained more than 70% of the variation in intake.

Key Words: Forage, Digestibility, Intake

360   Effect of water soluble carbohydrates on selection by sheep. S. W. Coleman*[1] and H. Dove[2], [1]*USDA-ARS, El Reno, OK,* [2]*CSIRO Plant Industry, Canberra, ACT, Australia.*

A series of experiments was conducted to examine whether sheep select herbage of higher water soluble carbohydrates (WSC) content. In late November 1998, a field of *Phalaris aquatica* at the research facility near Canberra, Australia, was partitioned and cut at either 0530 (M) or at 1130 (N) based on previous observations of the times of minimum and maximum herbage WSC content in phalaris swards. The cut material was conditioned that afternoon and compressed into rectangular bales the next morning. Cut hay dried rapidly, since maximum temperatures on the days of cutting and baling were $36°$ and $33°$C, respectively. Each hay was assayed for WSC (M 53.6 g/kg; N 78.7 g/kg DM) in duplicate and about 100 kg of each was coarsely chopped. A separate hay of moderate quality was used as a control (C). Each of the three chopped hays was fed to four sheep to determine rate of intake over five 2 minute intervals. Intake rates were 3.1, 5.0, and 2.7 g/min (P = .06) for C, M, and N hay respectively. A replicated 3x3 latin square design was used for the selectivity trials with the treatment being one of three two-hay comparisons (C-M, C-N, M-N). Sheep ate more M than C (difference = 2.9g/min; P < .05), more M than N (3.2g/min; P < .05) and equal proportions of C and N. Reduced intake rate and the observation of a harsh feel after grinding for N hay suggested that physical characteristics of the hays influenced selection more than the chemical differences between them. Samples of the M and N hays were ground through a Christy-Norris mill to pass a 1 mm screen and the ground material was applied to the C hay with sufficient water to cause it to adhere. The three hays were then fed as above one treatment being the control hay without ground material. Statistically, the sheep made no preference for any hay, but there was a numerical preference for N over both M (.4 g/min) and C (.6 g/min). These data suggest that any preference for increased WSC in these hays was masked by physical characteristics.

Key Words: Selectivity, Water-soluble carbohydrates

361   Evaluation of equations for estimating voluntary intake of forages and forage-based diets. J. E. Moore* and W. E. Kunkle, *University of Florida, Gainesville.*

Equations for estimating voluntary intake (VI) have been proposed by the National Research Council (NRC) and the National Forage Testing Association (NFTA). The NRC equations are based on NEm, or CP+ADF (1984 and 1996 beef bulletins). The NFTA equation assumes NDF intake is a constant 1.2% of BW. Objectives were to (1) evaluate acceptability of these equations, and (2) develop and evaluate a new equation. The database was derived from 30 publications and Regional Project S-45. There were 93 grass hays fed alone (36 temperate, 41 tropical, and 16 native) and 133 mixed diets fed to non-lactating cattle. Estimates of NEm and TDN were based on in vivo digestibility. Observed VI (DM, as % of BW) was regressed on VI estimated by the equations. Differences between estimated and observed values were calculated. A difference was considered unacceptable if its absolute value was > .46% of BW (that is 20% of the overall mean VI, 2.3% of BW). Equations were evaluated on balanced subsets where each entry had both NDF and ADF. In the following, numbers in parentheses after equation identifications are the percentage of estimates that were unacceptable for 68 forages fed alone: NFTA (71), NEm-1996 (62), NEm-1984 (15), and CP+ADF (24); and for 140 forages and diets: NEm-1996 (51), NEm-1984 (28), and CP+ADF (26). New equations were developed on a subset that included 48 forages and 68 diets from 19 publications and S-45, and were evaluated on an independent subset. Equations fit the data better when ADF rather than NDF was included. The best new equation is as follows for forages fed alone: VI (DM, as % of BW) = - 2.318 + .442*CP - .0100*CP^2 - .0638*TDN + .000922*TDN^2 + .180*ADF - .00196*ADF^2 - .00529 * (CP*ADF). For mixed diets, add + .186. For the evaluation set of 46 forages and diets, the percentages of unacceptable estimates were NEm-1996 (60), NEm-1984 (20), CP+ADF (21), and the new equation (7). Based on this study, the NFTA and NRC NEm- 1996 VI equations are unacceptable for grasses or grass-based diets. Acceptability of the new equation is supported by a mean difference = 0 and r^2 = .76.

Key Words: Forage, Intake, Prediction

362   Effect of bale harvest method and feeding time on performance of yearling beef heifers. H. W. Harpster*, R. C. Stout, E. H. Cash, J. W. Comerford, L. L. Wilson, R. L. Swope, and V. H. Baumer, *The Pennsylvania State University, University Park.*

Stands of predominantly alfalfa forage were harvested as round bale silage by three methods: unprocessed, C (conventional round baling); Sliced, S (New Holland.® 644 silage special baler) and prototype, P (experimental baler with a flail type pickup head designed to chop the forage as it entered the bale chamber). All forages were baled approximately 24 h after mowing using alternate bale and windrow techniques and were immediately wrapped in plastic. Bales were stored outside undisturbed for approximately 3 months until the feeding trial was initiated. At similar dimensions, the wet weight of S and P bales was 14% and 22% greater than conventional C bales indicating marked increases in bale density. Post-storage forage quality (% of DM) was excellent for C, S and P bales, respectively: CP, 22.2, 22.5, 21.8; ADF, 30.2^{ab}, 29.3^b, 30.9^a; and DM, 29.6, 32.1, 29.2 (ab, P < . 05). Dry matter losses (%) during storage were 5.2^{ab}, 3.55^b and 7.9^a, respectively. Forty-eight crossbred pregnant yearling beef heifers (438 kg) were assigned to six pens of eight heifers per pen. Two pens of heifers were randomly assigned to the C, S, and P forages. A 61 d intake study was divided into three phases: I, ad-libitum forage access, elevated cone feeders, 31 d; II, 2 h/d forage access, elevated cone feeders, 14 d; and III, 2 h/d forage access, ring feeders, 14 d. Dry matter intake (kg $hd^{-1}d^{-1}$) for heifers fed C, S, and P bales were: I. 10.87, 11.44, 11.29; II. 6.11, 6.79, 6.00: and III. 6.14, 7.69, 6.51. Body weight gain for the entire trial was (kg $hd^{-1}d^{-1}$) 0.81^a, 1.00^b, 0.72^a for the C, S, and P treatments (ab, P < . 05). It is concluded that sliced processing of round bale silage during baling is conducive to improved forage intake and body weight gain by cattle but that no advantage to the prototype processing was noted.

Key Words: Forage, Intake, Beef cattle

363   Effects of feeding spearmint silage on nutrient utilization and rumen fermentation of steers. A. F. Mustafa*, J. J. McKinnon, and D. A. Christensen, *University of Saskatchewan, Saskatoon.*

The objectives of this study were to determine the effects of feeding spear mint (Mentha spicata) silage on ruminal fermentation and nutrient utilization by beef steers. Six steers fitted with rumen cannulae were fed mint silage or barley silage (three animals per treatment) in a 30-day metabolism trial. Relative to barley silage, mint silage contained 17, 180, 20, and 330% more (P<.05) neutral detergent fiber, acid detergent lignin (ADL), crude protein (CP), and acid detergent insoluble CP, respectively. Steers fed mint silage consumed less (P<.05) dry matter than steers fed barley silage. Ruminal pH was higher (P<.05) while volatile fatty acid concentrations were lower (P<.05) for mint silage fed steers than for barley silage fed steers. Ruminal degradability of dry matter, CP, and ADF were 46, 62, and 11%, respectively higher (P<.05) for barley silage than for mint silage. Total tract nutrient digestibility coefficients were higher (P<.05) for barley silage than for mint silage fed steers. Digestible energy content (Mcal/kg) was higher (P<.05) for barley silage (2.63) than for mint silage (1.86). The results suggest that due to its high ADL and acid detergent insoluble CP, mint silage was poorly utilized by steers.

Key Words: Mint silage, Rumen fermentation, Nutrient degradability

364   Pearl millet grain hybrid silage: Forage quality and growing steer performance. G. M. Hill*[1], P. R. Utley[1], R. N. Gates[2], W. W. Hanna[2], and J. C. Johnson, Jr., [1]*University of Georgia Coastal Plain Station, Tifton, GA, USA,* [2]*USDA-ARS, Coastal Plain Station, Tifton, GA, USA.*

Spring-planted "HGM-100" pearl millet grain hybrid [*Pennisetum glaucum* (L.) R. Br.] and corn (*Zea mays* L.) were compared as silages for growing steers. Pearl millet (PM) was planted May 20, 1996 (4.85 ha; 5.60 kg/ha; .91 m rows). On July 31, 1996, PM was direct-cut with grain at soft dough stage, weighed, and a microbial inoculant (Pioneer 1177) was added as PM was packed in large silo bags (diameter: 4 m; length: 18 m). Spring-planted corn was harvested at 38% DM, and stored in an oxygen limiting upright silo. In a 56-d trial, 75 beef steers (BW = 272 ± 36 kg; age = 9 mo) were ranked by BW and randomly assigned to dietary treatments : millet silage (MS); millet silage with ground shelled corn (5.0% of forage wt) added at ensiling (MSC); and

corn silage (CS). Steers were implanted with Synovex-S® on d 1, and initial and final BW were means of two daily full weights. Silages were fed free-choice, and soybean meal was fed with MS and MSC at .45 kg/steer daily, and CS at .68 kg/steer daily. The DM (%) and CP, ADF, NDF, and TDN (% of DM), respectively, of silages were: MS= 31.2, 11.1, 38.3, 57.4, 57.2; MSC= 36.4, 11.5, 36.9, 55.8, 58.6; CS= 41.2, 8.0, 25.8, 42.3, 69.8. The pH and NH_3, lactic acid, acetic acid, total VFA (% of DM), and lactic:acetic, respectively, for silages were: MS=6.04, .06, 4.23, 1.25, 1.52, 3.38; MSC= 5.35, .06, 5.65, .78, .85, 7.24; CS= 4.00, .02, 6.61, .99, 1.06, 6.68; treatments were not different (P > .10) for these variables. Steer 56-d ADG, final BW, silage DMI, total DMI [(silage + soybean meal); kg] and DM/gain, respectively, were: MS= .78b, 315.6b, 5.31b, 5.71b, 7.35a; MSC= .77b, 315.2b, 5.80a, 6.21a, 7.92a; CS= 1.22a, 340.6a, 5.58a, 6.21a, 5.05b; variables without common letters differ (P <.05) across treatments. Corn added at ensiling improved PM silage fermentation, but supplemental energy for PM silage would be required to equal performance of steers fed high-energy corn silage.

Key Words: silage, steer, millet

365   Comparison of sorghum silages, corn silage, and a typical feedlot receiving ration for average daily gain, feed intake and feed efficiency. B. Gravett*[1], K. R. Pond[1], V. G. Allen[1], R. Rice[2], and C. Johnson[2], [1]*Texas Tech University,* [2]*Seed Resource, Inc.*

Three sorghum silages and one corn silage, grown on the Texas South Plains, and a typical feedlot receiving ration were fed to 350 kg steers to determine daily gain (ADG), feed intake (FI) and feed-to-gain ratio (F:G). The study was a completely randomized block design using 80 steers, predominately Angus, with four steers per pen. The three sorghum silages were Fame (FM), Cow Vittals (CV) and Brown Mid-Rib (BMR) and were balanced to 12% crude protein using cottonseed meal (CSM). All steers were fed a vitamin and mineral pre-mix (PM). The corn silage (CS) was also balanced to contain 12% crude protein using CSM and PM. The feedlot receiving ration consisted of steam-flaked corn, ground alfalfa hay, CSM, urea, PM, fat and molasses. Steers were placed on a typical feedlot starter ration during a 2-wk adjustment period. On d 15, steers were weighed and treatments were introduced during a 4-d adjustment period. After 14 d, the CNTL diet was increased to an 80% concentrate corn diet, whereas the silage diets remained at 100%. On d 32, steers were weighed and daily gains, feed intake, and F:G were calculated. During the 32-d, FI kg/d differed (p < 0.05) and was 7.97a,5.93b, 5.98b, 6.35b, and 5.66b for the CNTL, FM, BMR, CV, and CS, respectively. The ADG, kg/d was 1.70a, 0.93b, 1.22b, 1.23b and 0.83b and the F:G was 4.73a, 6.56ac, 5.06ac, 5.98ac and 7.19bd for the respective diets. The CNTL diet was the most efficient diet overall and of the silage-based diets FM sorghum was more efficient.

Key Words: Silage, Sorghum, Beef Cattle

366   Role of supplemental vitamin E in neonatal lamb survival. P. G. Hatfield*, J. T. Daniels, R. W. Kott, and D. E. Burgess, *Montana State University, Bozeman, MT.*

Neonatal lamb mortality costs US sheep producers approximately $114 million annually. Mortality rates have been reported in excess of 20% with little improvement over the past 40 yr. Our objectives were to investigate: 1)the potential of supplemental vitamin E (**SE**), given to either newborn lambs or gestating ewes, to decrease neonatal lamb mortality and 2) the effect of SE on immune function. In a 2-yr study, 480 twin-born lambs/yr were used to determine the influence of SE (single dose of 390 IU/lamb) given to lambs shortly after birth on lamb survival. Although SE lambs had greater (P = .01) serum vitamin E concentrations than non-supplemented lambs (**NE**), lamb mortality and kg of lamb weaned/ewe did not differ (P > .56). In a 3-yr study, 430 ewes/yr were assigned to either NE or SE (330 IU daily, for 21d prior to lambing). During the first half of lambing, lamb mortality was lower (P = .03) in lambs born to SE than NE ewes (12 and 17% mortality, respectively), resulting in 2.6 kg more (P = .01) lamb weaned per SE than NE ewe. No differences (P > .20) were detected in mortality or kg of lamb weaned/ewe in late born lambs. To investigate SE and immune function, 52 twin-bearing ewes were assigned to NE or SE (400 IU daily, for 28 d prior to lambing). Half the ewes were vaccinated with Parainfluenza type 3 (**PI3**) to evoke an immune response that was measured as PI3 titers. Although serum vitamin E concentrations were greater (P < .01) in SE than NE ewes and lambs, no differences (P > .20) were

detected in colostral or serum IgG concentrations or serum PI3 titers of ewes and lambs. These results indicate that SE had no effect on these indicators of humoral immunity in the ewe or passive immunity to the lamb. Although SE when given to the ewe positively influenced lamb survival, the mechanisms of this effect remain unknown. Research directed towards cell-mediated immune function and fetal energy status may better address the role of vitamin E in neonatal lamb survival.

Key Words: Survival, Immunity, Vitamin E

367   Performance of Saint-Croix ewe-lambs under intensive grazing system in a seasonal rainfall meadow.

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The objective was to evaluate the effect of two intensive grazing systems, on different productive parameters of Saint-Croix ewe-lambs. Forty Saint-Croix ewe-lambs, three months old with 12.5 Kg initial body weight, were randomly alloted into two either short duration grazing (T1, n=20) or continuous grazing (T2, n=20) systems for a 168 days period. Grazing period for T1 was 3 days for about six hours per day in a lot of 1190 m2 of grassland. There were 21 grassland lots allowing one complete round in 60 days time enough for grass to growth. T2 was summited to continuous grazing, in a lot of 2500 m2 of grassland also six hours per day. The seasonal rainfall meadow was composite from two type of grasses, Buffel grass (Cenchrus ciliaris) and Pretoria 90 grass (Dichanthium annulatum). Precipitation during the period of study was 267 mm. Ewe-lambs were weighed (BW), measured heart girth circumference (HGC) and height at withers (HW), every 28 days either, to estimate growing. Results showed body weight were no different between treatments (T1=15.9kg, T2=14.9kg). HGC (T1=56.9cm, T2=58.3cm) and HW (T1=49.9cm, T2=51.4cm) were not significantly different also. However, at the end of 168 days period the grassland condition in T1 was good and in T2 is bad, whit a positive and negative tendency condition respectively. In conclusion, short duration grazing system showed a higher condition response at grazing, than continuous grazing system.

Key Words: Grazing systems, productive parameters, Saint-Croix

368   Selenium content of beef produced in North Dakota varies by geographic region.

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Recent evidence suggests that selenium (Se) has human health benefits including enhanced immune function, cancer prevention, and enhanced neuro-psychological function. Beef provides 17% of human dietary Se intake. Skeletal muscle from the semimembranosus, and liver samples were taken from cull cows obtained from twenty-one different ranches in five distinct geographic regions throughout North Dakota. Regions overlying geologic formations known to produce forages either high or low in Se were picked as target areas. Se concentrations were determined by hydride generator atomic absorption spectroscopy after acid digestion.

Differences in skeletal muscle and liver Se (mg/kg wet weight basis)

Region	Central (C)	Northwest (NW)	Southeast (SE)	South-central (SC)	Southwest (SW)
n	8	21	14	20	29
Muscle[1]	$.40 \pm .11^{b,c}$	$.67 \pm .22^{a}$	$.28 \pm .07^{c}$	$.48 \pm .10^{b}$	$.43 \pm .08^{b}$
Liver	$.61 \pm .11^{a,b,c}$	$.72 \pm .21^{a,b}$	$.47 \pm .07^{c}$	$.78 \pm .14^{a}$	$.60 \pm .17^{b,c}$

[1]Values are means $\pm$ SD; means with different superscripts are significantly different (P < .05)

Geographic region significantly affected muscle and liver Se content (P < .0001). All sampled areas in North Dakota produce beef higher in Se than the United States average (.22 mg/kg wet weight basis). Beef produced on land overlying seleniferous geologic formations have higher concentrations of Se in muscle and liver than the national and state averages. Further work is needed to show if beef high in Se can consistently be produced from these areas and whether this increase can enhance product marketability and producer profitability.

Key Words: Selenium, Beef, Liver

369   Quality characteristics and secondary chemistry of sericea lespedeza exposed to tropospheric ozone.

M. C. Powell*, D. D. Crosby, R. B. Muntifering, and A. H. Chappelka, *Auburn University, AL, USA*.

Tropospheric (i.e., ground-level) ozone (O_3) is the most significant phytotoxic air pollutant in the USA, and it is expected to increase globally by .3 to 1.0%/yr over the next 50 yr. Because little is known about O_3 effects on warm-season forages, we conducted an experiment in which 'Interstate 76' sericea lespedeza (*Lespedeza cuneata*) was grown in open-top chambers (OTC) to which added air had been carbon-filtered (CF), representative of that found at the cleanest air quality sites in the USA; non-filtered (NF), characteristic of ambient air in Auburn, AL; or enriched with O_3 to twice the ambient concentration of O_3 (2X). Primary-growth (early-vegetative, early-bloom and mid-bloom stages of maturity) and vegetative regrowth forage were harvested from each of six OTC (two OTC/air treatment) between 12 and 24 wk postseeding. Mean daytime O_3 concentrations over the entire experiment (May 7-October 23, 1997) were 22, 45 and 91 ppb, respectively, for CF, NF and 2X treatments. Mean ambient O_3 values peaked in mid-May and again in late August-early September at 50-60 ppb, and highest individual ambient O_3 values were recorded in late July, late August and mid-September at >90 ppb. Germination and seedling growth were unacceptably poor under 2X conditions, and this treatment was terminated following the initial primary-growth harvest. Concentrations of crude protein (CP) and cell wall constituents in primary-growth forage did not differ between CF and NF treatments, but CF regrowth forage had greater (P<.1) concentration of CP (15.9 vs 14.3%) and lower (P<.1) concentration of NDF (44.3 vs 47.1%) than did NF regrowth forage. Concentration of protein-precipitating tannins was greater (P<.1) for CF than NF primary-growth forage (115 vs 105 mg/g), although concentrations of total phenolics, condensed tannins and hydrolyzable tannins in primary-growth forage did not differ between treatments. In contrast, concentrations of total phenolics tended to be greater and condensed tannins lower in CF than NF regrowth forage. Seasonal changes in quality characteristics and secondary chemistry of sericea lespedeza exposed to ambient tropospheric O_3 may have nutritional implications to its utilization by herbivores.

Key Words: Tropospheric ozone, Forage quality, Sericea lespedeza

370   Effects of Seaweed extract and Endophyte infected-tall fescue grazing prior to the finishing period on beef color and shelf life.

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A total of 96 steers, 48 from Mississippi and 48 from Virginia were grazed on tall fescue that was either endophyte infected (E+) or endophyte free (E-) and had been treated or untreated with seaweed (Ascophyllum nodosum) extract. At the end of the grazing season steers from both locations were transported to the Texas Tech Feedlot and finished on the same finishing diet. After slaughter 48 strip loins were captured and delivered to the Texas Tech Meat Laboratory for color and shelf life determination. Steaks were removed from the strip loin at d 7, 14, 21, and 28 postmortem and placed in a display case for color determination. Color determinations were made by a beef sensory visual panel and a Minolta Colorimeter for 3 to 5 consecutive d for each of the four aging treatments. Additionally, cooked sensory determinations made. Seaweed extract treatment increased (P < .05) Hunter a* values and color scores and decreased percentage discoloration and browning. Effects of seaweed were greater in steers that grazed the E+ fescue (seaweed by endophyte interaction (P < .05). Cattle that grazed fescue not treated with seaweed extract had slightly increased initial and sustained tenderness and sustained juiciness panel scores over aging treatments (P < .05). Seaweed treatment on E+ fescue improved visual color, objective color, percentage browning and percentage discoloration measurements during d 2,3,4 and 5 of retail display by a $\frac{1}{2}$ to one full score (P < .05). The extension of shelf life in the retail case by treating fescue would result in fewer economic losses for the beef retailer. The mechanism through which seaweed increases the shelf life of beef is unknown and

requires further investigation but may be related to observed changes in antioxidant activities in the plant and animal.

Key Words: Endophytes, Seaweed Extract, Beef Color

371   Comparison of chromic oxide to chromium mordanted fiber for the estimation of ruminant fecal output. E. E. D. Felton* and M. S. Kerley, *University of Missouri-Columbia.*

Four dual-cannulated (rumen & duodenum) beef steers (average BW = 277 kg) were used in a replicated 2 x 2 Latin square designed experiment to compare the use of chromic oxide (Cr_2O_3) to chromium mordanted fiber (Cr-f) for the estimation of fecal output. Steers were individually tied in metabolism stalls, fed a common diet of chopped alfalfa hay and had *ad-libitum* access to water and trace mineralized salt blocks. Steers were fed at 110% of the previous day's intake. All steers were dosed twice daily at 12 h intervals with their respective treatment intra-ruminally, throughout each period. Each period consisted of 7 d of adaptation to diet and treatment followed by 3 d of total fecal collection. When predicted fecal output was expressed as a percent of actual fecal output, no difference was detected (P = .29) between the use of Cr_2O_3 (102.35%) and Cr-f (93.27%). Likewise, treatment (Cr_2O_3 vs Cr-f) had no effect (P > .10) on either dry matter intake (5.07 vs 4.90 kg/d) or diet digestibility (53.00 vs 49.76%). From these data it appears that both Cr_2O_3 and Cr-f do a similiar job as a tool for the estimation of fecal output.

Key Words: Fecal Output, Cattle, Chromium

372   Validation of a visual obstruction technique for estimating forage mass of Plains Old World bluestem. C. J. Ackerman*[1], H. T. Purvis II[1], G. W. Horn[1], M. E. Payton[1], L. T. Vermeire[2], S. I. Paisley[3], and T. N. Bodine[1], [1]*Oklahoma State University,* [2]*Texas Tech University,* [3]*Kansas State University.*

A visual obstruction technique was used to develop prediction equations for estimating forage mass of Plains Old World bluestem (*Bothriochloa ischaemum* L. Keng) during August of 1997 and 1998. Visual obstruction measurements (VOM) and clipped forage samples (CFS) were collected from 12 pastures (4.2 to 10.1 ha) assigned to a two-year stocking rate study. Pastures were grazed from May through August. Five VOM and CFS samples were collected at similar intervals throughout each pasture for a total of 120 observations. Forage samples were collected by clipping a quadrat (.1 m^2) to approximately 2 cm from the soil surface at the same site at which the VOM was recorded. Clipped forage samples were dried at 55^oC for approximately 72 h and weighed to estimate forage mass on a DM basis (FM). Experimental units for the stocking rate trial were individual pastures, therefore, the means of the five measurements from each pasture were used for the development of prediction equations. Regression analysis was conducted using FM and VOM as the dependent and independent variables, respectively. The relationship between FM and VOM was linear (P < .01) for both years. Dummy regression analysis indicated that the slopes of the regression lines for 1997 and 1998 did not differ (P = .23). However, the intercept of the regression line was greater (P = .02) in 1998 than in 1997, therefore, the prediction equations for each year are different and data were not pooled across years. Prediction equations for FM (kg DM/ha) were: Y = 1845.0 + 166.9x, r^2 = .60; Y = 2728.7 + 317.3x, r^2 = .57; for 1997 and 1998, respectively. Mean forage mass was 7338 (S_{yx} = 1833.8) and 6403 (S_{yx} = 1561) kg DM/ha for 1997 and 1998, respectively. Interpretation of these results may indicate that VOM has good potential for predicting forage mass of Plains Old World bluestem.

Key Words: Old World Bluestem, Forage Mass, Prediction Equations

373   Effects of terpenes on intake of alfalfa pellets by sheep. R. E. Estell*[1], E. L. Fredrickson[1], D. M. Anderson[1], K. M. Havstad[1], and M. D. Remmenga[2], [1]*USDA/ARS/Jornada Experimental Range, Las Cruces, NM,* [2]*New Mexico State University, Las Cruces, NM.*

Five experiments were conducted to examine influences of terpenes on intake of alfalfa pellets by sheep. Five mono- and sesquiterpenes that were related to tarbush (*Flourensia cernua*) consumption by livestock in previous studies using multivariate analysis were examined individually. Average concentrations of selected compounds (C) were 5, 25, 50,

100, and 10 'g/g of tarbush DM for *p*-cymene, α-humulene, 1,8-cineole, 3-carene, and sabinene, respectively. During each experiment, 45 individually penned lambs received one of five treatments (multiples of C: 0X, .5X, 1X, 2X, or 10X) for five consecutive days. Treatments were applied to alfalfa pellets (.64 kg, DM basis) and intake was monitored during a 20 min interval each morning. Lambs were adapted to handling and individual pen feeding for 10 d before experiments began and were maintained and fed alfalfa pellets (4.7% of BW, DM basis) as one group except during 20 min tests. No linear or quadratic responses of intake to treatment level were detected (P > .05) for any of the five compounds. These five terpenes had little influence on consumption of alfalfa pellets, suggesting these compounds are not responsible for differential herbivory of individual tarbush plants by livestock.

Key Words: Intake, Sheep, Terpenes

374   Effects of hay composition on forage intake by beef heifers. J. R. Russell*, M. J. Hersom, M. L. Hermann, K. J. Moore, and P. K. Patrick, *Iowa State University, Ames, IA.*

To evaluate chemical composition effects on forage intake by heifers, forages were mowed and baled as large round bales from second harvest alfalfa at and 4 wk after the one-tenth bloom maturity stage and from smooth bromegrass and big bluestem at and 4 wk after the boot maturity stage. Hays were tub-ground and fed *ad libitum* at mature:immature hay ratios of 1:0, 2:1, 1:2, and 0:1 with .9 kg of a soybean meal-based supplement twice daily to 12 crossbred yearling heifers (mean BW, 338 kg) in an experiment with three 4 x 4 Latin square designs with 7 d adjustment and intake recording periods. To estimate fecal output and diet digestibility, 1 gm chromic oxide was fed twice daily on d 8 to 14 and rectal fecal samples were collected twice daily on d 12 to 14 of each period. Forage samples were analyzed for IVDMD, CP, NDF, ADF and indigestible NDF (iNDF) determined by manual or automated methods with 96 and 48 h in vitro incubations, respectively. In vitro digestible DM and CP concentrations were higher (P<.01) and NDF, ADF and automated iNDF concentrations were lower (P<.01) in alfalfa diets than grass diets and in smooth bromegrass diets than big bluestem diets. Dietary IVDMD concentrations increased (P<.01) and ADF, manual iNDF and automated iNDF concentrations decreased (P<.05) as mature:immature hay ratios decreased. Intakes of DM, digestible DM, IVDMD, CP, and manual iNDF were greater (P<.01) and NDF and automated iNDF intakes were lower (P<.01) by heifers fed alfalfa diets than grass diets. Intake of CP was greater (P<.01) and DM, digestible DM, NDF, ADF, manual iNDF and automated iNDF intakes were lower (P<.01) in heifers fed smooth bromegrass than big bluestem hay. Intakes of DM, digestible DM, IVDMD, CP and NDF increased (P<.05) as the mature:immature hay ratios decreased. Mean fecal DM and NDF excretions were .85 and .44 % BW and did not differ between species or mature:immature hay ratios. Dry matter intake (% BW) was correlated to dietary undigested NDF (r^2=.51), digestible DM (r^2=.43), NDF (r^2=.20), and manual iNDF (r^2=.17) concentrations.

Key Words: Cattle, Forage, Intake

375   Effects of change in dietary forage level on dairy goat performance. A. L. Goetsch[1], M. I. Lachica*[1], R. Puchala[1], T. Sahlu[1], L. J. Dawson[2], and A. L. Adams[1], [1]*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK,* [2]*College of Veterinary Medicine, Oklahoma State University, Stillwater, OK.*

Thirty-one Alpine does and 31 doelings (52 ± 1.62 and 34 ± .86 kg, respectively) were used to determine effects of dietary levels of forage and ruminally undegraded protein (RUP), and change in forage level, on early lactation performance. Goats began a 2-wk covariate period at 3 to 9 d after parturition, then were assigned to treatments: 80 = 80% forage diet; 80R = 80 with RUP; 40 = 40% forage diet; 40R = 40 with RUP; A = 80 in wk 1 to 3, transition to 40 in wk 4 to 5, and 40 in wk 6 to 16; and AR = 80R in wk 1 to 3, transition to 40R in wk 4 to 5, and 40R in wk 6 to 16. Diets were formulated at 17.5% CP; for 80R and 40R, equal CP was supplied by blood, fish, and feather meals, substituting for 67% of soybean meal CP. Overall, parity did not interact with dietary treatment (P > .10). Milk production was greater (P < .05) for 40 and 40R than for 80 and 80R and influenced (P < .05) by RUP in wk 1 to 3 and 4 to 5 (wk 1 to 3: 2.51, 2.74, 2.72, 3.33, 2.44, and 2.54 kg/d; wk 4 to 5: 2.52, 2.73, 3.13, 3.59, 2.56, and 2.62 kg/d; wk 6 to 16: 2.18, 2.33, 2.85, 3.11, 2.54, and 3.01 kg/d for 80, 80R, 40, 40R, A, and AR, respectively). Dietary treatments had little or no effects on

milk fat and lactose levels; however, forage level influenced ($P < .05$) milk protein concentration (wk 1 and 3: 2.99, 2.99, 3.25, 3.11, 2.98, and 3.13%; wk 5: 2.81, 2.72, 2.91, 2.86, 2.76, and 2.94%; wk 7, 11, and 15: 2.48, 2.51, 2.86, 2.69, 2.74, and 2.68% for 80, 80R, 40, 40R, A, and AR, respectively). In conclusion, milk production and protein concentration were greater with 40 vs 80% forage throughout the 16-wk early lactation period, although RUP impacted milk production only in the first segment. Changing dietary forage level in early lactation of dairy goats did not influence subsequent production.

Key Words: Goat, Lactation, Forage

376   Evaluation of supplemental carbohydrate source on utilization of stockpiled tall fescue by beef steers. L. J. Driedger*, E. S. Vanzant, S. J. Lewis, B. T. Larson, and R. F. Bapst, *University of Kentucky, Lexington, KY.*

Twelve ruminally-fistulated, crossbred, beef steers (388 kg) grazing stockpiled tall fescue in December were blocked by weight and randomly assigned to control (C), fiber (F), or starch (S) treatments. Steers on C received no supplement, and S and F received corn starch (Cargill), or hydrogen peroxide-treated oat fiber (Snowite®, Canadian Harvest) at 0.75% BW via rumen fistula daily (0800). Adaptation (d 1 to d 11) was followed by ruminal Co:EDTA dosing and subsequent ruminal fluid sampling (d 12 at 0800, 1100, 1400, 1700, and 2000; d 13 at 0800), ruminal evacuation and masticate sampling (d 13 to d 16; AM and PM) total fecal collection (d 17 to d 22) and ruminal fluid sampling (d 23; 0800, 1100, 1400, 1700, and 2000h) for pH, ammonia, and VFA analyses. Treatments did not affect diet selection ($P > .10$). Masticate samples for C, F, and S averaged 87.4, 86.1, and 87.4% OM; 15.9, 15.4, and 16.1% CP; 47.2, 48.9, and 46.2% NDF; and 22.7, 24.1, and 22.3% ADF. Weight change (kg/d) was greater ($P < .10$) for F (1.3) than for C or S (-0.3 and 0.4). Fecal DM output (% BW) was greatest ($P < .10$) for F and lowest for S (0.53, 0.88, and 0.42 for C, F, and S). Ruminal DM fill (%BW) was lower ($P < .10$) for S (1.1) than for C or F (1.3 and 1.4) at the PM sampling, but was unaffected ($P > .10$) by treatment at the AM sampling (avg = .85). Ruminal liquid dilution rate (%/hr) was slower ($P < .10$) for S (10.4) than for C or F (14.6 and 14.6). Total VFA (mM) was greater ($P < .10$) and ruminal pH was lower ($P < .10$) for F (115.3; 6.26) than for C or S (105.2; 6.57 and 97.1; 6.47). Molar percentages of propionate (avg = 19.3) and butyrate (avg = 11.4) were not different ($P > .10$) among treatments. Acetate (%) and acetate:propionate ratio were lower ($P < .10$) for S (57.1; 2.9) than for C or F (66.7; 3.6 and 67.0; 3.5). Ruminal ammonia concentrations (mM) were greatest for C and lowest for S (31.2, 12.3, and 2.6, for C, F, and S). Supplementing steers with fiber- instead of starch-based supplements may enhance utilization of stockpiled tall fescue.

Key Words: Grazing, Fescue, Carbohydrate source

377   Effect of birdsfoot trefoil and tall fescue pastures on steer performance. L. Wen*, J. E. Williams, R. L. Kallenbach, C. Roberts, R. L. McGraw, P. Beuselinck, J. F. Thompson, and L. Gebrehiwot, *University of Missouri, Columbia, MO/USA.*

In a completely randomized design two varieties of birdsfoot trefoil interseeded with tall fescue were evaluated for its effects on steer performance in a continuous grazing system. The treatments consisted of birdfoot trefoil with rhizomes (RBFT), birdsfoot trefoil without rhizomes (BFT), tall fescue(TF), BFT+TF and RBFT+TF with 4 paddocks (0.53 hectare, ha) per treatment. The number of steers assigned to each paddock was based on forage availability using the put-and-take system. At two-week intervals, ADG was determined, while every month esophageal samples were taken for CP and NDF analysis. In experiment 1, 92 Angus crossbred steers (avg. BW 304 kg) were assigned to pasture treatments May 11 and removed July 1. During this period, ADG (kg/d) of steers grazing RBFT+TF (0.93) and BFT+TF (0.92) was greater (P≤0.01) than that of TF (0.65). Stocking rate (hd/ha) was greater (P≤0.05) for BFT+TF (8.9) and RBFT+TF (9.0) than for TF (7.3). The carrying capacity (total animal days/ha) was greater (P≤0.05) for BFT+TF (438) than for TF (359) with RBFT+TF (426) being intermediate. In experiment 2, 43 Angus crossbred steers (avg. BW 209 kg) were placed on pasture September 22 and removed November 18. During this period, ADG (kg/d) of steers was not different (P≥0.1) among BFT+TF (0.68), RBFT+TF (0.69) and TF (0.65). Stocking rate (hd/ha) was greater (P≤0.01) for BFT+TF (6.4) than TF (4.9)

with RBFT+TF (5.5) being intermediate. The carrying capacities (total animal days/ ha) were greater (P≤0.05) for BFT+TF (375) than for TF (275) with RBFT+TF (325) being intermediate. In experiment 1, the forage yield in BFT+TF and RBFT+TF were greater (P≤0.05) than that of TF. However, in experiment 2 yields were similar among treatments. In experiment 1, NDF was lower in BFT+TF (50.2%, P≤0.01) and RBFT+TF (52.1%, P≤0.1) than in TF (55.6%); CP was greater in BFT+TF (17.5%) than in RBFT+TF (16.12%, P≤0.05) and TF (15.4%, P≤0.01). In experiment 2, NDF was lower (P≤0.05) for BFT+TF (51.9%) and RBFT+TF(50.2%) than TF (58.5%); CP was greater (P≤0.01) for BFT+TF (15.3%) and RBFT+TF (15.7%) than TF (13.0%). From these results, tall fescue interseeded with BFT and RBFT yielded greater gain and forage availability than TF in spring and summer.

Key Words: Birdsfoot trefoil, Tall fescue, Gain

378   Ruminal parameters and voluntary intake in steers fed with a basal oat straw and supplemented with alfalfa hay. H. C. Hernández*[1], H. M. Ferreiro[2], L. C. De la Vega[2], A. C. Correa[3], A. M. Pérez[3], and H. G. González[3], [1]*Universidad Autónoma de Baja California Sur, Area Interdisciplinaria de Ciencias Agropecuarias,* [2]*Universidad Autónoma de Chihuahua,* [3]*Universidad Autónoma de Baja California.*

To evaluate the ruminal performance and the voluntary feed intake, four Hereford steers 230 kg and permanent cannulated were fed to a basal oat straw diet and supplemented with alfalfa hay to levels (0, 10, 20 and 30 %) of dry matter intake and .5 kg rolled milo per animal d^{-1}, all diets were isonitrogenous. Rumen fluid samples were collected at 0, 1.5, 3, 6, 9, 12 and 16 hours after first meal and analyzed for pH, ammonia-nitrogen and volatile fatty acids (VFA) concentration. The data were analyzed by using a 4x4 latin square. The results showed not significant differences (P>.05) on liquid rumen pH and ammonia-nitrogen production at different alfalfa hay levels. The VFA concentration had a linear trend to increment (P<.01) as the level of alfalfa increases. The ration with 20 and 30 % of alfalfa had the highest levels of acetic (79.6 and 78.7 mM) and propionic acid (15.07 and 15.96 mM). The voluntary intake of straw (57.3, 59.9, 62.3 and 72.6 g kg^{-1}W$^{.75}$) and total diet (64.6, 69.8, 80.7 and 81.1 g kg^{-1}W$^{.75}$) was improved (P<.01)proportional an increase in the supplements levels. Alfalfa hay clearly improve the efficiency of an oat straw basal ration.

Key Words: Steers, Ruminal parameters, Straw

379   Kinetics and particle size characterization of the solid fraction of ruminal contents and feces in steers fed a basal oat straw diet. H. G. González*[1], O. B. Ruiz[2], L. C. De la Vega[2], H. C. Hernández[3], A. C. Correa[1], A. E. Orozco[2], A. M. Pérez[1], and L. B. Gerlach[4], [1]*Universidad Autónoma de Baja California, Instituto de Ciencias Agrícolas,* [2]*Universidad Autónoma de Chihuahua, Facultad de Zootecnia,* [3]*Universidad Autónoma de Baja California Sur,* [4]*Universidad de Sonora.*

Four Hereford steers with permanent ruminal cannula were used in a switchback-designed feeding trial. The objective was to evaluate the effect of two sizes of chopped forage, 2.5 cm (T1) and 10 cm (T2), on the ruminal kinetics of the solid fraction, and to characterize the particle size of ruminal contents and feces. The animals were fed a diet of 80% oat straw and 20% alfalfa hay *ad libitum*. A wet sieving technique was used to determine the percentage of ruminal and fecal dry matter retained on 2.36 mm, 1.18 mm, .5 mm, .3 mm, and .15 mm sieves. A two-compartment model was used to determine K_1, K_2, and mean retention time of the solid fraction. Steers fed T1 had a greater (P < .05) dry matter intake than steers fed T2 (79.7 *vs* 70.8 g/kg BW$^{.75}$). Steers fed T1 had a greater (P < .05) K_1 (2.96 *vs* 2.49% h^{-1}), and a lower (P < .05) mean retention time (50.8 *vs* 57.5 h) than did steers fed T2. However, K_2 did not differ (P > .05) between treatments (5.9 *vs* 5.9% h^{-1}). The percentage of ruminal particles retained on a 2.36 mm sieve was higher (P < .01) for T2 than T1, 7.06 *vs* 5.36%, respectively. No treatment differences (P > .05) were found between T1 and T2 in the percentage of ruminal or fecal particles, respectively, retained on the following sieves: 1.18 mm (10.4 *vs* 10.8%; 3.65 *vs* 3.37%), .5 mm (12.8 *vs* 14.6%; 7.9 *vs* 8.1%), .3 mm (24.2 *vs* 22.4%; 23.2 *vs* 23.1%), .15 mm

(21.5 vs 19.1%; 29.3 vs 28.1%). No differences (P > .05) were found between T1 and T2 in the percentage soluble fraction of ruminal contents or feces (25.6 vs 26.1%; 35.8 vs 37.3%).

Key Words: Steers, Kinetics, Particle size

380   Determinant of forage quality in Clitoria ternatea. T Clavero*[1], [1]La Universidad del Zulia.

A field experiment under tropical dry forest conditions was carried out in dryland farming area in Venezuela in order to evaluate the nutritive value of Clitoria ternatea under three levels of N (0, 100, 200 kg/ha) and three levels of P (0, 150 300 kg/ha). A split-plot in a random block design with four replications was used. Result obtained show that the N*P interaction affected (P≤0.05) in vitro dry matter digestibility increased while the structural components decreased with increasing the fertilizer levels. The highest values for crude protein (25.2 %) and in vitro dry matter digestibility (68.3%) were obtained when C. ternatea was fertilized with 200 kg N/ha and 150 kg P/ha. The average decreased was 5 digestible units and 3 crude protein units between unfertilized and fertilized treatments. The contents of Ca and K were no affected for fertilization which showed a mean of 1.9 and 2.7 for Ca and K, respectively. These data indicate that N and P fertilization of Clitoria ternatea are critical for nutritive value of this legume

Key Words: Clitoria ternatea, nutritive value, fertilization

381   Effects of pasture applied biosolids on forage and soil mineral concentrations in North Florida. M. E. Tiffany, L. R. McDowell*, G. A. O Connor, H. Nguyen, F. G. Martin, N. S. Wilkinson, and E. C. Cardoso, University of Florida, Gainesville, FL.

The effects of single applications of exceptional quality biosolids to bahiagrass (Paspalum notatum) pasture as related to satisfying beef cattle nutrient requirements was studied. Twenty-five .8 ha pastures were divided into five blocks. Biosolids were applied as an "agronomic rate" (X) and 2X. Each pasture within a block received one of five treatments: 1) control .992 t/ha NH_4NO_3 added twice at 496 kg/ha per application, 2) Baltimore-1X biosolids applied at 22.4 t/ha, 3) Baltimore-2X biosolids applied at 44.8 t/ha, 4) Tampa-1X biosolids applied at 16.8 t/ha, and 5) Tampa-2X applied at 33.6 t/ha. Applications of biosolids to pastures elevated crude protein (CP) but had little effect on Ca, P, Na, and K. Some increases (P<0.05) in forage Co, Cu, Fe, Zn, and Se were observed at various sampling times, but the increases were generally small. Although forage Mo samples from pastures with the Tampa biosolids applied were consistently higher than the control (P<0.05), at no time did they approach levels considered toxic. In general, all treatments were associated with soils low in K but adequate in Ca, P, and Mg. Biosolids improved soil Cu, Mn, and Zn.In relation to grazing beef cattle requirements, all treatments resulted in generally adequate forage levels of Ca, P, Mg, K, and CP, however, Na, Co, Cu, Se and Zn concentrations were deficient.

Key Words: Biosolids, Forage, Minerals

382   Digestibility of Water Oak and Shining Sumac leaves fed to Alpine goat wethers. R. Merkel*[1], C. Toerien[1], T. Sahlu[1], and C. Blanche[2], [1]E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, [2]Dale Bumpers Small Farms Research Center, USDA, ARS, Booneville, AR.

Eight Alpine wethers (60.6 ± 2.43 kg BW) were randomly assigned to consume, free-choice, either Shining Sumac or Water Oak leaves as a sole diet. Leaves were collected and dried prior to feeding. A 14-d adaptation period was followed by a 4-d total fecal and urine collection. Chemical composition (%) of the fed tree leaves revealed similar levels of OM and N with higher concentrations of cell wall fractions, NDF and ADF, in Water Oak (OM 94 vs 96, NDF 55 vs 31, ADF 26 vs 35, and N 1.42 vs 1.54 for Shining Sumac and Water Oak, respectively). Body weight of wethers differed between treatments although, this difference did not affect DM intake (BW 64.3 vs 55.8, $P < .10$; DMI 60 vs 66 g/kg $BW^{.75}$, $P > .10$, for Shining Sumac and Water Oak, respectively). Daily intakes of DM (1.35 vs 1.35 kg), OM (1.29 vs 1.3 kg), ADF (.38 vs .43 kg), and N (18.3 vs 22.6 g) were similar between treatments ($P < .10$). However, NDF intake was lower ($P = .002$) in goats fed Shining Sumac than in those consuming Water Oak (.42 vs .75 kg). Daily

fecal output of all components with the exception of N was higher ($P < .05$) in Shining Sumac- than Water Oak-fed goats. Differing fecal outputs, coupled with similar intakes of DM, OM, and ADF led to lower apparent digestibilities (%) of these components in Water Oak-fed animals (DM 82 vs 71, OM 83 vs 72, ADF 75 vs 44, for Shining Sumac and Water Oak, respectively). The higher NDF intake and fecal output for the Water Oak treatment led to NDF digestibility similar to that for Shining Sumac (70 vs 63% for Shining Sumac and Water Oak, respectively). Nitrogen digestibility was similar between treatments (64 vs 56% for Shining Sumac and Water Oak, respectively). In conclusion, the higher OM digestibility by goats of Shining Sumac than Water Oak implies that goats consuming Shining Sumac would have a better ability to maintain and(or) increase BW gain or body condition.

Key Words: Goat, Water oak, Shining sumac

383   Effects of calendar date and summer management on in situ dry matter digestibility of stockpiled bermuda. D. A. Scarbrough*, W. K. Coblentz, K. P. Coffey, J. E. Turner, G. V. Davis, and D. W. Kellogg, Universtiy of Arkansas, Fayetteville AR/USA.

Five ruminally cannulated, cross-bred steers (mean BW = 387 kg) were used to determine the effects of calendar date and previous summer management scheme on the kinetics of in situ DM disappearance of stockpiled Greenfield bermudagrass. At one site, forage was stockpiled after a summer hay management system with high inputs of N fertilizer from poultry litter and commercial sources. At the second site, forage was stockpiled after a summer pasture management scheme with moderate N inputs. Forage samples were taken from each site under caged enclosures at four-week intervals, beginning 17 October 1997 and ending 9 January 1998. At the hay site, NDF concentrations increased ($P < 0.05$) from 69.9% to 75.8% over the sampling period. Concentrations of CP declined ($P < 0.05$) from 13.4% in October to 11.9% in December, but CP concentrations on the initial and final sampling dates were not different ($P > 0.05$). Neither NDF nor CP concentrations changed ($P > 0.05$) over sampling dates at the pasture site (overall means = 71.8% and 12.8%, respectively). On the basis of in situ analysis, forage DM was partitioned into three fractions. Fraction A was defined as being immediately soluble. Fraction B was the portion digestible at a measurable rate; fraction C was defined as that part of the forage that was unavailable to the animal. At the hay site, the degradation rate decreased ($P < 0.05$) from 0.048 hr^{-1} to 0.035 hr^{-1} over the sampling period, while the potential extent of digestion decreased ($P < 0.05$) from 65.6% in October to 44.9% in January. Fraction B decreased ($P < 0.05$) between October (43.9%) and January (27.5%); fraction C increased ($P < 0.05$) from 34.4% to 55.0% over the same time period. Similar trends were observed for the forages harvested at the pasture site, however, degradation rates did not differ across dates. These data are promising, but indicate that stockpiled bermuda should probably be utilized in late fall or early winter for optimal animal performance.

Key Words: Stockpiled Bermuda, In Situ, DM Disappearance

384   Effect of stocking rate on cow-calf productivity while grazing improved kikuyu pasture during fall versus spring calving seasons. J. R. Carpenter*[1], B. W. Mathews[2], B. R. LeaMaster[1], B. A. Buckley[1], and R. Y. Niino-DuPonte[1], [1]CTAHR, University of Hawai'i at Manoa, [2]CAFNRM, University of Hawai'i at Hilo.

Pasture is the primary feed for cow-calf systems in tropical beef production. Forage growth varies during the year, but stocking rates (SR) are usually fixed for the entire calving cycle. The objective was to determine the effect on production of increasing stocking rates of cow-calf pairs on improved kikuyu grass (Pennisetum clandestinum) pasture over two fall and three spring calving seasons [average (avg) 154 d/trial]. After calving, composite breed beef cow-calf pairs were randomly assigned by age and body weight to one of five treatments (trts) designated as low (1) to high (5) stocking rates (avg 3.2, 3.6, 3.9, 4.4, and 4.7 AUE/ha for trts 1 to 5, respectively). All trts had three 1.2 ha paddocks, each with a 4-wk rest and 2-wk grazing cycle. Grass samples from each cycle were taken to determine forage yield and nutrient composition. Animals were weighed and body condition scores given at the beginning and end of each trial; animals were weighed every 4 wk to determine ADG and feed efficiency. Average initial body weights (kg) for cows and calves were 511.6 and 108.4 in the fall and 487.6 and 117.3 in the spring (P>.05).

Forage composition was similar in the fall and spring, [avg 20.1, 12.1, 59.8, 31.3, 67.5, 1.5, and .9 in DM, CP, NDF, ADF, TDN (%), and NEl, and NEg (Mcal/kg DM), respectively]. Total DM yield was similar for the spring and fall (avg 83.0 kg/(ha·d)). ADG for the calves were .96, 1.01, .93, .89, .90 kg/d, for trt 1 to 5 respectively (P>.05). Total beef production of the calves increased linearly (P<.05) with SR [1.11, 1.31, 1.34, 1.42, 1.56 tonne/(ha·yr) for trt 1 to 5, respectively]. As SR increased, loss in cow body weight increased (P<.05), and was more pronounced in the fall than spring. Results indicate the benefits of determining and maintaining the proper SR over fall and spring calving seasons to maximize pasture yield and quality, and cow-calf productivity.

Key Words: Kikuyu grass, Tropical beef production, Stocking rate

385   Evaluation of forage management systems for spring-calving beef herds: winter. M. J. Hersom and J. R. Russell*, *Iowa State University, Ames, IA.*

A 3-yr experiment was conducted to compare BW, body condition score, and stored hay use by beef cows that sequentially grazed corn crop residues (CCR) and stockpiled endophyte-free tall fescue-red clover (TF-RC) or smooth bromegrass-red clover (SB-RC) forages to cows maintained in a drylot as the winter portion of a year-round management project. After grain harvest, twenty crossbred cows (BW, 527 kg; condition score, 5.3) in mid-gestation were allotted to four 3.04-ha fields containing CCR to strip-graze for 55 d followed by four 6.08-ha pastures containing stockpiled TF-RC (Year-round/TF-RC system) or SB-RC (Year-round/SB-RC system) forage to strip-graze for 120 d. Simultaneous to initiation of CCR grazing, sixteen similar cows were allotted to replicated drylots and fed hay harvested from four 1.52 to 2.02-ha areas in summer cool season grass-legume pastures (Minimal land system). All cows were offered hay as necessary to maintain a body condition score of 5. Forage samples were taken monthly from grazed and ungrazed areas in each pasture. During CCR and winter stockpiled forage grazing, BW and condition scores of cows in the Year-round systems decreased more (P<.05) than cows in the Minimal land system. During spring stockpiled forage grazing, cows in the Year-round systems lost less (P<.05) BW and gained more (P<.05) body condition than Minimal land system cows. Seasonal BW and condition score changes did not differ between management systems. Amounts of hay fed (P<.05) and amounts of hay harvested in excess of that fed (P<.05) were 155, 3,116; 199, 3,347; and 2,869, -1,611 kg/cow for the Year-round/TF-RC, Year-round/SB-RC, and Minimal land systems. Organic matter yields of CCR fields, TF-RC pastures, and SB-RC pastures were 4,016, 2,836, and 2,275 kg/ha at the initiation of CCR grazing and decreased at 29.9; 7.5; 10.1, 3.8; and 7.3, 1.9 kg/ha/d from grazed and ungrazed areas over 139 d. Concentrations of IVOMD (P<.05) from grazed and ungrazed CCR, TF-RC, and SB-RC decreased at .15, .07, .11, .11; and .03, .05 %/d over 139 d.

Key Words: Beef cattle, Corn crop residues, Stockpiled forages

386   Evaluation of three forage management systems for spring-calving beef herds: summer. M. J. Hersom and J. R. Russell*, *Iowa State University, Ames, IA.*

A 3-yr experiment was conducted to compare production of calves, stockers, hay and stockpiled forage from cool season grass-legume pastures as the summer portion of a year-round management project. In May, 16 crossbred cows (BW, 520 kg; condition score, 4.7) with calves were allotted to four 4.05-ha smooth bromegrass-orchardgrass-birdsfoot trefoil (SB-OG-BT) pastures to graze 2.025 to 2.53 ha by rotational stocking (Minimal land system). First growth forage was harvested as hay from the remaining 1.52 to 2.025 ha in mid-June. After regrowth, cow-calf pairs were allowed to graze each entire pasture until November. Calves were weaned in November and finished on a high grain diet. In the Year-round systems, 20 crossbred cows (BW, 510 kg; condition score, 5.0) with calves and 20 crossbred yearling cattle (289 kg) were allotted to four 4.05-ha SB-OG-BT pastures to grazed by rotational stocking for 40 d beginning in May. Cow-calf pairs from this system and one bull strip-grazed four 6.05-ha pastures containing second-growth endophyte-free tall fescue-red clover (TF-RC) or smooth bromegrass-red clover (SB-RC) for 60 d following a hay harvest. In August, yearlings were placed in a feedlot for finishing on a high grain diet and cow-calf pairs returned to the SB-OG-BT pastures to graze until November. Herbage masses of SB-OG-BT pastures where yearlings grazed in June and July were

greater (P<.05) then SB-OG-BT pastures in the Minimal land system or TF-RC and SB-RC pastures of the Year-round systems that cow-calf pairs had grazed. In August, IVDMD concentrations of forage from SB-OG-BT pastures that yearlings had grazed were greater (P<.05) than pastures that cow-calf pairs had grazed. Seasonal calf weight gains (P<.05), growing animal weight gains (P<.05), and total winter forage production (P<.05) from the Minimal land, Year-round/TF-RC, and Year-round/SB-RC systems were 193, 193, 1736; 95, 142, 4054; and 88, 133, 4422 kg/ha. It required 198 and 114 d in feedlot (P<.10) to finish calves from the Minimal land system and yearlings from the Year-round systems

Key Words: Beef cattle, Grazing, Rotational stocking

387   Vitamin E concentration in lamb muscle as influenced by concentrate or pasture finishing. K. E. McClure*[1], K. E. Turner[2], and W. P. Weiss[1], [1] *The Ohio State University, Wooster, OH*, [2] *USDA-ARS, Beaver, WV.*

Sixty Hampshire x Targhee wether lambs (26.1 kg initial BW) were used to compare the efficacy of vitamin E (RRR-α-tocopherol) in grazed forage with supplemental vitamin E (all rac α-tocopheryl acetate) in all-concentrate diets in drylot (DL) on α-tocopherol accumulation in carcass lean. Alfalfa (ALF) or ryegrass (RG) were rotationally grazed and DL diets (whole shelled corn + supplement pellet), offered ad libitum, were formulated to provide 16% CP and either 15 (NRC), 150 (10 NRC), or 300 (20 NRC) IU of supplemental vitamin E per kg of diet DM. Target slaughter BW were 51, and 53 kg for DL and grazed lambs. Fresh forages collected from test paddocks at the onset of each of 3 grazing rotations were stored on ice, frozen, and freeze dried. Aliquots of DL diet composites were obtained. On d 3 post-slaughter a boneless loin chop was frozen and stored at 60°C. Alpha-tocopherol concentrations (μg g^{-1}) in lamb diets were: ALF, 137; RG, 169; NRC, 17; 10 NRC, 184; and 20 NRC, 335. Alpha-tocopherol levels in loin tissue were: ALF, 2.5; RG, 2.89; NRC, .57; 10 NRC, 3.22; 20 NRC, 4.19 μg/g. For DL lambs the alpha-tocopherol concentration of muscle was linearly related to the natural logarithm (Ln) of the dietary vitamin E concentration (muscle alpha-tocopherol, μg/g = -2.81 + 1.189 x Ln dietary vitamin E, mg/kg; P<.01, r_2 = 0.97; RMSE = 0.29). Loin alpha-tocopherol concentrations were similar when lambs grazed ALF or RG or were fed the 10 NRC diet in drylot. The daily DMI (kg) of DL lambs were 1.46, 1.49 and 1.49 which were not different (P=.75). This resulted in daily supplemental Vitamin E intakes of 24.8, 274.2, and 499.1 IU in DL diets.

Key Words: Vitamin E, Pasture, Muscle

388   Biological treatment of rice straw using shittake culture waste. C. S. Ra*, G. Z. Lin, J. S. Shin, and B. J. Hong, *Kangwon National University, Korea.*

This research was conducted with two goals: first, to investigate the biological characteristic of shittake culture waste (SCW); and second, to evaluate the feed value of rice straw treated with SCW. Two types of experimental diet were formulated: 1) Rice straw was mixed with SCW, corn and molasses at the ratio of 1:0.067:0.18:0.02. This formula was used for control. 2) The mixture of rice straw, corn and molasses was anaerobically pre-fermented at 30 oC for 6 days, and then SCW was added and two weeks of aerobic treatment period was provided. Chemical composition, in situ nutrient disappearance and degradability of diets were analyzed and compared each other, to evaluate the feed value of treated diet with WSSC. In situ experiments were done with cannulated Korean cattle (Hanwoo). Biological study revealed that any microorganisms were not survived in rot-sapwood and heartwood layers, but lentus edodes hyphals were observed in non-rot-sapwood layer and they had enough activity to grow during the aerobic treatment. Finishing aerobic treatment with SCW, lentus edodes hyphals that were observed in non-rot-sapwood layer of SCW were also detected inside cell wall of rice straw. The contents of neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose and crude protein increased with the aerobic treatment with SCW, while hemicellulose content clearly decreased (P<0.01). In situ DM, NDF and ADF disappearance rates of the treated diet with SCW at 6 and 12 hours after feeding were lower than those of control diet. However, they were significantly increased with time progress, showing higher rates from 24 hours after feeding (P<0.01). Based on the results, it was concluded that reuse of SCW as an inoculum for the biological treatment of rice straw could be a useful

means to improve the feed value, as well as to alleviate disposal problems of agricultural wastes. Also, the employed pre-anaerobic treatment strategy can be an effective way for the prevention of microbial decomposition of rice straw occurring during the followed aerobic treatment with WSSC

Key Words: Shittake culture waste (SCW), Rice straw, Disappearance rate

389   Effect of hybrid, maturity and processing on ruminal degradability of corn plants. J. G. Andrae*[1], C. W. Hunt[1], C. G. Doggett[1], G. T. Pritchard[1], W. Kezar[2], and W. Mahanna[2], [1] *University of Idaho, Moscow,* [2] *Pioneer Hi-Bred, Johnston IA.*

Two trials were conducted to measure the effects of corn hybrid, maturity and processing on ruminal in situ degradability of corn plants. In trial one, eight hybrids were harvested when kernels were at either 2/3 milkline or blacklayer maturity. At each maturity, three hybrid replicates of twenty plants were obtained. Ten plants from each replicate were partitioned into ear and stover portions and weighed. The stover **(S)** and whole plant **(WP)** portions of each replicate were chopped and frozen for subsequent chemical analyses and 24 h in situ DM **(ISDMD)** and NDF **(ISNDFD)** disappearance. Samples were not further processed prior to incubation in 30 x 35 cm nylon bags. In trial two, each of the eight hybrids was harvested at blacklayer either with or without mechanical processing. Samples were ruminally incubated for 24 h in four cows. In trial 1, proportion of ear and S were affected by hybrid (P < .05) and maturity (P < .01). Both hybrid and maturity affected DM content of the S (P < .01) and WP (P < .01) fractions. There was a hybrid x maturity interaction (P < .01) for NDF content of both S and WP fractions. Stover NDF increased in four of the hybrids as maturity increased, but was unchanged for other hybrids. Similarly, WP NDF concentration decreased for some hybrids as maturity increased, but did not change for other hybrids. Stover and WP ISDMD were not affected by hybrid; however, increased maturity resulted in decreased ISDMD for both WP (P < .06) and S (P < .01). Stover ISNDFD was affected (P < .10) by hybrid and decreased (P < .01) as plants matured. In trial 2, a hybrid x processing interaction (P < .05) was observed. Processing increased (P < .05) ISDMD of five of the eight hybrids tested. Results from these studies indicate that corn hybrids mature and develop differently. Also, magnitude of improvement in corn silage degradability due to processing is variable across hybrids.

Key Words: Corn, Hybrid, Maturity

390   The effect of various levels of ammonia or a buffered propionic acid-based preservative on the fermentation and aerobic stability of corn silage. J. M. Robinson, L. Kung, Jr.*, N. K. Ranjit, and J. Y. Tavares, *University of Delaware, Newark.*

The objective of this study was to compare the effect of aqua-ammonia to a buffered propionic acid based-preservative (87% active ingredients) on the fermentation and aerobic stability of corn silage. Whole-plant corn was harvested at the $\frac{1}{2}$ milkline stage of maturity. Forage was packed in 20-L silos in triplicate with the following treatments (kg/ton of fresh forage weight): 1) control (untreated), 2) 0.9 kg of ammonia-N equivalent (an aqua-ammonia mix), 3) 1.8 kg of ammonia-N, 4) 2.7 kg of ammonia-N, 5) 0.9 kg of a buffered propionic acid-based preservative (BPAP), 6) 1.8 kg of BPAP, and 7) 2.7 kg of BPAP. After 106 days of ensiling, the silages treated with ammonia had higher pH ($P < 0.05$) than other treatments. The propionic acid content was 0.06, 0.21, 0.38, and 0.64% (DM basis) for untreated silage and silage treated with the low, moderate and high level of BPAP, respectively ($P < 0.05$). As expected, treatment with ammonia increased ($P < 0.05$) the ammonia-N and CP content of silage in a dose-dependent manner. The acetic acid contents of silage treated with the moderate (2.30%) and high (2.82%) amount of ammonia was greater ($P < 0.05$) than in untreated silage (2.18%). Increasing the amounts of ammonia, tended to increase the content of residual water soluble carbohydrates but decreased ($P < 0.05$) the production of ethanol when compared to untreated silage. The low and moderate doses of ammonia and BPAP numerically improved the aerobic stability ($2°C$ rise in temperature) of silage compared to untreated silage. The highest dose of ammonia (treatment 4, 82 hr of aerobic stability) and BPAP (treatment 7, 69 hr of aerobic stability) increased ($P < 0.05$) the hours of aerobic stability when compared to untreated silage

(35.3 hr of aerobic stability). These results indicate that ammonia and a buffered propionic acid preservative can improve the aerobic stability of corn silage to a similar extent.

Key Words: ammonia, propionic acid, aerobic stability

391   Evaluating silage hybrids for forage quality. D. J. R. Cherney* and W. J. Cox, *Cornell University, Ithaca, NY.*

The objective of this study was to evaluate the influence of corn silage sample preparation (either fresh or ensiled in mini-silos) on forage quality parameters of twelve commercial hybrids. The NDF, in vitro true digestibility (IVTD), and digestible NDF (dNDF) were determined for ensiled and fresh samples of three field replicates of each hybrid. Samples taken from mini-silos were much more variable than fresh samples for all parameters. The NDF in fresh samples ranged among hybrids from 38.2 to 46.2 % with a MS error of 2.7 resulting in detectable differences ($P < 0.05$) among the 12 hybrids. Samples taken from mini-silos had a similar range in NDF among hybrids (40.1 to 46.1 %), but they had a much higher MS error (19.4), resulting in no detectable differences ($P > 0.05$) among hybrids. Ranges for IVTD (approximately 13.5 percentage units difference among hybrids) and dNDF (approximately 27.5 percentage units difference among hybrids) for ensiled and fresh material were similar. As with NDF, however, ensiled samples had much higher MS errors (14.4 for IVTD and 49.1 for dNDF) than fresh samples (1.5 for IVTD and 8.0 for dNDF). As with NDF, this resulted in detectable differences among hybrids for fresh samples but not for ensiled samples. Ranking of hybrids varied with sample preparation such that there were no significant correlations between sample preparation types for NDF (r = 0.10, P > 0.10) or IVTD (r = 0.40, P > 0.10). The dNDF between sample preparation types was correlated at r = 0.52 (P < 0.09). Results of this study indicate that variability in forage quality parameters among samples preserved in mini-silos is much higher than among samples harvested directly. This increased variability of samples from mini-silos versus fresh samples prevented detection of differences in NDF, IVTD, and dNDF among hybrids.

Key Words: Corn silage, Forage quality, Mini-silo

392   The performance of pregnant ewes offered basal diets of hay or grass silage supplemented with molassed sugar beet pulp or a commercially available concentrate. T. F. Crosby*[1], J. V. O'Doherty[1], P. Nowakowski[2], P. J. Quinn[1], J. J. Callan[1], B. Flynn[1], and C. McGrane[1], [1] *University College Dublin, Dublin, Ireland,* [2] *Agricultural University of Wroclaw, Wroclaw, Poland.*

The objective was to examine the effects of supplementing a roughage based diet of hay or grass silage with molassed sugar beet pulp or with a balanced concentrate having a higher protein content on the performance of pregnant ewes and their lambs, and on colostrum yield and quality. From day 91 of pregnancy, twin bearing ewes (n=88) were offered hay or grass silage ad libitum, supplemented with 400 g DM/ewe/day of either molassed sugar beet pulp (MSBP) or a commercially available concentrate having crude protein percentages of 10.2 and 17.6 respectively. Average daily intakes per ewe of forage DM (0.78 and 1.09 kg), total metabolizable energy (2605 and 3417 calories) and total crude protein (127.3 and 147.3 g) were recorded for silage and hay fed ewes respectively. From day 98 to 24 hours post lambing, ewes on the MSBP treatments lost significantly more weight (5.3 vs. 2.9 kg; S.E.M. 0.55; P < 0.05) and body condition (0.82 vs. 0.33; S.E.M. 0.064; P < 0.001). Ewes offered the commercial concentrate produced higher (P < 0.05) yields (ml) of colostrum at 1h (421 vs 261; S.E.M. 40), 10h (515 vs 349; S.E.M. 41) and 18h (530 vs 346; S.E.M. 28) post lambing, having higher yields of total solids, protein (P < 0.001) and immunoglobulin (IgG)(P < 0.05). Lambs born to ewes offered the commercial concentrate consumed more colostrum (P < 0.05) and IgG (P < 0.001) than lambs born to ewes offered the MSBP. Lambs born to ewes on the commercial concentrate had higher growth rates (274 vs 251 g/d; S.E.M. 8.7;P < 0.05) to 7 weeks of age and also had higher weaning weights (30.2 vs 28.3 kg; S.E.M 0.7; P<0.05) than those on the MSBP treatment. These data support the theory of higher dietary intakes by pregnant ewes of hay relative to grass silage and the superiority of a balanced high protein concentrate as a supplement to those forages in terms of colostrum yield and quality and lamb growth to weaning.

Key Words: Ewe, Colostrum, Concentrate

PHARMACOLOGY AND TOXICOLOGY

393   Intravenous L-carnitine administration reduces hyperammonemia in Suffolk ewes experiencing urea toxicosis. M. M. Kaye*[1], J. M. Fernandez[1], L. D. Bunting[1], D. L. Thompson, Jr.[1], T. W. White[1], R. L. Walker[1], G. D. Harding[1], J. A. Barrett[1], and K. Q. Owen[2], [1]LSU Agricultural Center, Baton Rouge, LA, [2]Lonza, Inc., Fair Lawn, NJ.

An experiment was conducted to determine the effects of L-carnitine administration on plasma constituents in experimentally-induced hyperammonemic ewes. Non-bred Suffolk ewes (BW = 76 kg) were penned, and fed bermudagrass hay ad libitum supplemented with .45 kg of corn twice daily for 2 wk. On the morning of the experiment, feed and water were withheld, and the ewes were weighed and equipped with jugular vein catheters. Ewes were randomly assigned to one of two treatment groups: saline control (SAL; n = 8) and carnitine treatment (CAR; n = 8). Blood samples were collected at 15 min intervals throughout the 330 min collection schedule. Following 30 min of collection, hyperammonemia was induced using an oral urea load test (OULT, 400 mg urea/kg BW). Following the 60 min sampling, either 0 (SAL) or 6.4 (CAR) mmol L-carnitine/kg metabolic BW was administered i.v. Rumen fluid samples were obtained preceding (at 30 min) and 30 min after (at 60 min) the OULT. An 11-fold increase in ruminal ammonia N levels (5.6 vs 61.3 mmol/L) indicated that acute hyperammonemia had been achieved using the OULT. One of the SAL ewes succumbed to hyperammonemia within 60 min after the OULT and her data was not included in the statistical analyses. A treatment*time interaction (P < .05) was observed in plasma ammonia N, due to a reduction in peak plasma ammonia N levels in the CAR group, particularly within the first 60 min following CAR administration. In addition, CAR-treated ewes had elevated concentrations of plasma glucose between 75 and 225 min (treatment*time, P < .05). There were no treatment*time effects (P > .10) in plasma urea N and insulin. L-carnitine administration reduced plasma ammonia and increased glucose levels in hyperammonemic ewes. The data look promising, but further research is needed to investigate L-carnitine's effectiveness as a potential therapeutic agent in the treatment of hyperammonemia.

Key Words: Hyperammonemia, Carnitine, Sheep

394   Effects of locoweed on reproductive function in cattle. K. E. Panter* and L. F. James, USDA-ARs-Poisonous Plant Research Laboratory, Logan, Utah, USA.

Effects of Locoweed on Reproductive Function in Cattle K. E. Panter and L. F. James USDA ARS Poisonous Plant Research Laboratory Logan, Utah, USDA Locoweeds are defined as those species of the *Astragalus* and *Oxytropis* genera which contain the indolizidine alkaloid toxin, swainsonine. Locoweed poisoning is an induced lysosomal storage disease caused by swainsonine inhibition of lysosomal Golgi mannosidase II. This prevents the hydrolysis of mannose-rich oligosaccharides, subsequent lysosomal accumulation of these oligosaccharides and ultimately cellular dysfunction and death. Swainsonine-induced mannosidase Ii inhibition dysrupts normal protein glycosylation resulting in widespread cellular dysfunction including abnormal cell to cell communication, cell movement and cellular adhesion. Clinically, these changes are seen as abnormal hormone and receptor function resulting in anestrus, reproductive failure and abortion. Locoweeds in ranges and pastures inhibit optimum utilization and cause poisoning that results in significant losses to livestock producers. Clinical signs of poisoning usually occur after prolonged ingestion of these plants and include reproductive dysfunction, behavioral changes, loss of body condition, proprioceptive deficits, wasting and death. Reproductive dysfunction occurs soon after cows begin to graze locoweeds and include extended estrous cycle length, abnormal behavioral estrus, ovarian dysfunction and repeat breeding. Ingestion of locoweeds during pregnancy may result in embryonic/fetal loss during the first trimester and fetal death and abortion during the second and third trimesters. Recovery of reproductive function occurs once cows are removed from locoweed but the time to full recovery depends on the length of time cows have grazed the locoweed and their physical and behavioral condition at the time they are removed from locoweed.

Key Words: Locoweed, Swainsonine, Cattle

395   Serum swainsonine and selected serum constituent levels in sheep during the first twenty two hours after initial locoweed consumption. M. L. Vogt*, J. R. Strickland, C. R. Krehbiel, J. B. Taylor, A. K. Clayschulte, K. M. Whittet, K. W. Creighton, and M. A. Siepel, New Mexico State University, Las Cruces, NM USA.

The effects of locoweed consumption on serum swainsonine (SW) concentration and selected serum constituents during the first 22 h after initial consumption of locoweed in sheep were investigated. In Trial 1, six sheep (BW = 48.0 ± 12.6 kg) were stratified by weight and randomly assigned to one of three treatments; .2, .6, or 1.8 mg SW / kg BW. Diets were restricted to 1.75% BW (DMB) and formulated to be isonitrogenous and isocaloric. In Trial 2, thirteen sheep (BW = 47.2 ± 9.6 kg) were stratified by weight and randomly assigned to one of three treatments; .2, .4, or .8 mg SW / kg BW. Diets were restricted to 1.84% BW (DMB) and formulated to be isonitrogenous and isocaloric. Animals were adapted to a basal diet of blue grama and alfalfa hay for a minimum of 14 d for each trial. Locoweed (Oxytropis sericea) replaced alfalfa to provide SW. Blood samples were collected immediately prior to feeding locoweed (Time 0; control). Blood was then collected every 30 min for the first 6 h, every 1 h for the following 6 h, and every 2 h for the remaining 12 h. Serum SW, alkaline phosphatase (AP), total iron (FE), and unsaturated iron binding capacity (UIBC) were measured. A treatment by time interaction (P ≤ .05) for serum SW was detected in both trials. In both trials serum SW peaked between 10 and 20 h for all treatments. In Trial 1, no treatment or treatment by time interaction was detected for AP. In Trial 2, a treatment by time interaction (P < .001) was detected for AP, however no differences (P > .05) were detected within time. In both trials, no treatment or treatment by time interaction was detected for FE or UIBC. Interactions noted for serum AP levels in Trial 2 taken with data previously reported by our lab concerning elevated (P < .05) 24 h serum AP levels coupled with no changes in other tissue damage markers, may indicate early changes in serum AP are not related to cytotoxicity.

Key Words: Sheep, Locoweed, Alkaline Phosphatase

396   Effect of dietary supplements of dried red blood cell protein on growth and brain regional neurochemistry of starter pigs fed grains contaminated with deoxynivalenol and fusaric acid. T. K. Smith*[1] and E. J. MacDonald[2], [1]Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario, Canada, N1G 2W1., [2]Department of Pharmacology and Toxicology, University of Kuopio, Kuopio, Finland.

The feeding of grains contaminated with deoxynivalenol (DON) and fusaric acid (FA) can result in growth depression and alterations in brain regional neurochemistry in starter pigs. This has been thought to be due to an increase in hypothalamic tryptophan and serotonin concentrations. An experiment was conducted, therefore, to determine the potential for the feeding of diets rich in large neutral amino acids to overcome the mycotoxin-induced brain uptake of tryptophan. A total of 105 starter pigs (initial weight about 10 kg) were fed either (1) control (2) contaminated grains (4.1 ppm DON + 33.4 ppm FA) for (3) contaminated grains + 6% dried red blood cell protein for 21 days. Fifteen pigs fed each diet were subsequently euthanized and brains were excised, sectioned and analyzed for indolamines and metabolites. The feeding of the contaminated grains reduced growth over the 21-day period (P<0.05) with the biggest difference being in the first week of feeding. Pigs fed contaminated grains + dried red blood cell protein grew at a rate not different from controls (P>0.05). Hypothalamic serotonin concentrations tended to decline with the feeding of dried red blood cell proteins. It was concluded that the growth depressing effects of diets containing DON and FA can be at least partially overcome by the feeding of dried red blood cell protein. This effect is likely mediated through alterations in brain neurochemistry. (Supported by OMAFRA and Ontario Pork.)

Key Words: swine, deoxynivalenol, fusaric acid

397 Effect of ergotamine on pancreatic hormones, metabolites, and leptin in follicular phase heifers. R. Browning, Jr.*, S. J. Gissendanner, and T. Wakefield, Jr., *Tennessee State University, Nashville.*

The influence of ergotamine, a tall fescue ergopeptine alkaloid, on metabolic regulators and intermediates was assessed in four cycling Holstein F_1 heifers (397 kg; SD = 21). On two occasions, luteolysis for paired heifers was induced synchronously with two $PGF_{2\alpha}$ injections given 11 d apart. Two days after the second $PGF_{2\alpha}$ injection, plasma was sampled every 15 min for 1 h before an i.v. bolus of ergotamine tartrate (19 μg/kg body weight; ET) or saline vehicle (SV) and for 4 h after treatment. Heifers were then administered 100 USP units of oxytocin i.v. and bled every 30 min for an additional 3 h. Mean ambient temperature was $31.4°C$ (SD = 1.3) and relative humidity averaged 42% (SD = 11) during data collection. Each heifer received one treatment per synchronized period and both treatments during the study. Treatment x time affected ($P < .01$) plasma concentrations of insulin, glucagon, glucose, triglyceride, urea nitrogen and leptin. All means were separated by protected LSD procedure ($\alpha = .01$). Insulin decreased dramatically from $13.65 \pm .52$ μIU/mL before ET to $5.89 \pm .52$ μIU/mL 1 h after ET, then increased to $10.25 \pm .52$ μIU/mL by 4 h after ET, still lower than pretreatment. Insulin after SV declined gradually from $14.4 \pm .52$ μIU/mL before treatment to $10.16 \pm .52$ μIU/mL by 4 h after treatment. Glucagon increased from 57 ± 1.4 pg/mL before ET to 76.3 ± 1.4 pg/mL 1 h after ET. Glucagon after SV did not differ from before SV, however, glucagon increased for ET and SV heifers 1 h after oxytocin. Glucose increased from 80 ± 3 mg/dL before ET to 126 ± 3 mg/dL 1 h after ET, but was unchanged after SV. Urea nitrogen increased steadily from $9.6 \pm .3$ mg/dL before ET to $11 \pm .3$ mg/dL by 7 h after ET, but was unchanged after SV. Triglyceride increased from $11.4 \pm .5$ mg/dL before ET to $16.1 \pm .5$ mg/dL 1 h after ET, then declined to $6.9 \pm .5$ mg/dL by 4 h after ET, but was unchanged after SV. Leptin increased transiently from $2 \pm .05$ ng/mL before SV to $2.24 \pm .04$ ng/mL 1 h after SV. However, leptin for ET heifers increased continuously from $2.19 \pm .05$ ng/mL before treatment to $2.5 \pm .06$ ng/mL by 7 h after treatment. Results indicate ergotamine can alter plasma concentrations of hormones and intermediates involved in metabolic processes of cattle.

Key Words: Tall fescue ergopeptide, Pancreas, Leptin

398 Lipopolysaccharide Challenge to Steers Grazing Endophyte-Infected Tall Fescue. N. M. Filipov*[1,2], F. N. Thompson[2], T. H. Elsasser[3], J. A. Stuedemann[4], S. Kahl[3], R. P. Sharma[2], C. R. Young[5], and C. K. Smith[2], [1]*Wadsworth Center, New York State Dept. of Health, Albany, NY,* [2]*The University of Georgia, Athens, GA,* [3]*USDA/ARS, Beltsville, MD,* [4]*USDA/ARS, Watkinsville, GA,* [5]*USDA/ARS, College Station, TX.*

Fescue toxicosis in cattle is a result of consumption of ergot alkaloids found in endophyte-infected (E+, *Neotyphodium coenophialum*) tall fescue (*Festuca arundinacea*). The condition is characterized by pyrexia, decreased weight gains, rough hair coats, and decreased calving rates. The objective of this experiment was to investigate whether steers grazing E+ fescue have altered host response to lipopolysaccharide (endotoxin, LPS) challenge compared to steers grazing endophyte-free (E-) fescue. Angus steers (n=8) had continuously grazed either E+ (n=4) or E- (n=4) tall fescue grass for eight months prior to the experiment. The E+ steers had lower body weight, depressed average daily gain (ADG), and decreased basal serum prolactin (PRL) compared to the E- steers prior to LPS administration. Each steer received a single bolus i.v. injection of LPS (0.2 μgxkgxBW^{-1}; *Escherichia coli*; 026:B6) dissolved in sterile saline and blood was serially collected every 30 min for 4 h and at 24 h post LPS administration. Lipopolysaccharide increased serum tumor necrosis factor alpha (TNF-α), cortisol, and haptoglobin (Hp) but decreased plasma glucose and insulin-like growth factor-1 (IGF-1). Importantly, however, TNF-α, cortisol, and IGF-1 responses to LPS were greater in E+ compared to E-. These results indicate that animals grazing E+ fescue had altered integrated metabolic host response compared to animals grazing E- fescue. Potentially, combined exposure to E+ fescue and LPS, could have greater deleterious effects to the animal compared with exposure to only one of the two and would likely lead to increased catabolism.

Key Words: Fescue Toxicosis, Lipopolysaccharide (LPS), Steers

PHYSIOLOGY AND ENDOCRINOLOGY

399 Cytokine and NO modulation of cellular energetics, mitochondrial function and cytotoxicity. J. R. Lancaster*, *Louisiana State University Medical Center, New Orleans, LA.*

Nitric oxide (NO) is a ubiquitous messenger and cellular effector for an astonishing multitude of physiological and pathophysiological phenomena. In spite of this biological diversity, the immediate cellular actions of NO are dictated by only a few fundamental principles. While many actions of NO are beneficial and necessary in coordinating biological functions and aiding immune defense, other functions of NO can be deleterious in cytotoxic reactions within tissues. The three dominant interactions of NO in biological systems are (1) wide-ranging free diffusion of NO to multiple cells surrounding a single NO-producing cell, (2) reaction with oxygen species, and (3) reaction with transition metals. These principles will be reviewed in this presentation, followed by discussion of one important application of these principles, effects on cellular metabolism.

Key Words: Cytokine, Nitric oxide, Cytotoxicity

400 Role of proinflammatory cytokines and NO in pancreatic β-cell dysfunction and β-cell insulin resistance. M. L. McDaniel*, G. Kwon, G. Xu, and C. A. Marshall, *Washington University School of Medicine, St. Louis, MO.*

Our previous studies have addressed cellular mechanisms related to the development of type 1 diabetes that results in immunologically-mediated destruction of the β-cells of the islets of Langerhans. These approaches have focused on the ability of proinflammatory cytokines, in particular IL-1, to inhibit insulin secretion from the β-cell and facilitate β-cell destruction via the formation of the free radical, NO. The overproduction of NO resulting from expression of iNOS or NOS II mediates these effects by inactivating mitochondrial enzymes of the β-cell that contain iron-sulfur centers or clusters, and thus inhibit metabolism. Selective inhibitors of iNOS enzyme activity such as aminoguanidine or the IL-1 receptor antagonist protein, IRAP, which prevents iNOS expression in primary β-cells by blocking the IL-1 receptor, have proven effective in attenuating these deleterious effects of NO both *in vitro* and *in vivo*. Recent studies have identified a β-cell insulin receptor that functions in the regulation of protein translation and mitogenic signaling similar to that described for insulin-sensitive cells. These findings have raised the possibility that β-cells may exhibit insulin resistance similar to skeletal muscle, liver and fat. To test this hypothesis, the effects of TNFα, a cytokine proposed to mediate insulin resistance associated with obesity by interfering with insulin signaling, was evaluated. Our findings suggest that TNFα either alone or in the presence of other endogenous cytokines activate intraislet macrophages resulting in the release of IL-1 that then induces iNOS expression and overproduction of NO in β-cells. NO mediated inhibition of cellular metabolism leads to interference of insulin and growth factor signaling associated with β-cell growth and proliferation. These defects in β-cell insulin signaling are normalized by antidiabetic PPARγ agonists that down regulate macrophage iNOS expression and also by IRAP and aminoguanidine. These results suggest that a global inhibition of metabolism by NO may be a major factor in the pathogenesis of insulin resistance in β-cells and possibly other insulin-sensitive cells in type 2 diabetes.

Key Words: Pancreas, Nitric oxide, Insulin resistance

401 Cytokine modulation of reproductive processes. J. L. Pate*, *Ohio State University, Wooster, OH.*

Perhaps the early recognition that there is communication between the immune and reproductive systems came when it was realized that ovarian steroids could modulate immune response mechanisms, probably via effects on cytokine production and/or action. At about the same time, the field of neuroendocrinimmunology was born, with the understanding

that substances produced by immune cells could influence pituitary hormone secretion, and that some immune cells may possess receptors for hypothalamic or pituitary proteins. More recently, several investigators have provided evidence that cytokines may serve as direct messengers to facilitate communication between immune cells and gonadal cells. Cytokines such as macrophage chemoattractant protein-1 (MCP-1) and macrophage migration inhibitory factor (MIF) have been localized in ovarian follicles and corpora lutea, and are thought to recruit and retain macrophages during structural reorganization of these tissues. Pro-inflammatory cytokines, such as interferon-γ (IFN-γ) and tumor necrosis factor-α (TNF-α) are produced in the ovary, and may serve as local regulators of steroidogenesis, in addition to augmenting a localized immune/inflammatory response. Interleukin-1β is produced in the ovary, and appears to play an intermediary role in ovulation. Some of these cytokines have also been found in the testis, and have some functional effects on testicular cells in vitro. Finally, it has become clear that cytokines (IFN-τ, GM-CSF and others) are involved in the communication between the embryo and maternal tissues to facilitate maternal recognition of pregnancy and embryonic development. This review will focus on recent advances in our understanding of how cytokines are involved in regulating reproductive processes.

Key Words: Cytokines, Reproduction, Monokines

402   Role of prostaglandins in modulating uterine immune responses in postpartum ewes. R. C. Seals*[1], M. C. Wulster-Radcliffe[1], E. L. Hensley[1], and G. S. Lewis[1], [1]*Virginia Polytechnic Institute and State University, Blacksburg.*

Exogenous progesterone (P4) and PGE$_2$ can make the uterus susceptible to infection. Thus, we studied the roles of P4 and PG in uterine immune function. Ewes were assigned to randomized treatments in a 2 $\times$ 2 factorial array (n = 4 to 5 ewes/group); ovariectomy and exogenous P4 (5 mg/2.5 mL of canola oil i.m., 2 $\times$/d) were main effects. Ewes were sham-ovariectomized (SHAM) or ovariectomized (OVEX) on d 9 postpartum (d 0 = parturition), and their uteri were inoculated with 56 $\times$ 10^7 cfu of *Arcanobacterium pyogenes* and 26 $\times$ 10^7 cfu of *E. coli* on d 15. Vena caval blood was collected on d 9, 14, and 15 to 19. Uteri were collected on d 20. Ewes began receiving either canola oil (OIL) or P4 in the oil (PROG) on d 10. Lymphocytes from each blood sample were assigned to a 2 $\times$ 2 factorial array of in vitro treatments; 10^{-7} M PGE$_2$ and 10^{-7} M indomethacin (INDO), a PG synthesis inhibitor, were main effects. The amount of sediment and ability to culture *A. pyogenes* and *E. coli* from uterine flushings were used to diagnose infections. Lymphocyte blastogenesis (i.e., [^{3}H]thymidine incorporation) and P4 were quantified. Progesterone was greater (P = .001) in PROG than in OIL (3.6 vs .7 ng/mL; SEM = .2). The blastogenic response in OVEX-PROG was less than in SHAM-OIL, SHAM-PROG, and OVEX-OIL (4.1 vs 5.4, 5.7, and 5.8 pmol, respectively; SEM = .5). Concanavalin A (ConA)-stimulated blastogenesis was less (P =.03) in OVEX than in SHAM (9.9 vs 11.8 pmol; SEM = .6). Lymphocyte blastogenesis was less (P < .01) in PGE$_2$ and PGE$_2$+INDO (4 and 4.3 pmol) than in control or INDO (6 and 6.6 pmol; SEM = .5). Also, ConA-stimulated lymphocyte blastogenesis was less (P < .01) in PGE$_2$ and PGE$_2$+INDO (7.5 and 8.3 pmol) than in control or INDO (12.9 and 14.7 pmol; SEM = .9). In conclusion, in vivo treatment with P4 and in vitro treatment with PGE$_2$ have negative effects on uterine immunity in postpartum ewes. Methods for modulating uterine PGE$_2$ may be useful for reducing the susceptibility to uterine infections.

Key Words: Sheep, Uterine Infections, Prostaglandins

403   Immune system function of neonatal pigs born naturally or by Cesarean section. J. A. Daniel*[1], D. H. Keisler[1], L. A. Beausang[2], M. E. Zannelli[2], R. L. Matteri[3], and J. A. Carroll[3], [1]*Depart. Animal Sciences, University of Missouri-Columbia, [2]Endogen, Inc., Woburn, MA, [3]Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO.*

Eight full term crossbred sows were selected for a study to compare the immune function of pigs born by Cesarean section (c-section) or natural-birth (n = 4 each for natural-birth and c-section). Gestation length and birth weight did not differ between natural-birth and c-section pigs (P = 0.34 and 0.62, respectively). Blood and tissue samples were collected from 44 pigs at birth. Forty-five pigs were weaned at 13 d and fitted with an indwelling jugular cannula for blood sample collection at 14 d. Pigs received an i.p. injection of lipopolysaccaride (LPS; 150 μg/kg)

or saline at min 0, blood serum samples were collected at -20, -10, 0, 5, 10, 20, 40, 60, 90 and 120 min, and tissue samples were collected immediately following the 120 min sample. Serum concentrations of cortisol, ACTH, and prolactin were determined by RIA. Serum concentrations of interferon-γ (INF-γ) and tumor necrosis factor-α (TNF-α) were determined by ELISA. Natural-birth pigs had 21% greater ADG than c-section pigs (P $\leq$ 0.01). Centrifuge clot to blood ratio was greater among natural-birth than c-section pigs at birth (P $\leq$ 0.01) but did not differ at 14 d (P = 0.37). Basal serum ACTH and cortisol was greater in c-section than natural-birth pigs at birth (P $\leq$ 0.01) but was not different at 14 d (P = 0.99 and 0.80, respectively). Basal serum prolactin did not differ at birth or 14 d (P = 0.13 and 0.36, respectively) but decreased from birth to 14 d (P $\leq$ 0.01). Serum ACTH, cortisol, prolactin, INF-γ, and TNF-α increased in response to LPS challenge (P $\leq$ 0.01) but was not different between c-section and natural-birth (P $\geq$ 0.22). Basal serum TNF-α tended to be greater in c-section versus natural-birth pigs at 14 d (P $\leq$ 0.10). Basal serum INF-γ tended to be lower in c-section pigs versus natural-birth pigs at 14 d (P $\leq$ 0.08). These data indicate that c-section birth may alter basal immune system function in neonatal pigs.

Key Words: Neonatal Pig, Immune system, Cesarean section

404   Growth hormone (GH) administration augments and vitamine E (E) attenuates increases in plasma nitrate+nitrite (NOx) and decreases in IGF-I after endotoxin (LPS) challenge. T. H. Elsasser*[1], S. Kahl[1], T. S. Rumsey[1], and R. Hoffman[2], [1]*USDA, Agricultural Research Service, Beltsville, MD, [2]Monsanto Co., St. Louis, MO.*

GH has been shown to increase the plasma NOx response to LPS, indicative of the increased metabolism of arginine to nitric oxide. The objective of this study was to determine whether daily injection of E would affect plasma concentrations of NOx and IGF-I and decrease hepatic production of cytotoxic peroxynitrite (ONOO$^-$). Fifteen yearling heifers (334 $\pm$ 4 kg) were fed a forage concentrate diet (15% CP) to appetite, and synchronized to a similar stage of the estrus cycle with two injections of prostaglandin F$_{2\alpha}$ (F). Heifers were assigned to control (C, daily corn oil and saline-bicarbonate injections, C), GH treatment (GH, 0.1 mg/kg, im., for 12 days), or GH + E (mixed tocopherol, im., 800 IU/d). All heifers were challenged with LPS (.003 mg/kg) 8 d after the last injection of F and again 2 days later. Blood samples were obtained at 0, 1, 2, 3, 4, 6, 8, 12 and 24 h relative to LPS and liver tissue was obtained via biopsy 6-8 h after the last LPS. All heifers responded to LPS with increases in TNF; LPS1 responses were greater than those in LPS2 (P<.001); in LPS2 plasma TNF responses were greater (P<.006) in GH than C or E. Plasma IGF- I, increased with GH but decreased transiently in C (-22% maximum) and E (-11% maximum) after LPS. The decrease in IGF-I in GH (-39% maximum) was maintained to the end of the sampling period (P<.01). NOx responses were augmented over C with GH (P<.01) but diminished to C responses in GH + E (P<.01). Liver ONOO$^-$ responses, detected by immunocytochemistry for nitrotyrosine were increased in a gradient around central vein and periportal structures in GH but attenuated with the use of E. The data suggest that E may be effective in curbing some elements of cytotoxicity associated with increased production of NOx.

Key Words: Growth Hormone, Endotoxin, Vitamine E

405   Lutalyse changes the immune response in ewes after intrauterine bacterial inoculation. M. C. Wulster-Radcliffe*, J. L. Bardugone, R. C. Seals, and G. S. Lewis, *Virginia Polytechnic Institute and State University, Blacksburg.*

The uterus is susceptible to infection during the luteal phase, and PGF$_{2\alpha}$ allows the uterus to clear the infection. Thus, we determined whether Lutalyse (LUT; Pharmacia & Upjohn), a PGF$_{2\alpha}$ analogue, alters the uterine immune response to bacterial challenge (BC). Ewes (n = 6/group) were assigned to randomized treatments in a 2 $\times$ 2 factorial array; BC and LUT were main effects. Vena caval blood was collected on d 5 through 11 of the estrous cycle. On d 6, each uterus received either 35 $\times$ 10^7 cfu of *Escherichia coli* and 75 $\times$ 10^7 cfu of *Arcanobacterium pyogenes* in PBS or PBS. On d 9, ewes received two i.m. injections of either saline or Lutalyse (5 mg with a 5-h interval). The lymphocyte blastogenic response to mitogens was determined to evaluate the immune status of the ewes, progesterone (P4) was quantified, and white blood cells were counted. Uteri were collected at slaughter on d 11. The

packed cell volume (PCV) in uterine flushings and the ability to culture *E. coli* and *A. pyogenes* were used to diagnosis uterine infections. Bacterial challenge affected (BC vs PBS; $P < .05$) daily percentages of neutrophils (41 vs 50%), lymphocytes (41 vs 28%), and eosinophils (6 vs 10 %). The LUT increased ($P < .05$) the percentage of neutrophils (LUT vs saline; 50 vs 42%). The BC induced infections (PCV > 1% and bacterial regrowth) in all ewes, but none of the PBS-treated ewes developed infections (PCV < 1% and no regrowth). Ewes given BC and treated with LUT seemed to clear uterine infections (PCV < 1% and no regrowth). The LUT decreased ($P < .05$) daily P4 concentrations and enhanced ($P < .01$) basal lymphocyte blastogenesis, but not blastogenic response to mitogens. A reduction in uterine infections in ewes treated with LUT indicates that LUT enhanced the immune response to BC in sheep. However, the change in immune function after LUT did not seem to be in response to changes in lymphocyte actions.

Key Words: Sheep, Uterine infections, Lutalyse

406   Expression of two variants of growth hormone receptor messenger ribonucleic acid in porcine liver. J. Liu*[1], J. A. Carroll[2], R. L. Matteri[2], and M. C. Lucy[1], [1]*University of Missouri, Columbia,* [2]*Animal Physiology Unit, ARS-USDA, Columbia, MO.*

Transcription of growth hormone receptor (GHR) mRNA is initiated from multiple promoters. Most GHR mRNA arise from Promoter 1 and 2 that transcribe GHR 1A and GHR 1B mRNA, respectively. The objective was to characterize the developmental expression of GHR 1A and GHR 1B mRNA in liver of castrated male pigs (Study 1) and intact male pigs treated with recombinant porcine somatotropin (rpST; Study 2). For Study 1, 24 castrated male pigs were slaughtered at one of four ages (1, 14, 28, and 42 d, n = 6/age group). For Study 2, 24 intact male pigs were treated with rpST (200 μg/kg BW/d) or control beginning at 7, 28, or 63 d of age and slaughtered 14 d later (21, 42, and 77 d; n = 4 pigs/treatment/age). Tissue samples were collected at slaughter for mRNA analyses. The porcine GHR 1A and GHR 1B cDNA were cloned and were 89.2% and 89.7% homologous to bovine, respectively. A ribonuclease protection assay was used to measure GHR 1A and GHR 1B mRNA. Liver expressed GHR 1A and GHR 1B mRNA, whereas muscle, uterus, and ovary expressed GHR 1B mRNA. The liver of castrated male pigs (Study 1) expressed GHR 1B mRNA at all ages and the amount of GHR 1B tended to increase ($P < .10$) with increasing age (.11, .25, .25, and .38 units for 1, 14, 28, and 42 d, respectively; SEM = .03). GHR 1A mRNA in the liver was not expressed until 42 d of age in castrated male pigs. The liver of intact male pigs (Study 2) expressed GHR 1A and GHR 1B mRNA by 21 d and there was an age-related increase in GHR 1A mRNA (.04, .12, and .20; SEM = .03; P < .01) and GHR 1B mRNA (.56, .59, and .70; SEM = .06; P < .10; 21, 42, and 77 d, respectively). Administration of rpST had no effect (P > .20) on expression of GHR 1A or GHR 1B mRNA. In conclusion, GHR mRNA in porcine liver was composed of at least two variants (GHR 1A and GHR 1B). The GHR 1B mRNA was found at all ages whereas GHR 1A mRNA was detected by 21 (intact male) or 42 (castrated male) d of age. Both GHR 1A and GHR 1B mRNA increased with age.

Key Words: Pig, Liver, GH receptor

407   Feeding-induced increases in insulin do not suppress secretion of growth hormone. C. D. McMahon, L. T. Chapin*, K. J. Lookingland, R. P. Radcliff, and H. A. Tucker, *Michigan State University, East Lansing, MI.*

Insulin inhibits both basal and growth hormone-releasing hormone (GHRH)-induced release of growth hormone (GH) from the anterior pituitary gland. Steers fed ad libitum for a 2-h period once each day have reduced concentrations of GH after feeding, and GHRH-induced release of GH is suppressed. We hypothesized that increased secretion of insulin during feeding inhibits release of GH from the anterior pituitary gland. Our objectives were to determine whether: (1) alloxan prevents feeding-induced increases in concentrations of insulin; (2) concentrations of GH remain high after feeding in alloxan-treated steers; and (3) GHRH stimulates release of GH in alloxan-treated steers after feeding. Steers were injected i.v. with either sterile saline (control) or with freshly prepared alloxan monohydrate (110 mg/kg body weight) (n = 4 per group). Concentrations of insulin were lower ($P < .05$) in alloxan-treated steers (69.7 pmol/l) than in control steers (105.3 pmol/l) (pooled SEM = 9.3). In addition, alloxan prevented concentrations of insulin from increasing (P

= .02) after feeding (131.8 pmol/l) compared with control steers (442 pmol/l) (pooled SEM = 66.5). Concentrations of GH were higher (P < .05) in alloxan-treated (6.9 ng/ml) than in control steers (4.0 ng/ml) (pooled SEM = .61), but concentrations of GH decreased during feeding and remained low after feeding in both groups. Intravenous injection of GHRH stimulated release of GH 1 h before feeding, but net areas under the GH curve were not different between control and alloxan-treated steers (P = .96). Growth hormone-releasing hormone-induced release of GH was greatly suppressed (P < .001) in both groups 1 h after feeding, and the net areas under the GH curve were not different between groups (P = .98). We conclude that although reduced concentrations of insulin increase basal concentrations of GH in serum, insulin does not mediate feeding-induced decreases in secretion of GH.

Key Words: Insulin, Growth Hormone, Meal-Feeding

408   LH response to slow-release Deslorelin in estradiol benzoate (EV) primed ovariectomized gilts. R. R. Kraeling*[1], C. R. Barb[1], G. B. Rampacek[2], D. Thompson[3], J. Gibson[4], S. Sullivan[4], B. Simon[5], and P. J Burns[5], [1]*USDA, Agricultural Research Service,SAA; Athens, GA 30604,* [2]*University of Georgia, Athens, Ga 30602,* [3]*Louisiana State University, Baton Rouge, LA,* [4]*Southern Biosystems Inc., Birmingham, AL,* [5]*Thorn BioScience, Lexington, KY.*

A dose response study was conducted to determine if Deslorelin, a potent GnRH analogue, delivered via the SABER Delivery System, a biodegradable controlled release system, would stimulate an ovulatory-like LH surge in the pig. Twenty ovariectomized gilts, approximately 200 d old and 100 kg BW, received, i.m., 15 μg of EB/kg BW and 48 h later, 4 gilts each received, i.m., 12.5, 25, 50 or 100 μg of Deslorelin as Deslorelin acetate (DA) in sucrose acetate isobutyrate (SAIB)/propylene carbonate while 4 others received vehicle. Blood samples were taken at 0, 0.5, 1, 2, 4, 6, 12, 18, 24, 30, 36, 42 and 48 h after DA. Blood Deslorelin levels were elevated (P<.05) for 6 to 12 h; peak levels from 53 to 487 μg/ml in the 12.5 and 100 μg groups, respectively. Serum LH concentrations increased (P<.05) after DA compared to controls; mean peak concentrations from 8.7 in the 25 μg group to 17.8 ng/ml in the 12.5 μg group. Serum LH response was greatest (P<.05) in the 12.5 μg and 50.0 μg groups indicated by area under the curve and peak serum LH concentration. Lack of a dose response indicates that the amount of LH released was similar for the 12.5 μg and higher doses. Lack of decreased LH response to the higher doses of DA indicates that down-regulation of GnRH receptors did not occur at doses up to 100 μg. Doses less than 12.5 μg may also be effective. Serum LH peak concentrations were approximately double previously reported ovulatory concentrations of 6 to 10 ng/ml in gilts. Thus, 12.5 μg of Deslorelin as DA via SABER stimulated an ovulatory LH surge gilts.

Key Words: GnRH, LH surge, pig

409   Prolactin induces activation of focal adhesion kinase (FAK) via JAK2-mediated activation of c-src. L. G. Sheffield*, *University of Wisconsin, Madison, WI.*

Treatment of normal murine mammary epithelial cells (NMuMG line) with prolactin induced a rapid and transient increase in the tyrosine kinase activity of focal adhesion kinase (FAK), measured by immunoprecipitation of FAK followed by assessment of phosphorylation of substrate peptides. Maximum response was a 5.8 ± 0.8 fold increase, observed after 10 minutes in response to 10 nM prolactin. After 60 minutes, FAK activity had returned to baseline. The increased FAK activity was associated with increased tyrosine phosphorylation of the enzyme. The activation of FAK was largely paralleled to the activation of two other tyrosine kinases, JAK2 and c-src. Prolactin (10 nM for 10 minutes) gave a 5.6 ± 0.7 fold increase in c-src activity and a 7.4 ± 1.1 fold increase in JAK2 activity. Inhibition of JAK2 activity with a kinase inactive (dominant negative) JAK2 blocked not only JAK2 activation, but completely eliminated the activation of both c-src and FAK. In contrast, JAK2 activation was not eliminated by a kinase inactive c-src, but the activation of FAK was blocked. In addition, FAK and c-src were physically associated (as measured by co-immunoprecipitation), and this association was unaffected by prolactin or by dominant negative inhibitors of JAK2 or c-src. In contrast, association of the c-src-FAK complex with prolactin receptor was increased by prolactin. This association was not affected by dominant negative c-src, suggesting that the association of c-src and FAK with the prolactin receptor was not a consequence of c-src or FAK activation. However, kinase inactive JAK2 blocked the association of

c-src and FAK with the prolactin receptor. These results indicate that prolactin, via activation of JAK2, induces a phosphorylation event that results in the translocation of a FAK-c-src complex to the prolactin receptor. This is followed by activation of c-src, which in turn activates FAK.

Key Words: Prolactin, Mammary Gland, Signaling

410   Vasoactive intestinal polypeptide stimulates prolactin secretion in pony mares. P. R. Buff*, N. C. Whitley, E. L. McFadin-Buff, W. E. Loch, and D. H. Keisler, *University of Missouri, Columbia*.

Our objective was to determine if vasoactive intestinal polypeptide (VIP) would affect the secretion of prolactin (PRL) in seasonally anestrous vs. cyclic pony mares. Ten pony mares weighing 258 ± 16.6 kg were separated into two groups during early winter and used in 3 replications (rep) at least one day apart. Five mares were housed under 16 h of artificial light to induce cyclicity and five were kept in ambient light conditions to maintain anestrous status. Mares in the first rep exhibited a naturally synchronized estrus but a single i.m. injection of prostaglandin $F_2\alpha$ was used to synchronize estrus for the other reps. Doses were administered via jugular cannulae and consisted of .3 mg VIP, 500 μg of thyrotropin releasing hormone (TRH) or 3 ml saline for the first rep while the second and third reps also included .6 mg VIP (n=5 to 7/trt). Blood samples were collected into tubes containing EDTA every 10 min from -30 to +60 min (treatment = 0 min) and every 30 min from +90 to +210 min via jugular cannulae. Plasma was collected and analyzed for PRL via radioimmunoassay. Prolactin secretion was affected by a treatment by season (status) interaction (P<.01). Treatment with VIP at .3 and .6 mg increased (P<.02) PRL in cyclic mares when compared to anestrous mares. In addition, TRH increased PRL in both anestrous and cyclic mares when compared to saline treatment (P<.01). Average PRL secretion was .80 $\pm$ .29, 1.33 $\pm$ .26, and 1.36 $\pm$ 30 ng/ml for control, .3 mg VIP and .6 mg VIP in cyclic mares, respectively compared to .39 $\pm$ .31, .34 $\pm$ .26, and .22 $\pm$ .36 ng/ml for control, .3 mg VIP and .6 mg VIP in seasonally anestrous mares, respectively. Prolactin averaged 2.57 $\pm$ .32 and 4.80 $\pm$ .29 ng/ml for TRH treatment in anestrous and cyclic mares, respectively. In conclusion, vasoactive intestinal polypeptide increased plasma prolactin in cyclic compared to anestrous pony mares when administered intravenously.

Key Words: Mares, Vasoactive intestinal polypeptide, Prolactin

411   Continuous, intracerebroventricular infusion of neuropeptide Y induces a prolonged suppression of LH. C. D. Morrison*, J. A. Daniel, P. R. Buff, and D. H. Keisler, *University of Missouri, Columbia MO/USA*.

Neuropeptide Y (NPY) is a neurotransmitter which provides an important hypothalamic link between nutrition and reproduction. A role for NPY in nutritional control of reproduction is supported by elevated expression of NPY in nutritionally anestrous animals, and by the suppression of LHRH/LH secretion in response to a single intracerebroventricular (i.c.v.) injection of NPY. It is currently not known, however, if NPY can continuously inhibit the secretion of LH over longer periods. The objective, therefore, was to determine if i.c.v. infused NPY can suppress LH secretion for a sustained duration. Eight ovariectomized ewe lambs were fitted with lateral cerebroventricular cannula. NPY or saline (n = 4 per group) was continuously infused for 20 hours in a linearly increasing dose, ending at a maximum dose of 50 μg/hr. Blood samples were collected via jugular cannula every 10 minutes at hours -4 to 0 (Bleed 1, pretreatment), 6 to 10 (Bleed 2) and 16 to 20 (Bleed 3) relative to the initiation of NPY infusion. Serum concentrations of luteinizing hormone (LH) and growth hormone (GH) were determined by radioimmunoassay. Mean LH and LH pulse frequency were similar between NPY and saline infused lambs during Bleed 1 (Mean: 15.4 vs. 12.6 ng/ml, P = .11; Frequency: 3.25 vs. 3.75 peaks/bleed, P = .23) but then decreased in NPY versus saline infused lambs during Bleed 2 (Mean: 5.9 vs. 16.5 ng/ml, P = .001; Frequency: 1 vs. 2.75 peaks/bleed, P = .001) and Bleed 3 (Mean: 4.2 vs. 10.2 ng/ml, P = .003; Frequency: .25 vs. 3.5 peaks/bleed, P = .001). NPY did not affect GH secretion (P > .10). From these data we propose that increasing levels of i.c.v. infused NPY can suppress the secretion of LH for extended periods of time without

compensatory desensitization, and that chronic, i.c.v. infusion of NPY may be used as a model system for the nutritionally anestrous ewe.

Key Words: Neuropeptide Y, LH

412   Orexin regulates appetite in sheep. J. L. Sartin*[1], D. L. Buxton[1], C. J. Dyer[2], R. L. Matteri[2], M. A. Shores[1], and B. P. Steele[1], [1]*Auburn University, Auburn, AL,* [2]*Animal Physiology Unit, ARS, USDA, Columbia, MO.*

Orexin is a hypothalamic neuropeptide that regulates feeding behavior in rats. Orexin-B has recently been cloned in pigs and was shown to stimulate food intake after intramuscular injection. This study was designed to determine whether icv and iv injections of orexin could regulate appetite in sheep. Suffolk whethers were moved to indoor facilities and adapted to diets for 6 weeks and trained to stand in stanchions for 3 to 6 hours each day for 2 weeks before having lateral ventricle cannulas installed. These sheep were provided water and fed ad libitum. On the day before an experiment, sheep were provided jugular cannulas and on the day of an experiment were placed in stanchions and allowed to stand for 1 hour before use. Sheep were then monitored over a 2-hour control period prior to iv injection with saline or porcine orexin-B (3 μg/kg BW) or icv injection with artificial CSF, orexin-B (0.3 μg/kg BW), neuropeptide Y (NPY; 0.3 μg/kg BW) or orexin and NPY. Food intake was monitored for consecutive 2-hour periods. In both iv and icv sheep, food intake was increased in the first 2 hours by P<0.05). In the comparison with NPY, orexin had a similar effect to the NPY injection in the first two hours after injection (.09 kg food intake to .23 and .2 kg respectively). The combination of NPY and orexin had a slightly greater, though nonsignificant effect on food intake (to .34 kg). Differences were not apparent in the subsequent 2 h interval. These data indicate that orexin stimulates feed intake in sheep after icv stimulation, and as described for the pig, orexin also enhances appetite when administered through a peripheral route.μ

Key Words: Orexin, Neuropeptide Y, Sheep

413   Effect of insulin administration on feed intake and conception rate in ewe lambs. E. L. McFadin-Buff*, N. C. Whitley, and D. H. Keisler, *University of Missouri, Columbia*.

The objective was to determine the effect of once daily insulin injection on feed intake and post-treatment conception rate in ewe lambs. Eighty-four nulliparous ewe lambs (Romanov, Hampshire, Columbia, and crossbreds) weighing 45±.9 kg were selected for study in the fall of the year. Estrus was synchronized using an intravaginal progesterone releasing device (Eazi-Breed CIDR; Inter Ag; Hamilton, NZ), and (or) a single injection of prostaglandin $F_2\alpha$(10 mg; Lutalyse; Pharmacia & Upjohn; Kalamazoo, MI). Ewes were observed for estrus twice daily using sterile rams and penned individually beginning on d 7 following estrus. A mixed ration was fed twice daily at a total rate of 4% BW. On d 9 through 13 following estrus, ewes received once daily injections (s.c.) of either 1 IU/kg BW of insulin (Eli Lilly Lente Iletin I, beef/pork; n=44) or an equivalent volume of saline (n=40). Feed intake was not influenced by treatment and averaged 1.76±.04 kg/d. On day 14, ewes were removed from their pens and managed on pasture in groups of no more than 15 ewes per fertile ram (wearing marking harnesses). Ewes in estrus during the 10 d interval following insulin or saline treatment (i.e. until d 23 following the synchronized estrus) were recorded. Estrous cycle length and percentage of ewes in estrus did not differ between insulin and saline treatment (81±5.9% vs. 77±6.6%, respectively). Thirty days post-breeding, pregnancy was determined via trans-rectal ultrasonography using a 3.5 MHz probe. Conception rate did not differ with respect to insulin vs. saline treatment (89±5.3% vs. 81±7.2%, respectively). Of interest, however, feed intake among insulin-treated ewes was negatively related to conception rate (r= -.38; P < .03), while no such relationship existed among saline-treated ewes (r= -.21; P < .25). Treatment of ewes with insulin did not influence conception rate or feed intake in nulliparous ewe lambs under these conditions.

Key Words: Ewe, Insulin, Intake

414 Leptin receptor mRNA expression in the brain, pituitary and other tissues in the pig. J. Lin[*1], C. R. Barb[2], R. L. Matteri[3], R. R. Kraeling[2], X. Chen[1], G. B. Rampacek[1], and R. J. Meinersmann[2], [1]*University of Georgia; Athens, GA, USA,* [2]*USDA, Agricultural Research Service, SAA; Athens, GA USA,* [3]*USDA, Agricultural Research Service, Columbia, MO.*

Recently, much effort has focused on understanding the role of leptin, the obese gene product secreted by adipocytes, in regulating growth and reproduction in rodents, human and domestic animals. We previously demonstrated that leptin inhibited feed intake and stimulated GH and LH seceretion in the pig. Therefore, this study was conducted to determine location of leptin receptors in various tissues of the pig. The leptin receptor has several splice variants in the human and mouse, but the long form receptor (LR) is the major form capable of signal tansduction. The LR is expressed primarily in hypothalamus of the human and rodent but has been located in other tissues as well. In the present study, a partial porcine long form leptin receptor cDNA, cloned in our laboratory and specific to the intracellular domain, was used to evaluate the LR mRNA expression by RT-PCR in the brain and other tissues in three 105 day old gilts and 50 day fetus. The LR was expressed in brain, intestine, muscle, fat, liver and umbilical cord in 50 day fetus. In 105 day old gilts, leptin LR was expressed in the hypothalamus, cerebral cortex, amygdala, thalamus, cerebellum, area postrema and pituitary. In addition, LR was also expressed in ovary, uterine body, liver, kidney, pancreas, adrenal gland, lung, intestine, bone marrow, muscle and adipose tissue. However, it was not found in thyroid, thymus or superior vena cava. These results support the idea that leptin plays a role in regulating numerous physiological functions. Further work is needed to identify these functions.

Key Words: leptin, receptor, pig

415 Comparison of area under the curve and a two-time point method to determine growth hormone (GH) response to growth hormone releasing factor (GRF). W. J. Weber, L. H. Baumgard, and B. A. Crooker*, *University of Minnesota, St. Paul.*

A retrospective analysis of four studies was conducted to compare a simplified two-time point (TTP) method with area under the curve (AUC) to determine GH response to GRF. Each study utilized animals from a breeding project that developed control (CL) and select (SL) lines of Holstein cows that differed ($> 3,800$ kg/ 305 d lactation) in their ability to produce milk. Objectives were to determine effects of dose (Study 1; 0, 2.5, 5, 10, 20 μg GRF/100 kg BW), gender and age (Study 1, 2), stage of lactation (Study 3, 4), and line (all studies) on GH response. Studies 2, 3, and 4 used 4 μg GRF/100 kg BW. Growing heifers, bulls, steers and mature cows (68 CL, 75 SL; 919 dosings) were sampled (n=14 from jugular catheters) from -30 to 120 min after GRF dosing. The AUC was quantified (0 to 45, 60, or 90 min post dosing) after subtracting mean pre-dosing GH concentrations. The TTP was calculated as the difference between the 0 and 7.5, 10, or 20 min GH concentrations. Effects were evaluated using PROC MIXED and PROC CORR of SAS. Duration of measurement had little affect on AUC but TTP7.5 generally differed from TTP10 and TTP20. A strong correlation between AUC60 and TTP20 occurred within each study (r = .76 to .91, P<.001) but variation increased when correlations were limited to main effects within a study (r = .22 to .94, P<.001). Although TTP and AUC generally detected similar main treatment effects, line differed (CL $>$ SL) in Study 2 with TTP20 but not AUC60. Separation of main effects revealed substantial differences. In Study 1, TTP20 continued to decrease (57^a, 49^b, 41^c ng/ml) with age (4, 7, 10 months) but AUC60 stabilized (2390^a, 1907^b, 1904^b ng·min·ml^{-1})and AUC60 increased with dose but TTP20 plateaued. In Study 3, AUC60 (470^a, 458^a, 691^b ng·min·ml^{-1}) and TTP10 (14^a, 6^b, 14^a ng/ml) at -14, 9, and 64 d postpartum differed. In general, TTP and AUC were highly correlated but results and interpretations did differ. Factors affecting AUC and TTP need to be clarified before results from each can be used interchangeably.

Key Words: Growth hormone, GRF, Cattle

416 Increased concentrations of IGF binding protein-1 in bovine luteal tissue during PGF$_{2\alpha}$-induced luteolysis. B. L. Sayre*, R. Taft, E. K. Inskeep, and J. Killefer, *West Virginia University, Morgantown.*

A novel message that increased during PGF$_{2\alpha}$-induced luteal regression was identified as insulin-like growth factor binding protein-1 (IGFBP-1) by RT-PCR (Taft et al., J. Reprod. Fert. Suppl. 54: 1999). The objective of this experiment was to determine if expression of IGFBP-1 differed when luteal regression was induced on d 4 or d 10. Cows were treated with PGF$_{2\alpha}$ (15 mg) or saline (3 ml) every 8 h on d 4 (n=15) or d 10 (n=15) after estrus until tissue collection 24 or 48 h later. Jugular blood samples were collected every 8 h from 24 h before treatment and until tissue collection. Corpora lutea were collected via supravaginal incision. Concentrations of progesterone, and of IGFBP-1 and its mRNA were determined by RIA, Western ligand blot analysis, and RT-PCR, respectively. Concentrations of progesterone were decreased (P $<$ .05) 8 h after treatment with PGF$_{2\alpha}$ began on d 10 (2.54, 1.38, .63, and .39 ng/ml), but were not decreased until 24 h on d 4 (.44, .42, .31, and .21 ng/ml) for 0, 8, 16, and 24 h, respectively. IGFBP-1 mRNA was increased (P $<$ .05) 24 h after treatment with PGF$_{2\alpha}$ began on d 10 (10, 490, and 190 arbitrary densitometric units), but not until 48 h on d 4 (213, 196, and 512 arbitrary densitometric units) for control, 24 and 48 h of treatment with PGF$_{2\alpha}$, respectively. Concentrations of IGFBP-1 were increased (P $<$ .05), in a pattern similar to expression of mRNA, on d 10 (140, 718, and 980 arbitrary densitometric units), and d 4 (398, 541, and 1074 arbitrary densitometric units) for control, 24 and 48 h of treatment with PGF$_{2\alpha}$, respectively. Increased luteal IGFBP-1 may inhibit the steroidogenic effects of IGF-I on secretion of progesterone during luteal regression.

Key Words: Insulin-like growth factor binding protein-1, Corpus luteum, Cattle

417 Does anterior pituitary responsiveness to GnRH predict age at puberty in beef heifers? R. L. Stanko[*1,2] and G. L. Williams[1], [1]*Texas A&M University Agricultural Research Station, Beeville, Texas,* [2]*Texas A&M University-Kingsville, Kingsville, Texas.*

Anterior pituitary responses to GnRH were determined in prepubertal beef heifers to assess statistical distributions of LH response variables relative to the mean of the sample population. Santa Cruz heifers (n =110) were challenged with GnRH (.22 μg/kg, i.v.) at 271 (254.6 ± 2.3 kg BW) and 336 (292.9 ± 2.9 kg BW) days of age in two consecutive years (n= 55/year). Single blood samples were collected via jugular or coccygeal vein at 0, 10, 30, 60, 120, and 240 min from GnRH treatment. Additional blood samples were collected twice weekly, beginning at 240 days of age, for determination of puberty. Blood samples were placed immediately on ice, with serum was harvested and stored at -20° C within 8 h. Serum from intensive samples were analyzed for LH and biweekly samples assayed for progesterone via radioimmunoassays. Responses to GnRH were averaged across the 2 challenges for each heifer. Over both years, individual peak concentrations of LH exceeded or were less than the mean of the population by at least 1 SD in 16.4 and 14.6 (yr 1), and 18.2 and 12.7% (yr 2) of heifers, respectively. Based on the foregoing statistical criteria, heifers were classified as Low, Intermediate, or High responders within each year. Across year, peak LH (ng/ml) and AUC (ng·ml-1 ·4 h-1) were greater (P $<$ .05) in the High (37.7 ± 2.2, 17.8 ± 1.0) than the Intermediate (20.9 ± 0.6, 8.1 ± 0.4) and Low (10.7 ± 0.3, 4.5 ± 0.2) heifers. Age at puberty (d) was similar (P $>$ .1) among High (367 ± 13), Intermediate (356 ± 6) and Low (346 ± 13) heifers. Prepubertal beef heifers exhibit intrinsic variation in anterior pituitary responsiveness to GnRH. This variation may provide a physiological indicator for reproductive efficiency in heifers selected for this response over time. In an unselected population, phenotypic responses were not related to one measure of puberty, age at puberty.

Key Words: Anterior Pituitary, Puberty, Bovine

418 The role of estradiol on the frequency of release of pulses of LH from 4 months of age to puberty. J. W. Koch*, M. L. Mussard, L. R. Ehnis, H. Jimenez-Severiano, V. Vega-Murillo, and J. E. Kinder, *University of Nebraska-Lincoln.*

The objective of this study was to evaluate the role of estradiol (E$_2$) in regulation of LH pulse frequency in heifers from 6 to 8 mo of age (when

precocious puberty was previously detected in some heifers) to frequencies of LH pulses preceding and subsequent to this time until the typical ages of puberty (about 14 mo of age). Prepubertal heifers were randomly assigned to one of three treatments;control (n=7, CONT), ovariectomized (n=6, OVEX), and ovariectomized plus E$_2$ (n=6, OVEX+E$_2$). Serum samples were collected once each mo at 20-min intervals for 24 h from 4 to 14 mo of age to evaluate concentrations of E$_2$ and frequency of LH pulses. Throughout the study serum E$_2$ was greater (p≤0.05) in heifers of the OVEX+E$_2$ than CONT and OVEX heifers and in heifers of the CONT group than OVEX heifers. Serum E$_2$ increased in CONT heifers between 7 and 8 (0.83 vs 1.37 pg/mL serum; p=0.0008), 9 and 10 (1.21 vs 1.71 pg/mL serum; p=0.04) and 12 and 13 (1.58 vs 2.44 pg/mL serum; p=0.01) mo of age. Serum E$_2$ increased (p=0.0001) after implantation with E$_2$ and declined with increases in body weight in heifers of the OVEX+E$_2$ group. From 4 to 14 mo of age, OVEX heifers had greater (p=0.0001) pulse frequencies of LH (# pulses/24 h) compared with those of the CONT and OVEX+E$_2$ groups. From 6 to 13 but not at 14 mo of age, CONT heifers had greater (p≤0.05) LH pulse frequency than those of the OVEX+E$_2$ group. Heifers of the CONT group had greater (p≤0.05) frequency of pulses of LH at 6 mo (4.1±1.0) than 5 mo (0.9±1.0), 8 mo (4.0±0.9) than 7 mo (2.2±0.9), 11 mo (7.0±0.9) than 10 mo (4.7±0.9), and 14 mo (10.3±1.0) than 13 mo (7.3±0.9) of age. Heifers of the OVEX+E$_2$ group had greater (p≤0.0004) frequency of LH pulses at 11 mo (2.2±1.0) than 10 mo (1.0±1.0) and 14 mo (8.5±1.0) than 13 mo (3.8±1.0) of age. Frequency of LH pulses changed between 5 and 10 mo of age in CONT heifers that may explain why some heifers have precocious puberty at this age.

Key Words: Prepubertal heifers, Estradiol, LH pulse frequency

419   Neonatal handling permanently altered behaviour and basal and stressor-induced hypothalamic-pituitary-adrenal axis activity in pigs. S. A. Weaver*[1], M. J. M. Meaney[2], W. T. Dixon[1], and A. L. Schaefer[3], [1]*University of Alberta, Edmonton, Alberta, Canada,* [2]*McGill University, Montreal, Quebec, Canada,* [3]*Agriculture and Agri-Food Canada, Lacombe, Alberta, Canada.*

Neonatal handling in rats resulted in a permanent attenuation of hypothalamic-pituitary-adrenal (HPA) responses to stressors (Meaney et al. 1985). Our objectives were to determine whether neonatal handling would permanently alter HPA function and behaviour in pigs. Six litters of pigs were separated from the sows daily for 10 minutes during the first 14 days of life (H). Six additional litters were left undisturbed (NH). Boars were tested at 7 months of age. Locomotor behaviour in an open field test (OFT) was evaluated. Boars were implanted with indwelling ear vein catheters and basal and stressor-induced plasma ACTH and cortisol concentrations were measured using radioimmunoassays. Plasma corticosteroid-binding capacity (CBC) and glucocorticoid receptor (GR) concentrations (western blotting), in specific brain regions, were also examined. OFT revealed that H boars entered significantly (P<.03) more inner squares than NH boars (36.18 ± 3.86 vs 25.67 ± 2.65 squares). Using ANOVA with repeated measures analysis, H boars had significantly (P<.02) higher plasma CBC concentrations (546.29 ± 29.27 vs 352.10 ± 19.73 fmol/mg protein) and significantly (P<.05) reduced basal plasma cortisol concentrations (13.82 ± 1.22 vs 18.09 ± 1.00 ng/ml) compared to NH boars. ANCOVA analysis, with the age at sacrifice as the covariate, revealed significantly (P<.02) higher plasma ACTH responses (270.34 ± 43.10 vs 145.71 ± 14.52 pg/ml) in H boars at slaughter. GR levels in the pituitary gland, hypothalamus, prefrontal cortex, or hippocampus did not differ between H and NH boars. We have demonstrated that a sensitive period for development of the HPA exists in pigs; however, neonatal handling produced changes in HPA function dissimilar to those induced by this treatment in rats.

Key Words: Glucocorticoid receptor, Stress, Handling

420   A prolonged surge in cortisol is evoked in pigs infected with *Actinobacillus pleuropneumoniae.* B. Ramanathan[1], K. J. Wright[1], J. L. Turner[1], C. M. Hill[1], S. S. Dritz[1], B. Fenwick[1], J. A. Carroll[2], and J. E. Minton*[1], [1]*Kansas State University, Manhattan, KS,* [2]*Animal Physiology Research Unit, ARS-USDA, Columbia, MO.*

Bacterial lipopolysaccharide (LPS) has been used experimentally to model infectious processes. However, the fever, anorexia, and neuroendocrine responses to LPS are limited to a few hours post-challenge.

Yet, the febrile response to a bona fide infectious processes is more prolonged, suggesting that LPS challenge models have limitations for modeling infection. The current study was designed to assess activation of the hypothalamic-pituitary-adrenal (HPA) axis in pigs in response to *Actinobacillus pleuropneumoniae* (APP) infection. Weaned pigs were housed in individual pens in environmentally controlled rooms, with free access to feed and water. Jugular catheters were inserted nonsurgically into all pigs about 7 days prior to challenge. Samples of serum were collected at frequent intervals from -12 to 72 h relative to infection, and were later assayed for cortisol. Feed intake also was assessed at 12-h intervals during this time to mark the clinical course of the disease. At infection, pigs were given 5 X 10^{8} CFU APP intranasally (n=6), or a similar intranasal volume of sterile growth media (n=6). Feed intake was reduced to the greatest extent in the first 12 h following infection (.16 ± .05 vs .57 ± .05 kg; P<.0001), and also was reduced at 24 to 36 (P<.001), 48 to 60 (P=.053), and 60 to 72 (P<.05) h post-infection. Serum cortisol was increased by 3 h post-infection (47.7 ± 5.5 vs 18.8 ± 5.5 ng/mL; P<.001), peaking at 12 h, before gradually returning to control concentrations at 30 h post-treatment. A second surge in cortisol was evident in the latter portion of the sampling period at 36 (P=.056), 42 (P<.001), and 60 (P=.056) h. Thus, bacterial infection evokes a surge in serum cortisol that is sustained to a much greater extent than that stimulated by sublethal doses of LPS.

Key Words: infection, cortisol, pig

421   Development of a mammary inflammation model of lactation failure in swine. R. S. Kensinger*, A. L. Magliaro, R. Graboski, L. M. Sordillo, and L. C. Griel, Jr., *Pennsylvania State University, University Park, PA.*

Previous work indicated that a majority of gilts and sows in commercial swine units with hungry and weak litters show signs of infection. The objective of the present study was to determine the pattern of rectal temperature, plasma prolactin and clinical signs after intramammary (IMM) endotoxin infusion in lactating gilts. Yorkshire crossbred gilts (n=15, in 5 groups of 3) with mean body weight of 188 kg received either 0, 0.5 or 1.5 ug of endotoxin (ET)/kg body weight into a single mammary gland. Adhesive tape was used to seal the teat so the infusate was not removed by a piglet, but other nursing activity continued. Blood samples were collected from indwelling cannulae every 15 min for 2 h prior to 8 h post IMM infusion. Prolactin in plasma was analyzed by radioimmunoassay. Covariance analysis of data was used to correct for differences among gilts pretreatment. The model included block of gilts, treatment, time and treatment by time interaction. Rectal temperatures from h 3 through 8 post IMM infusion in 0, 0.5 and 1.5 ug ET/kg gilts averaged 38.9, 39.7 and 40.0 C, respectively; with peak rectal temperatures at 3-5 h post-infusion. At 8 h post infusion rectal temperatures remained elevated in gilts receiving 1.5 ug, but not in 0.5 ug gilts. There were also significant reductions in plasma prolactin concentration after IMM ET infusion, as prolactin averaged 27.4, 26.8, and 22.5 ng/ml in the control, 0.5 ug, and 1.5 ug groups, respectively. The largest differences in prolactin among treatments were from 3.5 to 5.5 h post-treatment, with the 0.5 ug group not different from the control gilts after 6 h. Results suggest that this is a model to study inadequate milk production in early lactation gilts. This is the first direct evidence that intramammary endotoxin administration (to mimic a field case of mastitis) leads to decreased plasma prolactin, and that reduced prolactin is coincident with a febrile response. This model will be used to examine new management strategies to prevent or treat lactation failure in swine.

Key Words: Porcine lactation, Endotoxin, Prolactin

422   Effect of vitamin E and chromium-methionine supplementation on serum levels of inmunoglobulin G and M, and aspartate aminotransferase enzyme in calves recently arrived to feedlot. L. Almeida* and R. Barajas, *Universidad Autonoma de Sinaloa Mexico.*

To determinate the effect of Vitamin E and Chromium methionine supplementation on serum levels of inmunoglobulin G (IgG), inmunoglobulin M (IgM), and aspartate aminotransferase enzyme (AST) in calves recently arrived to feedlot. Sixty drought Master bull calves (BW=134 kg) just arrived to feedlot after 330 km truck transported, were used in a 28 days randomized design experiment with a 2x2 factorial arrangement of treatments. Fifteen calves (three groups of five calves) were

assigned to consume the diets in that consist the treatments: 1)Reception corn based diet (14%CP) with 35:65 roughage:concentrate relationship (control); 2)Control diet supplemented with 150 IU of Vitamin E/kg(Vit.E); 3)Control diet supplemented with 1.0 PPM of chromium from Chromium-Methionine(Cr); and 4)Control diet supplemented with Vit.E and Cr(Vit.E+Cr). Blood samples from jugular were taken at days 0,7,14, and 28 of experiment. Vitamin E supplementation consistently increased (P=0.04) serum IgG levels in more than 10% with values of 1,718 vs 1,910 mg/dL; 1,860 vs 2,125 mg/dL and 1,985 vs 2190 mg/dL for days 7, 14, and 28 respectively. And had not effect on IgM serum concentration levels (P>0.14). Vitamin E treatments, tended to diminished (P=0.06) the serum values of AST in day 7; the serum values of aspartate aminotransferase enzyme (25.43 vs 19.29 U/L) in day 28. Chromium Methionine supplementation, had not effect on IgG serum values (P>0.25), but increased (P=0.01) in 8% or more the IgM serum concentration with, values of 260 vs 295 mg/dL; 270 vs 322 mg/dL; and 246 vs 267 mg/dL. Chromium treatments decreased (P<0.01) 24% the serum values of AST (25.43 vs 19.29 U/L) in day 28. One interaction (P=0.01) Vit.E x Cr was observed in day 7. It is concluded that both Vitamin E and Chromium Methionine supplementation improve the inmunoglobulin response of calves recently arrived to feedlot, but they are actuating by different pathways.

Key Words: Chromium, Calves, Inmunoglobulin

423 Streptozotocin-induced diabetes mellitus in beef cows.
H. L. Higdon III*, J. C. Spitzer, S. N. Johnson, S. P. Kennedy, G. L. Burns, and W. C. Bridges, Jr., *Clemson University, SC.*

Since insulin has been implicated to play a role in many physiological events in cattle, our laboratory has pursued development of a diabetic cow model for the study of reproduction. Our objective in this preliminary study was to determine if diabetes mellitus could be induced in beef cows with streptozotocin (STZ). Streptozotocin was intravenously administered at 75(n=1), 85(n=1), and 100(n=1)mg/kg BW with corresponding amounts of carrier solution given to matched controls (CON;n=3). Intravenous glucose tolerance tests (IVGTT) were conducted biweekly following initial IVGTT to monitor diabetic condition. Intravenous glucose tolerance tests were performed by collecting a baseline blood sample (time 0), followed by glucose infusion (0.5g/kg BW; 50% glucose solution) and blood samples collected at 20, 40, 60, 90, 120, 180, and 240 min. Means reported are from IVGTT conducted at 1-2 wk, 1 mo, 2 mo, and immediately prior to euthanasia. Analysis of variance with repeated measures design was used to compare dosages of STZ and controls followed by separation of means by pairwise t-tests. Least square means of glucose (GLU) and insulin (INS) concentrations for CON and dosages of STZ during IVGTT are compared in the accompanying table. Severe side effects involving multiple organ systems were observed in STZ-treated cows. Of physiological abnormalities observed, tubulointerstitial nephritis was most pronounced ranging from mild to severe with each increasing dosage of STZ. Results of this study demonstrate susceptibility of bovine pancreas to intravenously administered STZ, but insults to other organ systems were also observed.

	Time (min)	0	20	40	60	90	120	180	240
GLU (mg/dl)	CON	61^a	251^a	135^a	91^a	68^a	63^a	60^a	59^a
	75mg	77^a	291^{ab}	227^b	190^b	147^b	121^b	94^a	79^a
	85mg	99^a	338^b	240^b	186^b	154^b	129^b	108^a	108^a
	100mg	139^b	485^c	409^c	384^c	356^c	332^c	229^b	260^b
INS (ng/ml)	CON	0.87	8.95^a	7.33^a	3.11^a	1.33	1.01	0.72	0.74
	75mg	0.67	1.59^b	1.47^b	1.51^a	1.32	1.18	0.94	0.67
	85mg	0.67	1.49^b	1.29^b	1.03^b	0.95	0.64	0.59	0.67
	100mg	0.38	0.58^b	0.45^b	0.45^b	0.43	0.45	0.4	0.42

a,b,cValues within columns and with different superscipts differ (P < .05)

Key Words: Cattle, Insulin, Streptozotocin

424 Factors affecting fetal hematocrit (HC) and fetal plasma iron (PI) at 105 days of gestation in swine.
J. L. Vallet*, G. A. Rohrer, H. G. Klemcke, and R. K. Christenson, *USDA, ARS, Roman L. Hruska US Meat Animal Research Center.*

Most neonatal pigs are iron deficient. This deficiency may be worsened in large litters where uterine crowding occurs. To test this idea, 98 half

White crossbred, half Meishan gilts were unilaterally hysterectomized-ovariectomized (which increases intrauterine crowding) at 100 d of age and then were mated after at least one estrous cycle. At 105 d gestation, gilts were slaughtered and the uterus was recovered and opened. An umbilical arterial blood sample was obtained from each fetus and measured for HC and PI. Each placenta, fetus and fetal liver was weighed. There was a relationship between HC and PI (r = .3, P < .01). Analyses using HC and PI as dependent variables and dam, placental weight, fetal, and fetal liver weight as independent variables indicated that all four independent variables were statistically significant (P < .01). Thus, HC and PI are lower in small fetuses attached to small placentae, suggesting that intrauterine crowding impairs blood cell synthesis and iron transport. The greatest source of variation in HC and PI was maternal (47 and 53%, respectively). To identify regions of the maternal genome that influenced fetal HC and PI, a genome scan was performed on a subset (n = 69) of the gilts. The least squares means for fetal HC and PI for each gilt adjusted for placental weight, fetal weight, fetal liver weight and PI (HC only) were used as phenotypes. A quantitative trait locus (qtl) was detected on chromosome 12 for PI. The average Meishan allele increased PI .34 μg/mL and explained 9.3% of the variation in PI and 2.8% of the variation in HC. These results suggest that (1) blood cell synthesis and iron transport are decreased by uterine crowding, (2) maternal factors, placental, fetal, and fetal liver weight all influence HC, and PI and (3) a qtl for fetal PI is located on chromosome 12. This qtl could be used to improve fetal PI, possibly resulting in improved piglet survival.

Key Words: Erythropoiesis, Uterus, Pregnancy

425 Withdrawn. , .

426 Effects of locoweed toxin (swainsonine) on bovine oocyte fertilization *in vitro*.
S. Wang*[1], K. E. Panter[2], G. R. Holyoak[1], G. Liu[1], R. J. Molyneux[3], R. C. Evans[1], and T. D. Bunch[1], [1]*Utah State University, Logan, UT,* [2]*USDA-ARS, Poisonous Research Laboratory, Logan, UT,* [3]*USDA-ARS, Western Regional Research Center, Albany, CA.*

Swainsonine, a plant indolizidine alkaloid and inhibitor of α-mannosidases, is found to be responsible for locoweed intoxication (locoism) and reproductive dysfunctions when animals continuously graze certain species of *Astragalus* and *Oxytropis*. A randomized complete block (3 replications) design with three treatments (TRT) was used to investigate the effects of swainsonine on the fertility capability of bovine oocyte and sperm by the use of *in vitro* fertilization (IVF) procedures. Bovine oocytes (n = 527) were aspirated from abattoir ovaries and *in vitro* matured (IVM) for 24 h in M199 plus 10% fetal bovine serum (FBS), penicillin G 100 IU/mL, streptomycin 100 μg/mL, .5 μg/mL FSH, 5.0 μg/mL LH, 1.0 μg/mL estradiol in a humidified 5% CO_2 atmosphere at 39°C. Cryopreserved bovine semen was thawed and the live spermatozoa separated by a Percoll gradient. Spermatozoa were added to the fertilization medium (fert-TALP) at a final concentration of 1.5 x 10^6 per mL. Capacitation occurred in fert-TALP containing 10 μg/mL heparin. The IVM oocytes were removed into IVF media containing swainsonine at 0 ng/mL (TRT1, Control), 10 ng/mL (TRT2) and 20 ng/mL (TRT3), respectively. The IVF culture lasted approximately 17 h in a humidified 5% CO_2 atmosphere at 39°C. The IVM/IVF derived zygotes were then *in vitro* cultured (IVC) using modified CR2 medium in a humidified 5% CO_2 atmosphere at 39 °C. Preimplantation embryo development was evaluated at d 2, d 6, and d 8 of IVC (IVF = d 0). The cleavage rates were 83.8%, 86.3% and 84.8%; the percentage of morulae at d 6 of IVC was 24.0, 23.1, and 20.7; and the percentage of blastocysts at d 8 of IVC was 8.7, 10.8 and 7.1 for TRT1, 2 and 3, respectively. There was no significant difference (P > .05) between treatments. In conclusion, swainsonine did not appear to have significant adverse effects on fertilization capability of bovine oocyte and spermatozoa *in vitro*.

Key Words: Bovine, *In vitro* fertilization, Swainsonine

427   Fish oil supplementation decreases average daily gain and changes the immune response in orphaned, milk-fed lambs. J. L. Bardugone*, J. H. Herbein, M. C. Wulster-Radcliffe, and G. S. Lewis, *Virginia Polytechnic Institute and State University, Blacksburg.*

After in vivo ω-3 fatty acid supplementation, in vitro lymphocyte blastogenic response can be either up-regulated or down-regulated, depending on the concentration of fetal calf serum in the culture medium. The purpose of this experiment was to determine whether fish oil (FO; General Nutrition Corp., Pittsburgh, PA), a preparation rich in ω-3 fatty acids, altered the immune status of orphaned, milk fed lambs. Lambs (n = 30) were weaned on d 1 of age and fed milk replacer (35% crude fat; Land O' Lakes, Fort Dodge, IA) for ad libitum consumption. After a 12-d adjustment period, lambs were assigned to randomized treatments in a 2×2 factorial array; FO and phytohemagglutinin (PHA) were main effects. On d 12 to 28, lambs received either 1 g of FO, in a capsule orally, twice daily (total dose 2 g/d) or nothing. On d 7, 12, 19, and 26, jugular blood was collected, and lambs were weighed. The blastogenic response of peripheral blood lymphocytes to mitogens was determined to evaluate the immune status of the lambs. On d 26, each lamb received either an intradermal injection of PHA (10 mg) diluted in .2 mL of saline or .2 mL of saline. Skin fold thickness was measured at 0, 6, 12, and 24 h relative to PHA or saline. The FO decreased ($P < .01$) ADG (FO vs control, 218 vs 317 g/d). Intradermal PHA, but not FO, increased ($P < .01$) skin fold thickness. The FO tended ($P < .07$) to decrease lipopolysaccharide (LPS)-stimulated blastogenesis. The FO $\times$ day interaction was significant ($P < .01$) for concanavalin A- and LPS-stimulated blastogenic responses. Fish oil altered the cell-mediated and humoral immune responses in milk-fed orphaned lambs, and it reduced the rate of gain in the lambs.

Key Words: Lambs, Fish oils, Immune response

428   Interaction of Nutrition and *Acacia berlandieri* on Cortisol Production in Female Goats. K. N. Livingston*[1], J. W. Koch[1], C. M. Hensarling[2], S. S. Siecknius[2], T. D. A. Forbes[2], R. D. Randel[3], T. H. Welsh, Jr[1], and H. R. Vera-Avila[4], [1]*Texas Agricultural Experiment Station, College Station, [2]Uvalde, [3]Overton, TX, [4]INIFAP, Mexico.*

Phenolic amines are sympathomimetic compounds which, when consumed, can adversely affect growth and reproductive parameters. These compounds are found throughout the plant kingdom including the guajillo shrub *Acacia berlandieri*. Mature Angora nannies (31 ± 1.1 kg BW) were randomly assigned to one of four dietary regimens to evaluate the effects of phenolic amines and high and low energy diets on cortisol production over a 60-day period. Diets consisted of: 1) 3.6% BW of a diet based on corn, cottonseed meal, and cottonseed hulls (HC, n=9), 2) 2% BW of the same diet (LC, n=9), 3) diet 2 with ad-lib fresh *A. berlandieri* leaf (HG, n=10), or 4) 1% BW of the diet with ad-lib fresh *A. berlandieri* leaf (LG, n=10). Phenolic amine content and intake of guajillo was measured daily and body weight were obtained weekly. At the conclusion of the study, goats were euthanized and tissues obtained for histomorphometric analysis. Pituitary gland, anterior pituitary gland, and paired adrenal gland weights did not differ among treatments. Total adrenal gland area, adrenomedullary area, and adrenocortical area did not differ among treatments. Cortisol production was evaluated both in vivo and in vitro. Concentrations of cortisol in blood samples collected during the four weeks prior to exsanguination were higher (p $\leq$ 0.005) in the HG group (9.96 ± 3.78 ng/ml) compared to those in the LC, HC, and LG groups (5.54 ± 1.73, 6.07 ± 2.42, and 7.11 ± 1.77 ng/ml respectively). In addition, HG nannies had the highest cortisol concentration in incubations of adrenocortical slices prior to ACTH challenge. Addition of ACTH (10 and 100 pg/ml) increased medium cortisol for all groups with the greater response (p $\leq$ 0.02) noted for HC goats. Relative to the HC goats, guajillo consumption (HG) increased basal cortisol in vivo and in vitro, but reduced ACTH-induced in vitro production of cortisol. Guajillo ingestion may alter adrenal gland responsiveness in goats.

Key Words: HPA Axis, Goats, Acacia berlandieri

429   Development of a new estrous synchronization protocol (7-11 Synch) for beef cattle with short-term feeding of melengestrol acetate (MGA). F. N. Kojima*, J. F. Bader, B. E. Salfen, M. F. Smith, and D. J. Patterson, *University of Missouri, Columbia.*

A new estrous synchronization treatment (7-11 Synch) was developed to synchronize the first follicular wave and timing of ovulation in postpartum beef cows. The 7-11 Synch protocol consisted of feeding MGA ($.5\text{mg}\cdot\text{cow}^{-1}\cdot\text{d}^{-1}$) for 7 d with an injection of $PGF_{2\alpha}$ (PG: 25 mg) on the last day of MGA. Cows received an injection of GnRH (100 μg) 4 d after PG, and a second injection of PG 11 d after the last day of MGA. Multiparous beef cows were stratified by breed and postpartum interval and were randomly assigned to the 7-11 Synch (n = 44) or Select Synch protocols (100 μg GnRH followed by PG 7 d later: n=45). Cows were observed for estrus 3 times/d and artificially inseminated 12 h after estrus for 7 d following GnRH and 7 d after the last PG. Fertile bulls were introduced beginning 2 wk after the AI period for 60 d. Pregnancy was determined by transrectal ultrasonography 60 d after the last AI. Timing of estrus after the last PG (0 h) ranged from 42 to 102 h in 7-11 Synch and -30 to 114 h in Select Synch treated cows. Eight cows (18 %) in the Select Synch group exhibited estrus 30 h before to 18 h after PG. Synchronized estrus peaked between 42 to 66 h after the last PG with a maximum response at 54 h for both treatment groups. Synchrony of estrus from 42 to 66 h was greater (P < .05) in 7-11 Synch (91 %: 41/44) than for Select Synch treated cows (69 %: 31/45). AI pregnancy from 42 to 66 h was greater (P < .05) in the 7-11 Synch group (66 %: 29/44) than the Select Synch group (40 %: 18/45). Overall AI pregnancy and pregnancy rates did not differ (P > .10) between treatments (7-11 Synch: 66 %: 29/44 and 89 %: 39/44, respectively; Select Synch: 60 %: 27/45 and 91 %: 41/45, respectively). In summary, 7-11 Synch improved synchrony of estrus with resulting high fertility. This protocol provides potential future application in estrous synchronization and timed AI programs for use in beef cattle production systems.

Key Words: Estrous Synchronization, Artificial Insemination, Beef Cows

430   Addition of GnRH to a melengestrol acetate (MGA) prostaglandin $F_{2\alpha}$ (PG) estrous synchronization treatment improves synchrony of estrus and maintains high fertility in postpartum suckled beef cows. D. J. Patterson*, F. N. Kojima, and M. F. Smith, *University of Missouri, Columbia.*

This experiment was conducted to determine whether addition of GnRH to a MGA-PG protocol would improve synchrony of estrus without compromising fertility in postpartum suckled beef cows. Multiparous Angus crossbred cows (n=120) were assigned by age, body condition score (BCS) and days postpartum (dpp) to one of two treatments. Cows in each treatment were fed melengestrol acetate ($0.5\text{mg}\cdot\text{hd}^{-1}\cdot\text{d}^{-1}$) for 14 d followed by an injection of PG (25 mg Lutalyse®) 17 d after MGA withdrawal. MGA was delivered in a ground corn carrier of 1.8 kg$\cdot\text{hd}^{-1}\cdot\text{d}^{-1}$. GnRH (100 μg Cystorelin®) was administered to 60 cows 10 d after MGA withdrawal and 7 d before PG. Control cows received only MGA-PG. Average BCS and dpp for cows in each group at the initiation of treatment were 5.5 and 39 d, respectively. Blood samples were collected from all cows 10 d before and on the first day of MGA and 7 d before and on the day PG was administered. Concentrations of P4 in serum at the initiation of treatment were elevated (> 1 ng/ml) in 45% of controls and 38% of GnRH-treated cows, respectively. Cows were detected for signs of behavioral estrus for 7 d after PG and insemination was performed 12 h after observed estrus. Estrous response did not differ (P > .1) between treatments (control = 80%, 48/60; GnRH = 83%, 50/60). However, the peak synchronized period for both treatments was observed between 48 and 96 h after PG, during which time 48% (29/60) of control cows and 80% (48/60) of GnRH-treated cows exhibited estrus (P<.05). Synchronized conception (SCR: no.pregnant/no. inseminated) and pregnancy rate (SPR: no. pregnant/no. treated) did not differ between treatments [SCR=83% (40/48), 78% (39/50); SPR=67% (40/60), 65% (39/60) for control and GnRH-treated cows, respectively]. In summary, addition of GnRH to a 14-17 d MGA-PG treatment in postpartum suckled beef cows improved synchrony of estrus and maintained high fertility during the synchronized period.

Key Words: Progestin, GnRH, Prostaglandin F2α

431 Effect of royal jelly on estrus synchronization and pregnancy rate of ewes using fluorogestone acetate sponges. M. Q. Husein*[1], R. T. Kridli[1], and W. D. Humphrey[2], [1] *Jordan University of Science and Technology, Irbid/Jordan,* [2] *Arkansas State University, State University.*

The objective of the study was to examine the effect of using natural royal jelly (RJ) paste on estrus synchronization and pregnancy rate of Awassi ewes. Royal jelly treatment has been known to enhance libido in males. In May, twenty Awassi ewes (2- to 5-year-old, 52 ± 2 kg) were treated with 40 mg fluorogestone acetate (FGA) intravaginal sponges for 12 d. Half of the ewes were administered orally with a total of 3 g of RJ paste given in 12 equal doses of 250 mg per day starting at the time of FGA sponge insertion. Ewes were exposed to two fertile Awassi rams at the time FGA sponges were removed (0 h, 0 d) for 5 d. Blood samples were drawn on alternate days from 0 d until d 19. Incidence of estrus was greater (8/10 vs 4/10; $P < .01$) in RJ-treated than in control ewes and intervals from 0 h to onset of estrus were similar (55 ± 2 h vs 53 ± 2 h, respectively) between the two groups of ewes. Progesterone concentration increased at d 5 in all ewes and remained elevated through d 19 in 6/10 RJ-treated and 2/10 control ewes ($P < .1$). These ewes lambed 149 d following d 0 and the number of lambs born was similar between the two groups of ewes ($P > .1$). In conclusion, results demonstrate that RJ treatment in conjunction with a source of exogenous progesterone can be used to induce estrus and increase first service conception rate in sheep.

Key Words: Royal jelly, Ewes, Reproduction

432 Evaluation of a two-part melengestrol acetate regime to synchronize estrus in beef cattle. S. Wright*, D. Kreider, R. Rorie, N. Huber, and G. Murphy, *University of Arkansas, Fayetteville.*

An experiment was conducted to evaluate a method of estrus synchronization by orally administrating melengestrol acetate (MGA). Cows and heifers (n=41 and 43, respectively) were ranked by days postpartum and lactational status, and randomly assigned to two treatment groups. Body weights for the two treatments were 480.9 ± 9.02 kg for treatment 1 and 460.5 ± 13.16 kg for treatment 2 and body condition scores were $4.7 \pm .095$ and $4.6 \pm .063$ receptively. Animals in each treatment initially received .5 mg per day of MGA contained in 2.26 kg of supplement for fourteen days. Both treatment groups then received 2.26 kg per day of supplement without MGA for the next 17 days. On day 17, after the MGA withdrawal, Treatment 1 received an intramuscular injection of $PGF_{2\alpha}$ (25mg) while Treatment 2 was given MGA orally at .5mg per day for an additional five days. A Heatwatch estrous detection system was used to determine the number of cows that exhibited estrus. After the first MGA withdrawal, $76.1 \pm .046\%$ (mean $\pm$ S.E.) of the 84 cows showed estrus. In the 10 day period following $PGF_{2\alpha}$ administration, $76.7 \pm .064\%$ of cows exhibited estrus, while $87.8 \pm .051\%$ of cows in Treatment 2 exhibited estrus in the 10 days following the second MGA withdrawal. Days from treatment to estrus cycle in both groups were not significantly different. (P>.05) We conclude that MGA fed for 14 days, followed by a 17 day withdrawl, followed by 5 days of MGA feeding, causes a high percentage of cows to display estrus.

Key Words: MGA, estrus, cows

433 Artificial insemination outcomes in beef females using bovine sperm with a detectable fertility-associated antigen. L. R. Sprott*[1], M. D. Harris[1], D. W. Forrest[1], H. M. Zhang[2], J. N. Oyarzo[2], M. E. Bellin[2], and R. L. Ax[2], [1] *Texas A&M University, College Station, TX,* [2] *University of Arizona, Tucson, AZ.*

Previous trials indicate that bulls with a detectable 31 kDa protein, known as fertility-associated antigen (FAA), on spermatozoal membranes were 9 to 40% more fertile in multiple-sire pastures than were herdmates producing sperm devoid of FAA. This field trial used AI to compare pregnancy rates to first AI service in females inseminated with extended, frozen semen from bulls either with (FAA+) or without (FFA-) the peptide on sperm. Fresh semen samples from 25 bulls that had passed a breeding soundness evaluation were analyzed for the presence or absence of FAA on spermatozoal membranes. Eighteen bulls were FFA+ and seven were FAA-. Semen from each bull was later extended and frozen in .5 ml straws. Replacement heifers (n=865) were estrous synchronized and inseminated either at timed AI or 12 h after being detected in estrus. Mature cows (n=285) were inseminated 12 h after being detected in estrus during a 45-d breeding period. Pregnancy rates (pooled) to first AI service for females (n=764) inseminated with FAA+ sperm and for females (n=386) inseminated with FAA- sperm were 65.6% and 49.7%, respectively (P<.005). Among estrous synchronized heifers, pregnancy rates to a single AI service for heifers (n=550) inseminated with FAA+ sperm and for heifers (n=315) inseminated with FAA- sperm were 62% and 45.7%, respectively (P<.005). This is the first trial that used AI to compare fertility differences between FAA+ and FAA- bulls, and results corroborate previous reports of higher fertility in FAA+ bulls compared to FAA- bulls used in natural mating programs. FAA is an important determinant for fertility potential of sperm from bulls to be used in AI programs, as well as natural breeding.

Key Words: Artificial Insemination, Fertility Associated-Antigen

434 Artificial insemination outcomes in beef females using bovine sperm with a detectable fertility-associated antigen. L. R. Sprott*[1], M. D. Harris[1], D. W. Forrest[1], H. M. Zhang[2], J. N. Oyarzo[2], M. E. Bellin[2], and R. L. Ax[2], [1] *Texas A&M University, College Station, TX,* [2] *University of Arizona, Tucson, AZ.*

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Key Words: Artificial Insemination, Fertility Associated-Antigen

435 Effects of dosage of estradiol benzoate given at time of administration of an intravaginal progesterone-releasing device on conception rates to a fixed-time insemination. D. L. Funk*[1], H. D. Hafs[2], and L. H. Anderson[1], [1] *University of Kentucky, Lexington* [2] *Rutgers University, New Brunswick, NJ.*

We hypothesized that conception rates may be increased if follicular development was synchronized prior to an induced ovulation for fixed-time insemination in beef cattle. The objective of this experiment was to determine the effect of dosage of estradiol benzoate, administered coincident with the insertion of an intravaginal progesterone-releasing device, on conception rate to a fixed-timed insemination in beef females. Postpartum cows (n = 417), 2 year old cows (n = 107) and yearling heifers (n = 212) at four locations were randomly assigned by calving date to receive either 0, 1 or 2 mg of estradiol benzoate (EB) on the day of insertion of an intravaginal progesterone-releasing device (controlled internal drug releasing (CIDR) device). On d 7 (day of CIDR insertion = 0), CIDR devices were removed and all cows were administered 25 mg $PGF_{2}\alpha$. To induce estrus and ovulation, cows were administered 1 mg EB and heifers were administered .5 mg of EB on d 8. All females were inseminated the following day (d 9). Beginning on d 14, all females were exposed to a 46-day natural breeding season. Conception to the timed insemination was determined by transrectal ultrasonography on

approximately day 90. Conception rates to the fixed-time insemination were similar ($P > .1$) among mature cows (50%, 45%, 49%), 2 year olds (19%, 41%, 48%) and heifers (48%, 38%, 50%) administered 0,1 or 2 mg of EB, respectively. Significant ($P < .05$)location and treatment by location effects were observed for conception rate. We conclude that synchronization of follicular development using estradiol benzoate at the time of insertion of an intravaginal progesterone-releasing device has no effect on conception rates.

Key Words: Estrus, Synchronization, Cattle

436   Effects of pre-synchronization and bST treatment on pregnancy rates to a timed artificial insemination protocol in lactating dairy cows. F. Moreira*[1], C. Orlandi[1], C. A. Risco[2], R. Mattos[1], F. L. Lopes[1], and W. W. Thatcher[1], [1]*Department of Dairy and Poultry Sciences, University of Florida,* [2]*College of Veterinary Medicine, University of Florida.*

Objectives were to: 1) determine if pre-synchronization of cows to initiate a timed artificial insemination (Ovsynch/TAI) protocol during early diestrus increases pregnancy rates (PR), 2) investigate if treatment of cows with bovine somatotropin (bST; Posilac®, Monsanto Co., MO; 500 mg, sc) affects PR, and 3) examine if bST influences PR when administered prior to or at TAI. Lactating dairy cows (n=543) were assigned to a 2x3 factorial experiment. The Ovsynch/TAI protocol was initiated at random stages of the cycle in half the cows (Control) whereas the remaining cows received a pre-synchronization treatment (Presynch) consisting of two injections of prostaglandin $F_{2\alpha}$ (PGF$_{2\alpha}$; Lutalyse®, Pharmacia-Upjohn Co., MI; 25 mg, im) given at 37±3 and at 51±3 d postpartum (dpp). The Ovsynch/TAI protocol was initiated at 63±3 dpp with an injection of GnRH (Cystorelin®, Merial, GA; 100 μg, im) and PGF$_{2\alpha}$ (40 mg, im) injected 7 d later. At 48 h after PGF$_{2\alpha}$, cows were injected with GnRH and inseminated 16 h later. Treatments with bST were initiated at injection of GnRH (d63-bST), or at insemination (d73-bST), or at 147 dpp for control (d147-bST). The six groups were: Control/d63-bST (n=89), Control/d73-bST (n=88), Control/d147-bST (n=97), Presynch/d63-bST (n=90), Presynch/d73-bST (n=91), and Presynch/d147-bST (n=88). Pregnancy was determined by palpation at 74 d after TAI. Orthogonal contrasts indicated that PR were greater for Presynch groups than for Control groups (42.8±3.4% > 29.3±3.3%; P<0.01). An interaction (P<0.01) between bST and Presynch treatments indicated that PR were greater for d63-bST (45.5±5.8%) and d73-bST (48.6±6.0%) groups than for d147-bST group (33.6±5.8%) for cows pre-synchronized. There was no difference in PR between cows initiating bST treatment prior to or at TAI. Pre-synchronization and bST administration increased PR to the Ovsynch/TAI protocol.

Key Words: Timed insemination

437   Use of asynchronous embryo transfer to investigate the role of uterine-embryo timing on placental size. M. E. Wilson*, K. A. Vonnhamme, and S. P. Ford, *Iowa State University, Ames IA.*

The ability of the uterus to accommodate a finite amount of placental tissue appears to be a major limitation to litter size. Meishan (M) preimplantation conceptuses contain fewer trophectoderm cells, produce less estradiol-17β (E$_2\beta$), elongate to a shorter length and exhibit a reduced placental size throughout gestation than Yorkshire (Y) conceptuses. Uterine luminal embryonic E$_2\beta$ content and growth factor content are positively associated at elongation. Based on this we have argued growth factor quantity regulates the length an embryo attains at elongation, and limits placental size. Recently, Wilson and Ford (1999; Proc Midwest ASAS) injected M gilts every 6h with E$_2\beta$ on d12 and 13 of gestation resulting in a 40% increase in placental size at term when compared to vehicle injected M gilts. This study was conducted to determine if transfer of embryos into the oviducts of asynchronous females (more or less advanced uterine environments) would alter fetal and/or placental size at term. Y gilts were checked 2x daily for estrus and bred to a Y boar 24h after the first exhibition of estrus. Embryos (1-4 cells) were flushed from the oviducts of each donor gilt on d2.5 of gestation and transferred in equal numbers to the oviducts of a recipient gilt on d1.5 (n=4), 2.5 (n=4) or 3.5 (n=4) of their estrous cycle. Gilts were slaughtered on d112 of gestation and fetal and placental weight, placental surface area (PSA) and implantation site lengths (IS) were determined. While litter sizes were similar (8.4±1.1), conceptuses transferred

to d3.5 recipients had heavier fetuses (1.57±.09 v 1.23±.04 kg, P<.001) larger PSA (1812±106 v 1458±43 cm^2, P<.01) and occupied longer IS (34±3 v 25±1 cm, P<.001) than those transferred to recipients on d1.5 or 2.5. Additionally, conceptuses transferred to d1.5 recipients exhibit no difference (P>.10) in PSA compared to those transferred on d2.5. These data demonstrate that transfer of embryos to a uterine environment as little as 24h more advanced can result in dramatic alterations in placental growth and function during gestation.

Key Words: Pig, Placenta, Embryo

438   Administration of ACTH to pregnant sows alters their pigs' hypothalamic-pituitary-adrenal (HPA) axis. M. F. Haussmann*[1], J. A. Carroll[2], G. D. Weesner[3], and D. C. Lay, Jr.[1], [1]*Iowa State University, Ames, IA,* [2]*USDA, ARS, Columbia, MO,* [3]*Purdue University, West Lafayette, IN.*

When a pregnant sow is stressed, cortisol will cross the placenta to possibly affect the fetal hypothalamus. Because modern livestock production has the potential to stress sows, this study examined the physiology of pigs whose dams were injected with ACTH during gestation. Control sows (CONT, n = 8) were given no treatment while the treatment sows (ACTH, n = 8) were administered an i.v. injection of ACTH (1 IU/kg BW) weekly from 6- to 12-wk of gestation. Three male pigs from each sow were sacrificed at either birth, 1- or 2-mo of age. The hypothalamus, pituitary gland and adrenal glands were immediately obtained and frozen. Hypothalamic corticotropin releasing factor (CRF) and β-endorphin as well as mRNA for pro-opiomelanocortin (POMC) and the adrenal gland ACTH receptor were quantified. At 2.5-mo of age a blood sample was taken from one pig from each litter and then the pig was placed in a pen with unfamiliar pigs for 10 d. Blood samples were drawn every other day to determine plasma cortisol concentrations. At 1-mo of age, ACTH pigs tended to have greater mRNA for the ACTH receptor then CONT pigs (1.27 ± .16 vs .82 ± .15 relative units; P = .08) and concentrations of CRF (1.26 ± .11 vs .77 ± .25 ng/g; P = .08), but they had a lower concentration of β-endorphin (9.6 ± 1.5 vs 17.8 ± 2.5 ng/g; P < .02). There was a treatment by period interaction for mRNA for POMC, with ACTH pigs expressing less than CONT pigs at birth (1.29 ± .17 vs 1.88 ± .20 relative units; P < .007) and greater concentrations at 2 months (3.06 ± .28 vs 2.27 ± .28 relative units; P < .007). The ACTH pigs tended to have heavier pituitary glands then CONT pigs at 2-mo of age (.007 ± .001 vs .005 ± .001 g/kg BW; P < .08). In response to mixing, ACTH pigs had greater concentrations of plasma cortisol then CONT pigs (70.79 ± 3.79 vs 59.61 ± 3.83 ng/mL; P = .03). These data indicate that exogenous ACTH during gestation alters the HPA axis of the sow's subsequent offspring.

Key Words: Pigs, ACTH, Prenatal Stress

439   Effect of breed on endocrine responses to ergotamine in steers. R. Browning, Jr.*, S. J. Gissendanner, D. Jenkins, D. F. Edwards, C. A. Hightower, and T. Wakefield, Jr., *Tennessee State University, Nashville.*

Seven Polled Hereford (302 kg) and seven Red Brahman steers (294 kg) were used to assess endocrine responses of heat-sensitive and heat-tolerant cattle to an ergopeptine alkaloid associated with fescue toxicosis. Steers were paired one Hereford to one Brahman and received an i.v. bolus of ergotamine tartrate at .02 mg/kg body weight. Plasma was sampled every 15 min for 2 h before and 4 h after treatment to determine plasma concentrations of cortisol, triiodothyronine, insulin, and glucagon. Respiration rates were recorded hourly. Ambient temperature averaged 30.9°C (SD = 1.7) and relative humidity averaged 48% (SD = 7.2) during sampling. Breed x time affected ($P < .01$) respiration rates, cortisol, triiodothyronine, insulin, and glucagon. All means were separated by protected LSD procedure ($\alpha = .01$). Ergotamine increased cortisol to peak concentrations 2 h after treatment in both breeds. The cortisol peak was higher for Brahman than for Hereford (48.7 vs 32 ± 2.3 ng/mL, respectively). Hereford had a steady increase of triiodothyronine from .84 ± .02 ng/mL before treatment to .95 ± .02 ng/mL by 3 h after treatment. Brahman had higher triiodothyronine concentrations than Hereford throughout the study and did not show a consistent triiodothyronine response to ergotamine. Both breeds exhibited ergotamine-induced increases in glucagon and lowering of insulin 1 h after ergotamine compared to pretreatment. Brahman had higher insulin than Hereford before treatment (12.7 vs 7.2 ± .6 μIU/mL), but insulin concentrations 1 h after ergotamine were similar for Brahman and

Hereford (5.5 vs 4.8 ± .6 μIU/mL) with Brahman having a more prominent decline. Hereford had higher glucagon than Brahman throughout the study. Respiration rates for Hereford increased from 16.2 ± 1 breaths/15 s before ergotamine to 23.6 ± 1 breaths/15 s by 4 h after ergotamine, whereas respiration rates did not change for Brahman in response to treatment. Brahman had lower hourly respiration rates than Hereford throughout the study. Results indicate Brahman and Hereford are both generally sensitive to ergotamine in terms of altered plasma concentrations of hormones governing metabolism and body temperature. However, respiration rates hint at a breed difference for response to ergotamine.

Key Words: Cattle Breeds, Tall fescue ergopeptide, Hormones

440   Stimulation of α_2-adrenergic receptors reduces activity of somatostatin neurons and increases concentrations of growth hormone in serum. C. D. McMahon*, L. T. Chapin, K. J. Lookingland, R. P. Radcliff, and H. A. Tucker, *Michigan State University, East Lansing, MI.*

Growth hormone (GH) is released from the anterior pituitary gland under the influence of two hypothalamic hormones: growth hormone-releasing hormone (GHRH), which stimulates release; and somatostatin (SS), which inhibits release. In addition, catecholamines regulate release of GHRH and SS. For example, we showed previously that activation of α_2-adrenergic receptors stimulated release of GHRH in vitro. In the current study, we hypothesized that the α_2-adrenergic receptor agonist, clonidine, would increase activity of GHRH neurons. Eight Holstein steers were allocated to two groups (n = 4). Blood samples were collected at 20-min intervals for 80 min and assayed for GH. Clonidine was injected i.v. (8 μg/kg BW) into 4 steers after the first 20-min sample was collected. At 80 min, steers were euthanized with pentobarbital and their brains were perfused with 4% paraformaldehyde. Dual-label immunohistochemistry was performed on 40 μm thick hypothalamic sections using antibodies to GHRH and SS together with antibodies to Fos and Fos-related antigens (Fos/FRA), which were used as markers of neuronal activity. Clonidine increased (P < .05) concentrations of GH (1195 ng·min·ml^{-1}) compared with controls (-73 ng·min·ml^{-1}) (pooled SEM = 324). Clonidine reduced (P < .05) the percent of SS neurons with Fos/FRA detected in their nuclei from 39% (± 3.5) to 25% (± 3.1%) compared with controls, but did not alter the percent of GHRH neurons with Fos/FRA detected in their nuclei. We conclude that α_2-adrenergic receptor-mediated secretion of GH is associated with decreased activity of SS neurons, rather than increased activity of GHRH neurons.

Key Words: Growth Hormone-Releasing Hormone, Somatostatin, α_2-Adrenergic Receptors

441   NeuropeptideY: A possible link between LH and GH secretion in the gilt. C. R. Barb*[1], R. R. Kraeling[1], G. B. Rampacek[2], and J. B. Barrett[1], [1]*USDA, Agricultural Research Service, SAA; Athens, GA,* [2]*University of Georgia, Athens.*

We previously reported that leptin treatment increased GH secretion and inhibited feed intake and stimulated in vitro GnRH secretion from hypothalamic tissue in the pig. The action of leptin on the neuroendocrine system is attributed to neuropeptide Y (NPY). Therefore, the objective of the present study was to determine if central administration of NPY affects LH and GH secretion. Ovariectomized prepuberal gilts, 140 to 150 d of age and 76.9 ± 3.2 kg BW, were fed each day at 0800 and 1700 h over a 2 wk period before the experiment. On the day of the experiment, pigs were fed at 07:30 h and at 08:00 h, blood was collected every 15 min for 3 h before and 4 h after intracerebroventricular injections of .9% saline (S; n = 8), 10 μg (n = 9), 50 μg (n = 7) or 100 μg (n = 7) of NPY in S. Before injection, serum LH and GH concentrations were similar among groups. Serum LH levels decreased (P < .05) by 45 min after injection of 50 μg (.8 ± .2 ng/mL) and 100 μg (.8 ± .2 ng/mL) of NPY and by 75 min after treatment with 10 μg (.8 ± .2 ng/mL) of NPY compared to S (1.4 ± .2 ng/mL) treatment. LH secretion remained suppressed for .5 h, 2 h and 3 h in the 10 μg, 50 μg and 100 μg treated pigs, respectively. Serum GH concentrations increased (P < .05) by 15 min after treatment with 50 μg (3.5 ± .5 ng/mL) and 100 μg (4.9 ± .5 ng/mL) of NPY compared to S (1.9 ± .5 ng/mL) animals. However, GH secretion was not affected by the 10 μg dose of NPY. These results

support the idea that NPY modulates LH and GH secretion and may act as a link between the reproductive and growth axis.

Key Words: NPY, LH,GH, pig

442   Dopamine antagonist affects growth hormone secretion during the follicular and metestrus phases of the estrous cycle in Holstein cows. A. Ahmadzadeh*, R. M. Akers, and M. A. Barnes, *Virginia Polytechnic Institute and State University, Blacksburg.*

Fluphenazine (FLU), a dopamine receptor antagonist, was used to investigate the role of endogenous dopamine on serum growth hormone (GH) and prolactin (PRL) concentrations during the follicular and metestrus phases of the estrous cycle. In Exp.1, 15 lactating Holstein cows received 25 mg prostaglandin (PGF2α) and on day 9 or 10 post-estrus, all cows received a second dose of PGF2α (25 mg). Thirty-three h post-PGF2α (early follicular phase), cows were randomly assigned to receive either saline (n=7) or .3 mg FLU/kg BW i.v. (n=8). Blood samples were collected at 15-min intervals for 4 h before and 5.5 h after treatment. Mean serum progesterone concentration was .5 ± .3 ng/ml. Fluphenazine transiently increased (P < .05) GH concentration from 4.7 ± .8 to 8.6 ± .7 ng/ml but serum GH concentration did not change in saline-treated cows. Fluphenazine increased (P < .01) PRL concentration, while saline had no effect. In Exp. 2, 15 lactating Holstein cows received 25 mg PGF2α and after detection of estrus, occurrence of ovulation was confirmed using ultrasound. Fifteen to 20 h post-ovulation (metestrus phase) cows were randomly assigned to receive either saline (n=7) or .3 mg FLU/kg BW (n=8). Experimental procedures were identical to Exp. 1, except that blood samples were collected at 12-min intervals. Mean serum progesterone concentration was .16 ± .13 ng/ml. Growth hormone concentration increased (P < .05) from 5.2 ± .9 to 8.7 ± .8 ng/ml in FLU-treated cows whereas it was unchanged in the saline-treated group. Fluphenazine increased (P < .01) PRL concentration, while saline had no effect. Results suggest that during the early follicular and early metestrus phases of the estrous cycle, when serum progesterone concentration is low, endogenous dopamine plays inhibitory role in GH and PRL secretion in lactating Holstein cows.

Key Words: Dopamine antagonist, Growth hormone, Dairy cattle

443   Feeding suppresses thyrotropin-releasing hormone (TRH) -induced secretion of growth hormone and reduces activity of TRH neurons. R. P. Radcliff*, L. T. Chapin, K. J. Lookingland, C. D. McMahon, and H. A. Tucker, *Michigan State University, E. Lansing.*

Thyrotropin-releasing hormone (TRH) released from the hypothalamus increases secretion of growth hormone (GH) from the anterior pituitary gland. Feeding steers ad libitum for 2 h each day reduces basal concentrations of GH after feeding. If feeding-induced inhibition of GH secretion occurs via a mechanism involving TRH, then TRH-induced secretion of GH or activity of TRH neurons would be reduced after feeding. Therefore, our objectives were to determine: (1) a dose of TRH that induces maximal release of GH; (2) if this dose induces similar increases in concentrations of GH before and after feeding; and (3) if activity of TRH neurons changes from before to after feeding. In experiment 1, steers were injected i.v. with either saline (control), or TRH (.1, .3, 1, 3, or 10 μg/kg BW) in a 6 × 6 Latin square design balanced for residuals. Injection of .3 μg TRH/kg BW induced the greatest area under the GH response curve (AUC, P = .0001) as well as greatest peak concentration of GH (P = .0001). In experiment 2, steers (n = 6) were injected with .3 μg TRH/kg BW at either 0900 (1 h before feeding) or 1300 h (1 h after feeding) in a switchback design. Relative to 1300 h, injection of TRH at 0900 induced greater AUC (964.4 vs. 667.2 ± 167.3 ng·min·ml^{-1}, P = .058) as well as peak GH concentration (21.1 vs. 9.0 ± 2.7 ng/ml, P = .01). In experiment 3, presence of immediate-early gene proteins Fos and Fos-related antigens (Fos/FRA) was used as an index of neuronal activity in TRH- immunoreactive (IR) neurons. Steers were euthanized at 0700, 0900, 1100, and 1300 h (n = 5 per time). The percentage of TRH-IR neurons containing Fos/FRA decreased from 16.3 ± 3.9% at 0700 h to 3.7 ± 3.4% at 1300 h (P = .04). We conclude that feeding reduces activity of TRH neurons and suppresses TRH-induced release of GH.

Key Words: Thyrotropin-releasing hormone, Growth hormone, Cattle

444   Use of Growth Hormone (GH) Response to Growth Hormone-Releasing Hormone (GHRH) to Determine Growth Potential in Beef Heifers. T. L. Auchtung*, E. E. Connor, S. M. Barao, L. W. Douglass, and G. E. Dahl, *University of Maryland, College Park, MD.*

We tested the hypothesis that GH response to a challenge dose of GHRH is predictive of rapid, lean growth in the beef heifer. GH response to a challenge of GHRH was measured in 67 Angus heifers averaging 225 d (SD = 21) of age. Blood samples were taken immediately prior to and 10 min following a clearance dose of 4.5 μg GHRH/100 kg BW (injected i.v.) and, 2 hr later, immediately prior to and 10 min following a challenge dose of either 1.5 or 4.5 μg GHRH/100 kg BW. The GHRH was a bovine analog (1-30) GHRH. Each animal received both challenge doses, which were randomly assigned across the 2 d of blood collection. Concentrations of GH in serum were measured by RIA. BW was measured every 28 d, and ADG was calculated at the end of a 140 d growth test. The clearance dose stabilized the within animal variation of response to the challenge doses (P <. 0001). There was a dose response to the two GHRH challenges (P <. 05). A positive relationship (r = . 52, P <. 0001) was found between the heifers' rankings for each dose, i.e. high responders to the low dose were high responders to the high dose. The correlation between ADG and predicted ADG was .21 (P <. 07) for a model based on treatment (1.5 μg GHRH/100 kg BW). For heifers (n = 28) whose sires (n = 3, HI; n = 2, LO) were selected for their GH response to GHRH, the correlation was .47 (P <. 01) for a model including the effect of sire and treatment (both doses). As in a similar study with Angus bulls, our results suggest that GH response to an injection of GHRH may be used as a predictor of growth in beef heifers. Further studies will be done to determine the relationship between carcass composition and maternal ability (e.g. milk production) of beef heifers and their GH response to GHRH challenge.

Key Words: Beef Cattle, Growth Hormone, Predicting Growth

445   Effects of provision of the anti-inflammatory ketoprofen alone or with local anesthesia during castration of bull calves on cortisol, in vitro interferon-γ production, and growth. M. A. Crowe*[1] and B. Earley[2], [1]*University College Dublin, Ireland,* [2]*Teagasc, Grange Research Centre, Co. Meath, Ireland.*

To determine the effects of ketoprofen (K) alone or in combination with local anesthesia (LA) during castration of calves on plasma cortisol, keyhole limpet hemocyanin (KLH)- and concanavalin A (Con A)-induced in vitro interferon (IFN)-γ production, and ADG, 40 Friesian bull calves (215 $\pm$ 3.5 kg) were assigned to five treatments on on d 0: 1) control (C); 2) surgical castration (S); 3) S following K (S + K); 4) S following LA (S + LA); and 5) S following a combination of K and LA (S + K + LA). Ketoprofen (3 mg/kg BW i.v.) and/or LA (9 ml lidocaine to each testis) were administered 20 min before castration. The area under the cortisol curve was greater (P<.05) in S, S + LA and S + K + LA than in C calves; and was not different between C and S + K calves. Peak cortisol concentrations were higher in S than in C, S + K, S + LA and S + K + LA calves. Within the castration treatments, the interval to peak cortisol was longer (P<.05) for S + K + LA calves than for either S or S + K; the interval for S + LA was intermediate, but not different (P>.05) from S or S + K and S + K + LA. There was no difference (P>.05) between treatments in either KLH- or Con A-induced IFN-γ production from lymphocytes collected on d 1 and 7. However on d 3, KLH-induced IFN-γ production was lower (P<.05) in S than in C calves, while there was no difference between controls and bulls castrated following either LA and/or K administration. Con A-induced IFN-γ production was lower (P<.05) in all castration groups than in C on d 3. ADG was higher (P<.05) in S + LA + K calves than in C and S calves; but was not different (P<.05) between C, S, S + LA and S + K calves or between S + K, S + LA and S + K + LA calves. In conclusion, the castration-associated increase in cortisol was suppressed by the administration of K but not LA. Ketoprofen and LA prevented the suppression of KLH-induced IFN-γ production, while Con A-induced IFN-γ production was suppressed in all castration groups on d 3 following castration.

Key Words: Cattle, Castration, Cortisol

446   Seasonal effects on estrous behavior and time of ovulation in beef cows. F. J. White*, M. L. Looper, and R. P. Wettemann, .

Estrous behavior and time of ovulation were determined in Angus x Hereford cows. The HeatWatch® system (an electronic sensor which records mounts) was used to determine estrous behavior for two consecutive estrous cycles in summer-1 (n=17), winter (n=20), spring (n=17), and summer-2 (n=21) seasons. Onset of estrous behavior was defined as the first of 3 mounts within a 4 h time period. To evaluate normal luteal activity, blood samples were obtained twice weekly, and progesterone was quantified by RIA. The first estrous cycle was used to quantify behavior, and the second cycle was used to determine time of ovulation. Commencing 16 h after the onset of the second estrus, transrectal ultrasonography was performed every 4 h until the dominant follicle was no longer present on the ovary. Season did not influence time of ovulation (P > .1), and cows ovulated 31.5 $\pm$ .4 h after the onset of estrus. Time of day when cows began estrous behavior was not influenced by season. Duration of estrus (P < .1), intensity of estrus (P < .05), and the greatest length of time between mounts (quiescence; P < .05) was influenced by season. Duration of estrus was longer in summer (17.9 $\pm$ 1.3) than in winter (14.4 $\pm$ .8 h). Duration of quiescence was shorter in winter (2.1 $\pm$ .3 h) than in summer (4.1 $\pm$ .7). Cows exhibited fewer mounts per estrus in summer (43.7 $\pm$ 6.9) than in winter (69.8 $\pm$ 9.5). We conclude that season of the year alters estrous behavior of beef cows; however, time of ovulation relative to the onset of estrus is similar during all seasons.

Key Words: Beef Cow, Estrus, Ovulation

447   Effects of estradiol benzoate (EB) on follicular turnover in lactating crossbred *Bos indicus* cows treated with an intravaginal progesterone insert (INSERT). J. K. Fullenwider*, J. R. Kempfer, C. L. Barnett, and J. V. Yelich, *University of Florida, Gainesville.*

Twenty-nine cows with an average postpartum interval (PPI) of 60 d and body condition score (BCS; scale 1-9) of 5.0 were used to examine the effectiveness of EB administered on d 0 of a 7-d INSERT (EAZI-BREED[TM] CIDR®) to initiate follicle turnover and synchronize follicular development for a timed-AI in conjunction with GnRH. Cows were randomly assigned to each of 4 treatments by cycling status, PPI and BCS. INSERTS were administered on d 0 of the experiment. Treatments were: 1) INSERT + PG on d 7 + GnRH 48 h after INSERT removal (n=7); 2) INSERT + PG on d 7 + GnRH 60 h after INSERT removal (n=8); 3) INSERT + 2 mg EB on d 0 + PG on d 7 + GnRH 48 h after INSERT removal (n=8); and 4) INSERT + 2 mg EB on d 0 + PG on d 7 + GnRH 60 h after INSERT removal (n=6). All cows were AI at GnRH injection. Ultrasound examinations were performed every other day from d 0 until INSERT removal and then every day until ovulation. Pregnancy was diagnosed by ultrasonography 30 d after AI. Follicle turnover was quantified in cows that had follicles $\geq$10 mm on day 0. Treatment with EB (n=12/12) increased (P< .05) follicle turnover compared to no EB (n=7/15). Independent of follicular turnover, there were no differences (P > .05) in follicle size (mean = 11.4 mm) at AI across treatments. There were no differences (P > .05) for estrous (57.1, 37.5, 37.5 and 42.9 %) or pregnancy rates (42.9, 25.0, 62.5 and 66.6 %) between treatments 1,2,3 and 4, respectively. However, EB-treated cows (64%) tended to have increased (P= .09) pregnancy rates than cows not receiving EB (33%), irrespective of time of AI. Administering EB on d 0 of a 7-d INSERT significantly increased follicle turnover and tended to increase pregnancy rates to a TAI in conjunction with GnRH in crossbred *Bos indicus* cattle.

Key Words: Bos indicus, follicle, GnRH

448   Effects of passive immunization against inhibin on superovulation in cattle. B. M. Pannagl* and W. Hansel, *Pennington Biomedical Research Center.*

Antisera were developed to three synthetic inhibin antigens: human α;C, bovine α;C and bovine α;N. These sera were harvested and, after purification by ammonium sulfate precipitation were injected subutaneously into 30 crossbred, estrous cycle-synchronized Hereford-Angus cows divided into 6 groups of 5 animals each, as follows: 1) superovulated

(Super...;Ov, 75 units, PGF_{2α;} 25 mg) 2)superovulated plus human α;C antiserum 3) superovulated plus bovine α;C antiserum 4) superovulated plus bovine α;N antiserum 5) bovine α;C antiserum alone and 6) bovine α;N antiserum alone. Antibody titers of human α;C antibodies were 3 times higher (P<0.05) than titers of bovine inhibin antibodies. Although none of the antisera increased (P<0.05) follicle development or ovulation rates, plasma concentrations of FSH in the cows that came into estrus were higher (P=0.004) in both groups receiving bovine α;C antiserum than in all other groups, from the beginning of FSH treatment to the end of estrus. Animals coming into estrus that received human α;C antibodies had higher (P<0.05) plasma estradiol concentrations during estrus than other immunized groups. Corpus luteum (CL) development after ovulation in cows that came into estrus, as assessed by plasma progesterone concentrations, was inhibited (P<0.05) in all inhibin antibody treated groups, except the bovine α;C superovulated group, when compared to the superovulated control group. In summary, passive immunization with inhibin antigens elevated FSH secretion, but failed to increase ovulation rates and inhibited development of subsequently formed corpora lutea.

Key Words: Inhibin, Antibodies, Hormones

449   Exogenous oxytocin and cervical manipulation do not affect ovum fertilization rates in sheep. E. L. Hensley*[1], E. A. Cowardin[1], M. C. Wulster-Radcliffe[1], R. C. Seals[1], J. N. Stellflug[2], V. LaVoie[2], and G. S. Lewis[1], [1]*Virginia Polytechnic Institute and State University*, [2]*USDA, ARS, USSES.*

Exogenous oxytocin (OT) dilates the cervix in ewes and aids the process of transcervical (TC) AI. In our previous work, OT did not affect fertilization rates, but the combined effects of OT and cervical manipulation (CM) have not been assessed. This experiment was conducted to determine whether OT and(or) CM before laparoscopic AI affected the interval from removal of progestogenated pessaries to ovulation, fertilization rate (FR), or pregnancy rate (PR). Ewes were assigned to treatments in a 2 × 2 factorial arrangement; OT and CM were main effects (n = 8 ewes/group). To synchronize estrus, progestogenated pessaries were inserted and left in place for 11 d. On d 6 after pessary insertion, PGF$_{2\alpha}$ (2 × 5 mg i.m., 4-h interval) was injected. At pessary removal, PMSG (400 IU i.m.) was injected. A laparoscopic procedure was used to AI ewes 48 to 52 h after pessary removal. All AI was laparoscopic so that the effects of OT and CM would not be confounded with AI procedure. At 30 to 60 min before AI, ewes received i.v. either 400 USP units of OT or 20 mL of saline, and the cervix was either manipulated (i.e., TC passage of AI catheter) or not manipulated. Beginning 32 h after pessary removal and continuing at 8-h intervals, ovaries were evaluated with transrectal ultrasonography to determine the interval (± 4 h) from pessary removal to ovulation (i.e., disappearance of largest follicles). Treatments did not affect (P > .05) ovum/embryo recovery rate (mean = 69%), FR (mean = 45.5%), or PR (mean = 51.6%). The OT tended to reduce (OT, 62 h vs saline, 66 h; P < .06) the interval to ovulation. The OT × CM interaction was not significant, but the interval (59 h) to ovulation in the OT-CM group seemed to explain the OT effect. In conclusion, the combined effects of exogenous oxytocin and cervical manipulation should not impair the success of transcervical AI in sheep.

Key Words: Sheep, AI, Cervix

450   Effectiveness of slow release steroids on maintenance of serum progesterone concentrations and induction of puberty in heifers. C. S. Whisnant*[1], *North Carolina State University, Raleigh, NC.*

Administration of progesterone (P) or its analogs can be used to synchronize estrus in cattle and it has also been shown to induce puberty in peripubertal heifers. Methods of administration include multiple injections, implants and feeding. All have some drawbacks in terms of convenience. A single injection that could release the hormone over time similar to the luteal phase of the estrous cycle could be useful in applications as described above. The objective of the first experiement was to characterize the pattern of serum P concentrations produced in cows by injection of two preparations containing P coupled to poly-L-lactide microspheres. Eight luteal phase cows were treated with 25 mg prostaglandin F2α and 12 hours later given an im injection of one of two preparations (n=4)containing 50 mg estradiol (E) and 625 mg P. Blood samples were taken twice weekly via tail vein puncture for 6 weeks to characterize P release and comparison with a subsequent normal luteal phase. Seven of 8 cows ovulated based on day 18-19 following injection as determined by serum P. In experiment 2, peripubertal Angus and Simmental heifers (10-11 months of age) were injected im with either vehicle, E (50 mg), P (625 mg) or a combination of E+P at the same doses (n=13 per group). More heifers (P<.05) from the groups treated with P ovulated within 3 weeks after injection compared to the other groups. The results suggest that the microsphere preparations are effective in obtaining sustained release of P and suggest they could be effective in estrus synchronization and puberty induction programs.

Key Words: Heifers, Progesterone, Puberty

451   Effects of short-term calf removal at two phases of synchronization protocol on ovulation rates in Nellore cows. J. L. M. Vasconcelos*[1], E. R. Vilela[1], R. A. Figueiredo[1], A. M. M. Alessandri[1], R. L.A. Cerri[1], F. S. Wechsler[1], and C. M. Barros[2], [1]*FMVZ - UNESP, Botucatu, Brazil*, [2]*IB - Botucatu, SP, Brazil.*

Treatments to reduce anestrus must focus on increasing LH pulse frequency and allowing follicles to reach the final stages of maturation. One method to increase LH pulses is short-term calf removal (CR). A protocol has been developed (GnRH - 7 days - PGF$_{2\alpha}$ - 24 h - EB - 24 h - AI) that synchronizes ovulation in Nellore cows. In anestrous cows, the pregnancy rate to this protocol is low (15% vs. 45% in cycling cows). The hypothesis is that CR increases LH pulses and delays the turnover of the dominant follicle, increasing the number of cows with presence of dominant follicles at the time of injections of GnRH and Estradiol Benzoate and ovulations. This study was designed to evaluate whether CR (48 to 52h) before GnRH (100 mg) injection and /or after PGF$_{2\alpha}$ (25 mg) injection could affect the ovulation rate to GnRH injection and the synchronization rate after the Estradiol Benzoate (1 mg) injection. Lactating Nellore cows (N=140), blocked by calf sex, suffered or not CR before GnRH injection and between PGF$_{2\alpha}$ injection and AI, in a 2 x 2 factorial. Ovarian morphology was evaluated by ultrasound, to determine: ovulation rate, by comparing the presence of follicle and CL on day of GnRH and on day of PGF$_{2\alpha}$ and synchronization rate, by the presence of follicle on day of AI and ovulation 24 h later. The effects of treatment (CR) on ovulation rate and synchronization rate were analyzed by Chi-square analysis. Cows that received calf removal had higher (P<.01) ovulation and synchronization rates than cows that were not exposed to calf removal, 74.6% (50 in 67) and 85.9% (55 in 64) vs. 52.1% (38 in 73) and 57.1% (40 in 70), respectively. Six cows ovulated before AI. Ovulation and synchronization rates were influenced by CR, probably due to increase in LH pulsatility and maintenance of the dominant follicle, thereby increasing the presence of dominant follicles at injection time.

Key Words: Beef Cows, Calf Removal, Synchronization Rate

452   Synchronizing estrus in replacement beef heifers using GnRH, melengestrol acetate, and PGF$_{2\alpha}$. J. S. Stevenson*[1], G. C. Lamb[2], J. A. Cartmill[1], B. A. Hensley[1], S. Z. El-Zarkouny[1], and T. J. Marple[1], [1]*Kansas State University, Manhattan*, [2]*University of Minnesota, Grand Rapids.*

Our objective was to determine if a 7-d, GnRH + PGF$_{2\alpha}$ protocol (Select Synch) was effective for synchronizing estrus in replacement beef heifers compared to traditionally used programs. Heifers (n = 588) at three Kansas locations consisting of Angus, Hereford, Simmental, and Hereford x Angus breeding were assigned randomly, but unequally, to each of three treatments: 1) two, 25 mg injections of PGF$_{2\alpha}$ (Lutalyse®) were given 14 d apart (d -14 and 0; 2xPGF$_{2\alpha}$; n = 139); 2) melengestrol acetate (MGA; 0.5 mg per head per day for 14 d) starting on d -31 plus 25 mg of PGF$_{2\alpha}$ administered 17 d later (d 0; MGA+PGF$_{2\alpha}$; n = 289); or 3) 100 μg of GnRH (Fertagyl®) was injected (d -7) followed by 25 mg of PGF$_{2\alpha}$ (d 0; GnRH+PGF$_{2\alpha}$; n = 160). Twice-daily observations for estrus began on d -5 and continued at varying durations thereafter. Inseminations were performed 10 to 14 h after first detected estrus. Pregnancy was diagnosed by transrectal ultrasonography between 33 and 37 d after insemination. Percentages of heifers detected in estrus (in order of treatments defined above) before (9, 6, and 12%), during (75, 82, and 72%), or after (9, 8, and 9%) the target breeding week were not different among treatments. Percentage of heifers not detected in estrus among treatments was not different (8, 4, and 6%). Overall conception rates (proportion pregnant of those inseminated) were 69, 68, and 64% and pregnancy rates (proportion pregnant

of those treated) were 52, 56, and 46%, respectively. Pregnancy rates tended to be greatest in the MGA + PGF$_{2\alpha}$ treatment; but treatment x location interactions were evident for estrus-detection, conception, and pregnancy rates. All three programs synchronized estrus, but overall, the Select Synch protocol tended to be least effective.

453   Estrous synchronization in beef heifers using MGA and PGF$_2\alpha$, or GnRH and PGF$_2\alpha$. J. M. Cassady*[1], J. E. Wheaton[1], C. M. Zehnder[1], A. DiCostanzo[1], G. C. Lamb[2], and B. Seguin[1], [1]*University of Minnesota, St. Paul,* [2]*North Central Experiment Station, Grand Rapids.*

Our objective was to determine whether a GnRH and PGF$_2\alpha$ protocol was an effective system for synchronizing estrus in replacement beef heifers compared to heifers synchronized with MGA and PGF$_2\alpha$. A heifer development operation in eastern Minnesota wintered 471 crossbred heifers from two separate locations. Prior to the breeding season, heifers were assigned randomly to two treatments: 1) heifers were offered MGA daily at .5 mg per head for 14 d, followed by a 25-mg injection of PGF$_2\alpha$ administered 17 d after MGA withdrawal (**MGA**); or 2) heifers received a 100-μg injection of GnRH on d -7, followed by a 25-mg injection of PGF$_2\alpha$ on d 0 (**GnRH**). Heifers were inseminated artificially for 96 h; heifers that did not exhibit estrus by 72 h were inseminated at a fixed time (84 h). Ultrasonography was used to determine the presence of a viable fetus. Overall pregnancy rates between treatments were similar (36.7% vs 35.0% for MGA and GnRH treatments, respectively). Conception rates for MGA-treated heifers detected in estrus were 48.7% compared to 14.4% for their counterparts that were inseminated at a fixed time. Similarly, heifers assigned to the GnRH treatment had conception rates of 45.7% after a detected estrus and 10.0% for those heifers inseminated at a fixed time. The average insemination time after PGF$_2\alpha$ administration differed (P < .05) in the GnRH treatment (66.8 $\pm$ 1.38 h) compared to the MGA treatment (71.8 $\pm$ 1.43 h). At initiation of treatments, BW for GnRH heifers were greater (P < .05) than for MGA heifers (291 $\pm$ 1.86 kg vs 218 $\pm$ 1.82 kg, respectively). However, MGA-treated heifers exhibited faster ADG which resulted in a similar final BW for the two groups. We conclude that there are no differences in conception rates between the GnRH and MGA treatments, however the average interval to detection of estrus was shorter in GnRH-treated heifers.

454   Effect of GnRH/PG combinations in synchronizing estrus in lactating crossbred cows of *Bos indicus* breeding. J. W. Lemaster*, C. L. Barnett, J. R. Kempfer, J. K. Fullenwider, M. D. Fanning, J. F. Selph, and J. V. Yelich, *University of Florida, Gainesville.*

Lactating crossbred cows across three locations were utilized to determine the efficacy of a 7-d GnRH/PG combination for estrous synchronization. Cows were randomly allotted to each of three treatments (TRT) by body condition score (BCS; scale 1-9) at all locations and postpartum interval (PPI) at two of three locations on d 0 (d 0 = GnRH administration): 1) GnRH + PG on d 7 and inseminated 12 h after detected in estrus for 5 d (n=198); 2) GnRH + PG on d 7 + GnRH 48 h later and timed-AI (TAI; n=196); 3) GnRH + PG on d 7 and inseminated 12 h after detected in estrus for 72 h, cows not detected in estrus were administered GnRH and TAI at 72 h after PG (n=200). Animals were bled at d -7 and 0 for determination of cycling status (progesterone > 1 ng/mL at either bleeding were considered cycling). Location, AI sire and AI technician were not significant (P>.05) for any of the variables tested and were removed from the statistical analysis. Mean body condition score (4.5), PPI (61.3 d) and percentage of cows cycling (39.2%) had no effect (P>.05) on estrous, conception and pregnancy rates among treatments. Estrous rates (45.5, 18.9 and 33.0%) were similar (P>.05) for cows in TRT 1, 2 and 3, respectively. Conception rates were greater (P<.05) for TRT 1 (44.4%) than TRT 2 (31.1%), but were similar to TRT 3 (35.5%) which was not different (P>.05) from TRT 2. Pregnancy rates were greater (P<.01) for TRT 2 and 3 (31.1 and 35.5%, respectively) compared with TRT 1 (20.7%). Pregnancy rates for animals bred by detected estrus in TRT 1 and 3 were similar (44.4 and 59.1%, respectively; P>.05), but greater (P<.05) compared with TRT 2 (31.1%). Pregnancy rates for animals not detected in estrus for TRT 3 but TAI at 72 h after PG was 23.9%. In conclusion, TRT 2 and 3

are a more effective method of synchronizing estrus in lactating crossbred cows of *Bos indicus* breeding compared with TRT 1 cows in a 7-d GnRH/PG protocol.

455   Timed artificial insemination in dairy heifers fed melengestrol acetate. S. M. Pancarci*[1], J. Vonk[2], F. Moreira[1], and W. W. Thatcher[1], [1]*University of Florida,* [2]*Wageningen Agricultural University.*

Two experiments were designed to improve synchronization of ovulation with a timed artificial insemination (Ovsynch/TAI) protocol by feeding melengestrol acetate (MGA, 0.5 mg). After estrus induced by prostaglandin F$_{2\alpha}$ (PGF$_{2\alpha}$, Lutalyse®; 25 mg, im), cows were injected with GnRH (Cystorelin®; 100 μg, im) on d3 (n=10), d5 (n=10), d15 (n=10) or d18 (n=9) of the cycle. MGA was fed daily for first 5 days of the Ovsynch/TAI protocol, PGF$_{2\alpha}$ injected on d7, GnRH injected on d9, and heifers inseminated 14 h later. Ovulation to first GnRH injection did not differ (0/10 for d3, 1/10 for d5, 2/10 for d15, and 2/9 for d18; P>.10). Feeding MGA concurrently with injection of GnRH reduced incidence of induced ovulations from expected for d5 and d18 groups with a dominant follicle. Pregnancy rates (PR) did not differ (35.9$\pm$7.8%; P>.10). Frequency of premature ovulations prior to the second GnRH injection was greater for the d18 (4/9) and d15 (2/10) groups (P<.01) compared to d3 and d5 (0/20) and contributed to low pregnancy rate. Heifers (n=34) of experiment 2 were injected with PGF$_{2\alpha}$ to induce estrus. Heifers in estrus (n=24, 71%) were assigned to initiate the Ovsynch/TAI protocol at d5 of cycle. Remaining nonresponsive heifers (n=10, 29%) began the Ovsynch/TAI protocol at 10 days after PGF$_{2\alpha}$ injection. Heifers received the Ovsynch/TAI protocol and were assigned to treatments: control (n=12), 6d-MGA feeding (n=11) and 5d-MGA feeding (n=11). MGA feeding was initiated at first GnRH injection in the 6d-MGA group and 1 day after GnRH injection in the 5d-MGA group. In MGA groups, last MGA feeding was 1 day before PGF$_{2\alpha}$ injection. Ovulation rates to the first GnRH injection were: control=91.6$\pm$10.4%, 6d-MGA=72.7$\pm$10.8% and 5d-MGA = 63.6$\pm$10.8%. No premature ovulations occurred prior to the second GnRH injection, and PR was 63.6$\pm$8.7%. Feeding MGA for 5 days, beginning 1 day after the initial GnRH injection and ending 1 day prior to PGF$_{2\alpha}$ injection, may improve synchronization without compromising fertility to the Ovsynch/TAI protocol.

456   Extending prostaglandin F$_{2\alpha}$ administration from 17 to 19 d in a melengestrol acetate-prostaglandin F$_{2\alpha}$ estrus-synchronization system for beef heifers. G. C. Lamb*[1], D. W. Nix[2], J. S. Stevenson[2], and L. R. Corah[3], [1]*University of Minnesota, Grand Rapids,* [2]*Kansas State University, Manhattan,* [3]*Certified Angus Beef, Manhattan, KS.*

Our objective was to determine whether extending the interval between melengestrol acetate (MGA) feed removal and prostaglandin F$_{2\alpha}$ (PGF) administration from 17 to 19 d would alter conception rates, pregnancy rates, and degree of synchrony in replacement beef heifers. A commercial heifer development operation located in north-central Kansas purchased 591 Angus x Hereford heifers from 12 sources. Prior to the spring breeding season, 14% of the heifers were culled. The remaining heifers were assigned randomly to two MGA-PGF synchronization systems. All heifers were fed MGA (0.5 mg per head per day) for 14 d and PGF was administered either 17 or 19 d after MGA feeding was complete. Heifers were inseminated artificially for 30 d followed by 30 d of natural mating. Based on each source, first-service conception rates ranged from 66% to 90%, whereas overall pregnancy rates ranged from 91% to 100%. Heifers given PGF on d 17 after MGA had first-service conception rates of 75.9% compared to 81.4% for heifers administered PGF on d 19. In response to the PGF injection, 99% of the d 19 heifers, which were detected in estrus, were inseminated artificially by 72 h after the PGF injection, whereas 74% of the heifers in the d 17 treatment were inseminated by 72 h after PGF. Average interval to AI after PGF was greater (P < .01) in the d 17 heifers (73.1 $\pm$ 1.1 h) than in the d 19 treatment (56.2 $\pm$ 1.1 h). No differences in conception rates or overall pregnancy rates occurred; however, heifers administered PGF on d 19 after MGA had shorter intervals to estrus and a greater proportion were inseminated within 72 h after PGF, thus possibly facilitating successful

timed inseminations of remaining heifers not yet inseminated by 72 h after PGF.

synchrony of estrus and ovulation necessary for fixed time insemination in lactating beef cows, regardless of ovulatory status.

457 Improved synchrony of estrus with addition of GnRH to a melengestrol acetate (MGA; 14 d) - prostaglandin F2α (PG: 19 d) estrous synchronization treatment in beef heifers. S. L. Wood*, M. C. Lucy, M. F. Smith, and D. J. Patterson, *University of Missouri, Columbia, MO.*

The objective of this experiment was to determine whether addition of GnRH to a MGA-PG protocol would improve synchrony of estrus by initiating a new follicular wave after withdrawal of MGA and prior to PG-induced luteal regression. Pubertal crossbred beef heifers (n=34) were randomly assigned to one of two treatments. Both treatments were fed MGA (.5 mg·hd^{-1}·d^{-1}) for 14 d followed by an injection of PG (25 mg Lutalyse[®]) 19 d after MGA withdrawal. MGA was delivered in a supplement of 1.8 kg·hd^{-1}·d^{-1}. Seventeen heifers received an injection of GnRH (100 μg Cystorelin[®]) 12 d after MGA withdrawal and 7 d prior to PG. The control group (n=17) received only MGA-PG. Estrus was detected 4 times/d for 7 d beginning on the day PG was administered. Transrectal ultrasonography was performed daily on 8 heifers from each treatment to monitor ovarian activity and characterize changes in follicular dynamics after MGA withdrawal and until ovulation after PG. GnRH-treated heifers ovulated or luteinized the dominant follicle following injection and initiated a new follicular wave (8/8, 100%). All GnRH-treated heifers (17/17, 100%) and 94% of controls (16/17) exhibited estrus after PG. Estrus was exhibited over a 132 h period (12 to 144 h) for control heifers compared with 60 h (48 to 108 h) for GnRH-treated heifers. The peak synchronized period for both treatments was between 48 and 72 h after PG during which time 76% (13/17) of GnRH-treated heifers exhibited estrus compared to 59% (10/13) of controls. Seventy-one percent (12/17) of the GnRH-treated heifers exhibited estrus from 48 to 60 h after PG, compared with 35% (6/17) of controls (P < .05). In summary, addition of GnRH to a 14-19 d MGA-PG protocol concentrated estrus during the synchronized period and reduced the time required to detect estrus. This protocol may offer potential for fixed-time insemination of replacement beef heifers.

458 Follicular dynamics, estrus and pregnancy after fixed time insemination in beef cows treated with intravaginal progesterone inserts and estradiol benzoate. P. J. Bridges*, P. E. Lewis, and E. K. Inskeep, *West Virginia University, Morgantown, WV.*

The effects of three short term treatments with progesterone and estradiol benzoate (EB) on follicular dynamics, synchrony of estrus and pregnancy rate after fixed time insemination were compared in lactating, postpartum beef cows on two farms. One week prior to, and at the onset of treatments, blood was collected to determine ovulatory status. In treatment 1, each cow received an intravaginal progesterone insert for 7 d with injection of EB (2 mg, i.m.) at the time of device insertion. In treatment 2, the insert was used for 5 days with injection of EB (2 mg, i.m.) at insertion. Cows in treatment 3 received an insert alone for 5 d. All cows received PGF$_2\alpha$ (25 mg, i.m.) at insert removal and an injection of EB (1 mg, i.m.) 30 h later. Cows were inseminated 28 to 30 h after treatment with EB (58 to 60 h after insert removal). Ovarian follicular dynamics were monitored in a random subset of cows within each treatment group. Treatment with 2 mg EB terminated growth of the largest ovarian follicle [>5 mm in diameter] at device insertion in 16/16 and 14/15 cows in treatments 1 and 2, respectively. The follicle destined to ovulate was larger in treatment 1 (11.8 ± 0.7 mm) than in treatment 2 (9.8 ± 0.3 mm, P < .05). Estrus was detected within an 8-h target period (48 to 56 h after insert removal) in 93, 87 and 81% of cows in treatments 1, 2 and 3, respectively (P > .05). Pregnancy rates at 39 d post insemination were 60, 50 and 51% for treatments 1, 2 and 3, respectively (P > .05). Pregnancy rates did not differ between cows that were anovulatory or had ovulated prior to initiation of treatments (54 vs 53%), nor among cows that were 28 to 40, 41 to 60 or >60 d postpartum at insemination (43, 59 and 54%, respectively). Injection of PGF$_2\alpha$ at insert removal and 1 mg EB 30 h later induced the high degree of

459 Ovulation responses, progesterone concentrations, and pregnancy rates in dairy cows after GnRH treatment at 7, 14, or 7 and 14 days after timed insemination. J. D. Ambrose*[1], J. P. Kastelic[2a], Y. Kappe[3], J. Small[2b], H. Mohamed[3], R. Rajamahendran[3], and L. Goonewardene[1], [1] *Alberta Agriculture, Edmonton,* [2] *Agriculture and Agri-Food Canada,* [a] *Lethbridge,* [b] *Brandon,* [3] *University of BC, Vancouver, Canada.*

Treatment with GnRH 7 or 14 d after insemination (AI) often causes ovulation, increases peripheral progesterone (P$_4$) concentrations, and may increase pregnancy rates. Our objectives were to determine these responses when GnRH was given 7, 14, or 7 and 14 d after timed AI in cows treated to synchronize ovulation. Lactating Holstein cows (n=78; 79±37 DIM) were given GnRH on d-10, PGF$_2\alpha$ (Lutalyse 25 mg, im; Pharmacia-Upjohn) on d -3, GnRH on d -1 and timed-inseminated about 16 h later (d 0). Cows were then randomly allocated to receive: saline on d 7 and 14 (SS; n=20); saline on d 7 and GnRH on d 14 (SG; n=19); GnRH on d 7 and saline on d 14 (GS; n=19); or GnRH on d 7 and 14 (GG; n=20). All GnRH treatments were Fertiline (Vetoquinol, 100 μg, im). Blood samples were collected on d 0, 7, 14 to 18, and 21 for P$_4$ analysis. Ovulation occurred in 30/39 (76.9%) and 10/39 (25.6%) of cows given GnRH on d 7 and d 14, respectively (P<0.01). Mean P$_4$ concentrations (ng/ml) were higher (P<0.05) in SG (5.7), GS (6.2) and GG (6.1) than in SS group (4.4). Pregnancy rates at 60 d (determined by palpation per rectum) were 50.0, 47.4, 33.3 and 50.0±0.12% for cows in SS, SG, GS and GG groups (P>0.05). Sixty five (83.3%) of the 78 cows responded to the synchronization treatment as determined by P$_4$ on d 0 (<1.0 ng/ml) and d 7 ($\geq$1.0 ng/ml). When only these cows were considered, pregnancy rates were 52.6 (SS), 52.9 (SG), 37.5 (GS) and 61.5 (GG)±0.06% (GG>GS, P=0.10). Administration of GnRH 7 and 14 d after timed AI may increase pregnancy rates in cows that respond to the treatment to synchronize ovulation. The low incidence of ovulation following treatment on d 14 (25.6%) warrants further study.

460 A nonlinear model for mammary gland growth in lactating sows. S. W. Kim*, M. Grossman, and R. A. Easter, *University of Illinois, Urbana IL.*

The objective of this study was to characterize mammary gland growth using an empirical dynamic model. Nonlinear mathematical functions can provide tools necessary to construct more flexible and realistic biological models. Mammary gland growth has been modeled in rats and mice, goats , guinea pigs, and cows. No similar model has been constructed for mammary gland growth in sows. Data from 61 sows were used to construct and to illustrate the use of empirical dynamic models to describe mammary gland growth during lactation. Sows were fed four diets during lactation: low energy low protein, LELP; low energy high protein, LEHP; high energy low protein, HELP; high energy high protein, HEHP. Data on weights and composition were collected from individual suckled mammary glands of sows by slaughtering throughout 31 days of lactation. Mean values of weights and composition variables (y) for each sow were computed for each day of lactation (x) and fitted by nonlinear regression. A logistic function was modified to have different rates of growth (d) and decay (f), $y=4a/\{\exp[(c-x)/2d]+\exp[(x-c)/2f]\}^2$, and was used to explain the asymmetric change in the mammary gland for each diet. Model parameters, a, c, d, and f, were used to derive the maximum value for each variable and the day of lactation at maximum. Sows fed a HEHP diet reached a maximum mammary gland wet weight of about 600 g on about day 23 of lactation. R-square of the model was .75. It was also possible to describe mammary gland growth of sows fed other diets for other variables, i.e., dry weight, protein amount, dry fat-free tissue amount, and DNA amount in individual suckled mammary glands with maximum values and day of lactation at maximum. A nonlinear asymmetric model is more flexible and closer to biological reality than a linear model. It should be possible to describe mammary gland change patterns in other species with this model.

| | Wet weight | | | Protein amount | | |
	Max, g	Day of lactation	R-square	Max, g	Day of lactation	R-square
LELP	519.1	21.4	.73	54.8	21.6	.73
LEHP	501.3	28.2	.65	60.5	23.7	.83
HELP	526.6	24.7	.66	56.0	25.4	.68
HEHP	599.1	22.9	.75	64.2	22.8	.86

Key Words: Nonlinear Model, Mammary gland, Lactating sows

461 Relationship among genotype at the BM1500 microsatellite, performance and carcass traits and plasma leptin concentration at slaughter determined by a multi-species RIA in cattle. A. G. Van Kessel*[1], F. C. Buchanan[1], H. C. Block[1], J. J. McKinnon[1], S. M. Schmutz[1], and B. Laarveld[1], [1]*Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, CANADA.*

Genotype at the BM1500 microsatellite, which is 3.5 kb downstream of the leptin gene, has been associated with fat deposition in cattle (Fitzsimmons *et al.*, 1998, Mamm. Genome 9:432). To examine the relationship among plasma leptin concentration, BM 1500 genotype and carcass traits in cattle, blood samples were collected 24 h prior to slaughter in 96 head homozygous for the 138 bp putative fat allele (n=50) or the 147 bp putative lean allele (n=46). Cattle were predominantly of Angus (n=29), Hereford (n=34) and Charolais (n=33) breed types. Cattle were limit fed to achieve 1 kg/d live weight gain for a 70-d background period. During finishing, animals were fed *ad libitum* such that half the animals within each breed type were slaughtered at 8 or 12 mm back fat determined by ultrasound. Plasma leptin was determined by a commercial multi-species RIA kit (LINCO, St. Charles, MO). Animals homozygous for the 138 bp allele had greater (P<.05) backfat depth at the beginning (2.34±0.19 vs. 1.79±0.20 mm) and end (2.98±0.16 vs. 2.37±0.17 mm) of the backgrounding period and reached target finishing back fat depths at lighter (P=.001) weights (550.9±7.5 vs. 588.0±7.9 kg) and in fewer (P<.05) total days on feed (180.6±4.7 vs. 195.2±5.0 d). Plasma leptin (ng/ml) was not affected by genotype but was significantly (P<.001) higher in animals fed to 12 (6.26±0.19) versus 8 (5.20±0.20) mm back fat. In animals fed to 8 mm backfat, no correlation between plasma leptin and carcass or production traits were found. In the 12 mm backfat group, leptin concentration correlated positively with ADG during backgrounding (r=0.37, P<.01) and average carcass fat depth (r=0.31, P<.05). The multi-species leptin RIA detected only minimal variation in leptin concentration associated with marked differences in body fat content and failed to differentiate rate of fat deposition predicted by genotype at the BM1500 microsatellite.

Key Words: Leptin, Cattle, Genetics

462 Anesthesia of calves for computer tomography (CT) examinations using *Xylazine* and *Tiletamin-Zolazepam* preparations. G. Hollo[1], L. Bardos[1], F. Szabo*[2], I. Repa[3], J. Pelbat[3], I. Hollo[3], J. Tozser[1], and E. Szucs[1], [1]*Godollo University of Agricultural Science, Godollo,* [2]*Pannon Agricultural University, Keszthely,* [3]*Pannon Agricultural University, Kaposvar, Hungary.*

In a pilote study preparations containing *Xylazine* and *Tiletamin-Zolazepam* active agents were used for anesthesia in calves before computer-assisted tomography. Holstein-Friesian x Hungarian Red Spotted male and female calves (N=20) were divided into four groups. Average live weights for Group 1, 2, 3 and 4 were 92.1 (66-115), 119.4 (105-139), 120.6 (106-140), 109.4 (90-130) kg, respectively. In Groups 1 and 2 *Xylazine* (Rometar) was administered intravenously vs. intramuscularly, while in Groups 3 and 4 mixture of *Tiletamin-Zolazepam* (1:1) (Zoletil) was administered intramuscularly. For evaulation of effects time spent until lying down and subsequent immobility were recorded as well as time elapsed before regain consciousness and time spent until calves had fully awaken (i.e.recovered). The physiological status of calves was monitored while they were anesthetized in all cases. In accordance with relevant literature intravenous administration of *Xylazine* resulted in lying down and narcosis within a shorter time than it was the case of intramuscular one. For CT examination 15 minutes are required. Having been examined the calves regain consciousness rapidly when Yohimbin antidote is administered. Thus, continuous working routine can be achieved. In parameters recorded substantial within group deviations were observed. Similar observation was established in other

species as well when using CT. Animals, however, showed different levels of reaction to identical doses of anesthetic which reveals individual sensitivity. Preliminary results obtained in this study indicate that, *Tiletamin-Zolazepam* anesthetic agent is suitable for effective application without any substantial side-effects in the anesthesia of calves for CT examination.

Key Words: Calf, Anesthesia, Computer tomography

463 Relationship between concentrations of ovarian steroids and insulin-like growth factor-I in the follicular fluids of the female camel (*Camelus dromedarius*). G. F. Basiouni*, *King Faisal University, Al-Hofuf, Saudi Arabia.*

The main objective of this study was to investigate whether ovarian follicular fluid concentrations vary with the oestrogenic status of the follicles in an induced ovulator, i.e., the female camel. For this purpose, ovaries from 12 female camels were collected after slaughter. All the follicles ≥ 2.5 mm were dissected and their diameter recorded. Follicular fluid was aspirated separately from each follicle and stored at -20°C until analyzed for oestradiol (E), testosterone (T) and IGF-I. A total of 117 follicles were studied. A bi-modal distribution of follicles was observed when their frequency was plotted against oestradiol:testosterone (E:T) ratio. As a result, individual follicles were classified as oestrogenic or non-oestrogenic if they had E:T ratio ≥ 7:1 or ≤ 7:1, respectively. The mean diameter did not differ between oestrogenic (9.1 ± 1.5 mm) and non-oestrogenic (9.4 ± 1.0 mm) follicles. Similarly, follicular fluid IGF-I concentrations were not different between oestrogenic (95.8 ± 9.7 ng/ml) and non-oestrogenic (120.5 ± 10.0 ng/ml) follicles. As expected, E concentrations were significantly (P < .006) higher in oestrogenic, while T concentrations were significantly (P < .02) higher in non-oestrogenic, follicles. The results of this study suggest the lack of any relationship between follicular fluid IGF-I concentrations and oestrogenic status of ovarian follicles in the female camel.

Key Words: Ovarian Steroids, Insuline Like Growth Factor-I, Follicular Fluid

464 *In vitro* production of bovine embryos in a single medium system. A. P. Gandhi* and R. L. Krisher, *Purdue University, West Lafayette, IN.*

Production of bovine embryos in vitro has traditionally utilized a complicated combination of culture media. Oocytes and embryos are exposed to varying culture conditions (such as pH and osmolarity) and may have to expend energy adjusting to the changing environment. This production system is also labor intensive and thus difficult to maintain. In the present study, a single base medium [synthetic oviductal fluid (SOF; J. Reprod. Fert. 30:493; Biol. Reprod. 50:390)] was evaluated for its ability to support maturation, fertilization and pre-implantation development of bovine embryos. Four treatments were examined: control (a standard production system; Mol Reprod Dev 44:193) and three SOF treatments; maturation in SOF with BSA (SOFBSA), SOF with bovine calf serum (SOFBCS) or the control maturation medium (TCM199 with BCS; 199SOF) followed by fertilization and culture in SOF medium. Oocytes were inseminated using standard fertilization and sperm wash media (Biol. Reprod. 38:1171) or SOF medium without glucose or glutamine (fertilization) and supplemented with additional lactic acid (sperm wash). Control zygotes were cultured for 72 h in mBM3 medium (Hum. Reprod. 6:64) with amino acids followed by 96 h in TCM199 with 10% BCS. Zygotes fertilized in the SOF system were cultured for 72 h in SOF with EDTA and taurine followed by 96 h in SOF with vitamins. The percentage of cleaved embryos and of embryos developing to the morula and blastocyst stage of total oocytes inseminated was not different between treatments (n=97-120/treatment: control 47.5 ± 8.6, 27.4 ± 5.3; SOFBSA 55.9 ± 6.3, 21.7 ± 4.5; SOFBCS 48.4 ± 6.2, 14.8 ± 3.9; 199SOF 52.6 ± 7.6, 26.8 ± 3.7, respectively). The average cell number of morulae and blastocysts was also not different among treatments (n=17-26/treatment; control 76.9 ± 5.7, SOFBSA 66.3 ± 6.8, SOFBCS 78.8 ± 5.8, 199SOF 67.1 ± 8.8). These results indicate that although bovine oocytes and embryos appear to be capable of withstanding variations in culture environment without compromising development, quality blastocysts can be easily and successfully produced in a single base medium system.

Key Words: Embryo, Culture, Bovine

465 Localization of zona pellucida receptors on porcine sperm by fluorescence microscopy. H. R. Burkin*[1] and D. J. Miller[1], *University of Illinois, Urbana-Champaign.*

During fertilization, the first molecular interactions between the sperm and egg occur at the zona pellucida. The zona pellucida is composed of three glycoproteins which form a protective extracellular coat that surrounds the egg and appears to limit egg access to homologous sperm. Upon binding the zona, mammalian sperm undergo the acrosome reaction, an exocytotic event which releases hydrolytic enzymes that allow the sperm to penetrate the zona and reach the egg plasma membrane. Although several candidate zona binding proteins have been identified on porcine sperm, their roles in fertilization and the sperm acrosome reaction are not clear. In addition, the specific region of the sperm that initially binds the zona pellucida is controversial. Our objective was to localize zona binding proteins on acrosome-intact and acrosome-reacted porcine sperm. We used fluorescence microscopy to visualize biotinylated solubilized zona proteins bound to sperm. The zona proteins consistently bound to the plasma membrane over the acrosomal region of the sperm head. Surprisingly, labeling was also detected on the post-acrosomal region at the base of the sperm head. When sperm were treated with the calcium ionophore A23187 to induce the acrosome reaction, acrosomal labeling was lost although labeling at the base of the sperm head remained. We have used this technique to show that solubilized porcine zona proteins can also bind bull and stallion sperm, exhibiting a similar labeling pattern to that seen in boar sperm. Our results support the hypothesis that a sperm plasma membrane receptor initially binds the zona, inducing the sperm acrosome reaction. After the acrosome reaction, these zona receptors are lost from the acrosomal region of the sperm head. The labeling that remains at the base regardless of sperm acrosomal status may indicate the presence of secondary zona receptors on sperm. Finally, our results indicate that these receptors may be conserved between porcine, bovine, and equine species.

Key Words: Sperm, Zona Pellucida, Receptor

466 Effect of maturation medium, stage of estrous cycle on in vitro maturation,fertilization and cleavage of bovine and buffalo oocytes. H. Abdel Rahman*[1], F. ElKeraby[2], A. Nebar[1], and S. Shamiah[2], [1]*Faculty of Agriculture, Shibin El Kom, Egypt,* [2]*Animal Production Research Institute, Ministry of Agriculture, Giza, Egypt.*

A total number of 500 buffalo and 329 bovine oocytes, collected by aspiration of medium sized follicle (3-<10 mm). Ovaries were obtained at 3 stages of estrous cycle (stage II, III and IV). Oocytes were cultured *in vitro* in two maturation culture media (TCM 199 or MEM). Rate of oocyte maturation (IVM) and fertilization (IVF) were tested. Cleavage rate (CR) and cleavage index (CI) were studied by *in vitro* culture and insemination of further 600 buffalo and bovine oocytes (300 of each species). Thyroid albumin lactate pyruvate medium (TALP) was used for fertilization and sperm capacitation. Heparin (20 μg/ml) was added to coculture of oocytes and sperms. Percentage of bovine oocytes reached metaphase II was 52.3% versus 43.2% in buffalo. Difference was insignificant. Percentage of degenerated buffalo oocytes was significantly greater (30.6%) than that in cattle (18.2%), P<.01. Neither maturation medium nor stage of estrous cycle significantly affected rate of IVM or IVF. Rate of IVF was 61.9% in cattle versus 27.8% in buffalo, P<.01. Oocyte CR was 41.0% in cattle versus 22.3% in buffalo, P<.01. CI was 64.2% versus 65.0% in buffalo. Only 6.7% of initially cultured bovine oocytes and 3.3% of buffalo oocytes reached morula stage.

Key Words: In vitro oocyte maturation, Fertilization, Buffalo and cattle

467 Effect of different energy sources on Luteinizing hormone secretion in prepubertal female goats. M. I. Vázquez*, H. Morello, M. Chaves, S. Ferrero, and G. Cufré, *Universidad Nacional de Rio Cuarto, Rio Cuarto, Cba., Argentina.*

The present experiment was aimed at i) determining the effects of different sources of energy on Luteinizing hormone (LH) secretion and ii) testing if a daily weight gain of 50 g would trigger puberty in prepubertal female Creole goats. The experiment was carried out at Río Cuarto, Argentina (33°08'S,64°20'W) between February and August under natural photoperiod conditions. Three month old prepubertal Creole does were assingned to the following treatments (n=4/group): basal diet (alfalfa hay, H), basal diet plus 2% of bypass commercial fat (F) and basal diet plus 30% of corn grain (G). The feed was offered in individual cages from 8 a.m. to 4 p.m. and after that all animals were allocated in the same pen. Live weight were recorded at monthly intervals. Serum progesterone concentrations were determined from blood samples obtained twice a week since month 5. Starting at month 6 (week 1), frequent blood samples (10 min. durng 6 h) were collected weekly to asses episodic LH secretion. Puberty was defined as occurrence of serum progesterone exceeding 1 ng/ml in at least two consecutive samples. Kruskal-Wallis test was used to analize frequency and amplitude of LH pulses. Although the LH pulse amplitude was higher than 1 ng/ml throughout the experimental period in animals G treatment, only differences was found among groups in week 8 (P < .0004). Furthermore, lower (P < .027) LH pulse frequency was also detected in G animals in the same week. Daily weight gain were higher in G (64.5 g/d) than H (49.8 g/d) and F (36.2 g/d) groups (P < .01) during the fifty last days. None of the diets was able to trigger puberty during the experimental period. Results indicate that only the grain stimulates LH pulse amplitude but target weight gain of 50 g/d is not adequate to attain puberty in female Creole goats.

Key Words: Luteinizing hormone, energy, prepubertal goats

468 The effect of flushing hair sheep ewes during the rainy season on St. Croix. R. W. Godfrey*, B. M. Pannagl, and H. A. Buroker, *Agricultural Experiment Station, University of the Virgin Islands, St. Croix.*

St. Croix White hair sheep ewes were used to evaluate the effect of supplemental nutrition around the time of breeding during the rainy season on St Croix on reproductive performance. Beginning 21 d prior to the start of the breeding season, and during the 35-d breeding season, 13 ewes were fed a pelleted complete ration (14% crude protein) at a level which provided 150% of the nutrient requirements, in addition to grazing guinea grass pasture (FLUSHED) and 12 ewes grazed pasture only (CONTROL). All ewes were bred to one ram. On day 6,7 or 8 (estrus = day 0) ovulation rate was determined laparoscopically in each ewe. Ewes were examined by transrectal ultrasound on days 24, 28, 32, 36 and 40 to monitor fetal number. The day of conception was determined by non-return to estrus. Kilograms of forage dry matter/ha, was measured at the start and end of the grazing period in pastures during the 56-d period. The FLUSHED ewes were heavier (P < .0001) than CONTROL ewes during the entire study. There was no difference (P > .10) in the cumulative percent in estrus or conception during the breeding period between CONTROL and FLUSHED ewes. Ovulation rate at first estrus was similar (P > .10) between FLUSHED and CONTROL ewes (1.9 ± .2 vs 2.1 ± .2 ovulations, respectively). Fetal number on days of ultrasonography was not different (P > .10) between FLUSHED and CONTROL ewes (1.75 ± .1 vs 1.75 ± .1 fetuses, respectively). There was a positive correlation between ovulation number and fetal number after the first estrus in FLUSHED ewes (R = .881, P = .0001) but not in CONTROL ewes (R = .566, P = .055). Because this study was conducted during the rainy season on St. Croix, it is hypothesized that the forage availability was high enough to provide adequate nutrition to allow the CONTROL ewes to achieve ovulation rates and fetal numbers similar to those of the FLUSHED ewes. The supplemental nutrition provided to the FLUSHED ewes does not appear to enhance ewe reproductive performance at this time of the year on St. Croix.

Key Words: Sheep, Flushing, Ovulation

469 Somatotropin and folliculogenesis in yearling beef heifers. M. Tripp*, D. Schreiber, X. Yang, S. Zinn, and T. Hoagland, *University of Connecticut, Storrs.*

To determine the impact of exogenous somatotropin (ST) on folliculogenesis in beef heifers, eight yearling heifers were rectally palpated twice/wk for one month. Ultrasonography was then conducted every other d for two wk to assess follicular populations. Based on the outcome of these sessions, animals were then randomly assigned to either a control (C) group or a ST (33ug/kg BW/d) group, with mean number of observed follicles being similar between groups. Each animal then underwent additional ultrasound sessions every other d for an additional two wk to assess the presence and rapidity of ovarian response to ST. Each animal then underwent twice weekly ovum pick-up (OPU) sessions for 9 wk, for a total of 19 sessions per animal. A total of 1,871 follicles were observed, 993 during the pre-OPU ultrasound sessions, and 878 during the OPU sessions. A total of 302 oocytes were recovered from the OPU

sessions. One heifer was removed from data analysis due to statistically excessive follicle numbers, and subsequent data was covaried with pre-OPU follicle numbers. Due to variations in ovarian dynamics and small animal numbers, statistical significance was not noted, although several trends emerged. Prior to treatment, follicles/session were 9.7 +/- 1.5. Follicles/session in the first wk after ST administration were similar for C and ST heifers at 9.1 and 8.3 +/- 1.7, respectively. Follicles in the second wk after ST administration tended to increase in ST heifers, with 7.9 and 12.0 +/- 1.6 for C and ST heifers, respectively (p=.22). This trend continued throughout the OPU sessions, with 5.8 and 8.5 +/- 1.5 follicles for C and ST heifers, respectively (p=.20). Control heifers yielded numerically more oocytes/session than ST heifers (2.5 vs. 2.0 +/- 0.8, respectively, p=.64). Oocyte quality and percentages of small, medium and large follicles were similar between treatments. In conclusion, in agreement with our earlier work, ST increased follicles and decreased recovered oocytes. Ovarian response was measurable as early as the second week after ST commencement.

Key Words: Somatotropin, Ovum pick up, Follicle

470   Effect of season on behavioral estrus, ovulation and estrous cycle length in Angus, Brahman and Senepol cows in a subtropical environment. J. V. Yelich*[1], C. L. Barnett[1], J. K. Fullenwider[1], J. R. Kempfer[1], J. W. Lemaster[1], and C. C. Chase, Jr.[2], [1]*University of Florida, Gainesville,* [2]*USDA-ARS, Brooksville, FL.*

Open, non-lactating Angus (A; n=10) , Brahman (B; n=10) and Senepol (S; n=10) cows were used during the summer (solstice), fall (equinox) and winter (solstice) to determine the effect of breed and season on the intensity and duration of estrus during a synchronized and spontaneous estrus; estrous cycle length after a synchronized estrus; and interval to ovulation after a spontaneous estrus. Estrus was synchronized using PG with 25 mg PG administered to cows on d 0 and 12.5 mg PG administered on d 11 and 12. Initiation, duration and intensity (total number of mounts received - mt) of the synchronized and spontaneous estrus were determined by HeatWatch®. Twelve hours after the initiation of the spontaneous estrus, ultrasonic examinations were performed every 4 h to determine time of ovulation. There was a season × breed effect (P=.02) on synchronized estrus intensity for A (42.4, 36.4 and 29.1 mt), B (22.1, 24.0 and 34.3 mt) and S (38.1, 19.8 and 16.6 mt) for summer, fall and winter, respectively. Synchronized estrus duration was similar (P>.05) between fall (12.9 h) and winter (14.4 h) which were longer (P<.05) than summer (9.8 h). The synchronized estrus duration in the A (13.7 h) and B (13.3 h) were similar but longer (P<.05) than S (10.1 h). Spontaneous estrus intensity was similar (P>.05) between summer (29.4 mt) and winter (29.6 mt) which were both greater (P<.05) than fall (16.8 mt). The B (18.8 mt) and S (22.1 mt) had fewer mt (P<.05) compared with A (35.0 mt) during the spontaneous estrus. Season had no effect on duration of the spontaneous estrus, but the B (8.3 h) and S (10.2 h) had similar but shorter (P<.05) duration of estrus than A (13.7 h). There was a season × breed effect (P=.05) on estrous cycle length for A (21.5, 22.7 and 25.0 d), B (21.2, 20.0 and 21.5 d) and S (23.8, 19.9 and 21.5 d) for summer, fall and winter, respectively. Season and breed had no effect (P>.05) on interval from the initiation of HeatWatch® spontaneous estrus to ovulation (30.8 h) or on ovulatory follicle size (14.4 mm). In conclusion, significant breed × season effects were observed for estrous behavior of beef cattle in a subtropical environment.

Key Words: Beef Cattle, Ovulation, Subtropics

471   Steroid hormone enrichment of brine shrimp (*Artemia salina*) nauplii. A. R. Barker*, A. V. Spicer, and R. A. Dailey, .

Growth patterns in many species of fish are sexually dimorphic with one sex growing more quickly and reaching larger sizes. Development of mono-sex populations via sex reversal (changing the developed gonad) or by sex inversion (changing the undifferentiated gonad) would allow the aquaculture industry to produce an economical market-sized fish in less time. As compared to other methods, administration of steroids via the diet produces a higher percentage of sexually inverted individuals. However, hormone-enriched commercial diets are unsuitable for larvae of fish species that require live zooplankton (such as *Artemia salina*) as their initial diet. Steroids have been added to zooplankton at larger stages of development, but size made them unsuitable for larval

fish requiring very small zooplankton. This experiment was conducted to determine the effect of incubation of *Artemia* nauplii with steroids prior to the first feeding instar II stage of *Artemia* development. Decapsulated *Artemia* cysts were incubated at a concentration of 3 g cysts/L in hatching media (1 L seawater at 1.030 SG, 0.08 g highly unsaturated fatty acid supplement) and either 20 mg 17 β-estradiol (E$_2$) or 17 α-methyldihydrotestosterone (MDHT) dissolved in 3 mL 70% ethyl alcohol or ethyl alcohol alone (control). Cysts were cultivated at 18-20°C for 24h. Nauplii were collected by filtering culture media, and were rinsed in 1 L fresh water. *Artemia* cultivated in control media contained 0.07 $\pm$ 0.01 ng E$_2$/mg dry weight, and E$_2$-treated *Artemia* contained 461 $\pm$ 40 ng E$_2$/mg dry weight (p <.0001). MDHT treated *Artemia* contained 546 $\pm$ 31 pg/mg dry weight and controls were below the level of detection (4pg/mL; p < .0001). Thus, steroid hormones can be incorporated into *Artemia* prior to the first feeding instar II stage. Enrichment of *Artemia* at this smaller size will allow them to be used as the initial diet of fish species that require small zooplankton, which may cause functional sexual inversion. Hormone enrichment of live zooplankton diets could be a useful tool in the development of mono-sex stocks of economically important species of fish.

Key Words: *Artemia salina*, Steroid, Sex inversion

472   Effects of genetic group and dietary treatment on initial reproductive performance of Targhee ewe lambs. W. Pittroff*[1], V. LaVoie[1], D. Keisler[2], H. D. Blackburn[1], and J. Stellflug[1], [1]*U.S. Sheep Experiment Station, Dubois,* [2]*University of Missouri, Dept. of Animal Sciences, Columbia.*

Onset of female puberty is thought to be influenced by degree of maturity, body weight and body condition. The discovery of leptin and its effects on the reproductive axis suggested a link between body composition and onset of puberty and initial reproductive performance. This experiment studied effects of body composition and development at the time of first service on onset of female puberty. Targhee ewe lambs of two different genetic lines (41: selected for total weight of lamb weaned; 42: random mating control) were assigned to 3 treatments: LEAN designed to maximize growth and development (2.35 Mcal/kg ME; 20.3% CP) fed ad lib, FAT, designed to provide energy surplus while protein-limiting lean growth (ME concentration 2.86 Mcal/kg; 7.9% CP), fed ad lib, and CONT, chopped alfalfa hay ad lib and 250 g barley/head/day. Ewe lambs were bred for two cycles. Weight and gain data were analyzed with linear models with genetic line and nutrition treatments as main effects; reproductive performance was analyzed within genetic groups and treatments with categorical response models. For the line selected for high fertility and growth (41) pregnancy percentages were 75% (CONT), 68.4% (FAT), 77.8% (LEAN); for unselected line 42: 50% (CONT), 83.3% (FAT) and 72.2% (LEAN). The value observed for 42-FAT was the highest percentage ever obtained for that line here; these animals also had the lowest weight of all groups. Effect of treatment on average daily gain in the week prior to begin of mating was highly significant, with the lowest value observed for FAT animals, and highest for LEAN. Only line effects were significant for ADG computed for the period bracketing the mating period with 41 higher than 42. Line and treatment effects were highly significant for weight at begin of mating; the contrast between LEAN and FAT was highly significant. Differences in reproductive performance were significant only for 42 FAT vs. 42 CONT. This is due to small subcell size varying from 16 to 19 animals and a clear line by treatment interaction. The fact that the group with the lowest average weight had the highest initial reproductive success raises the possibility that attributes such as weight, degree of maturity or ADG prior to mating may be uunsuitable predictors for initial female reproductive performance in sheep.

Key Words: Sheep, Female Puberty, Growth

473   Growth and the initiation of steroidogenesis in porcine follicles after weaning are associated with unique patterns of gene expression for individual components of the ovarian insulin-like growth factor (IGF) system. J. Liu*, A. T. Koenigsfeld, T. C. Cantley, and M. C. Lucy, *University of Missouri, Columbia, MO.*

Follicular growth and steroidogenesis are controlled by the interaction of IGF and gonadotropins. The objective was to measure mRNA for steroidogenic enzymes, gonadotropin receptors, and IGF systems in

porcine follicles during preovulatory follicular development after weaning. Follicles were collected at 2-3 mm (n = 5 sows), 4-5 mm (n = 4 sows), 6-7 mm (n = 4 sows), and 8 mm (n = 5 sows). Messenger RNA for LH receptor (LHR), FSH receptor (FSHR), cytochrome P450 17a-hydroxylase (P450$_{17a}$), aomatase (P450$_{arom}$), growth hormone receptor (GHR), IGF-I system genes (IGF-I and type I IGF receptor), IGF-II system genes (IGF-II and type II IGF receptor), and IGF binding protein (BP)-2 were measured by in situ hybridization and quantified by image analysis. The LHR mRNA (theca and granulosa) and steroidogenic enzyme mRNA (P450$_{17a}$ and P450$_{arom}$) increased as follicles grew from 2-3 mm to 6-7 mm but then decreased abruptly at 8 mm (P < .01). The FSHR mRNA (granulosa) underwent a rapid decline as follicles grew (P < .01) and was undetectable in follicles greater than 4-5 mm. The expression of IGF-I system genes (IGF-I in granulosa and stroma and type I IGF receptor in granulosa) or GHR (granulosa) failed to change as follicles grew (P > .10). The IGF-II mRNA (theca cells) increased (P < .01) from 2-3 mm (4.2 ± 1.8) to 6-7 mm (15.5 ± 2.0) and then decreased in 8 mm follicles (11.4 ± 1.8). The type II IGF receptor mRNA (granulosa), however, increased six-fold from 6-7 mm (5.5 ± 5.7) to 8 mm (33.4 ± 5.1). The IGFBP-2 mRNA (granulosa and theca) decreased (P < .001) as follicles grew. In summary, steroidogenic enzyme mRNA and LHR mRNA were coordinated during follicular growth. This suggests that LHR is required for steroidogenesis. The IGF-I system mRNA was constitutive whereas the IGF-II system mRNA underwent developmental regulation in preovulatory porcine follicles collected from weaned sows.

Key Words: Sow, Ovary, IGF

474   The effect of a GnRH agonist on plasma levels of steroid hormones in neonatal intact male pigs and its relation to the compounds associated with boar taint. P Sinclair*[1], J Raeside[1], J Britt[2], V Hedgepeth[2], and J Squires[1], [1]University of Guelph, Guelph, Ontario, Canada, [2]University of Tennessee, Knoxville, Tennessee, USA.

Two studies examined the effects of a GnRH agonist (Leuprolide[TM]) in depot or chronic injection administration, on plasma concentrations of steroid hormones, 16-androstene steroids and skatole in fat, as well as testicular development of intact neonatal male pigs. The depot study involved 60 neonatal male pigs assigned to 1 of 4 treatments: intact males, Leuprolide treated (100ug/kg or 200ug/kg), and castrates. The injection study involved 20 neonatal male pigs assigned to two different treatment groups: daily 200ul injection of Leuprolide (0.5mg/ml), and intact controls injected with saline. Blood samples were taken weekly during the first 4 weeks and then monthly up to 6 months of age for quantification of testosterone in both studies as well as androstenone and DHEAS in the injection study. Backfat and salivary glands were collected post slaughter on day 164 for quantification of skatole and 16-androstene steroids. Plasma steroid hormone concentrations significantly decreased (P<.0001) to castrate levels within 7 days of Leuprolide treatment. Following cessation of treatment, steroid levels returned to control levels and remained constant until the final rise at 5 months. By 164 days, testosterone levels of the 100ug/kg depot treatment group were significantly higher than that of the control and 200ug/kg group. This trend was not observed in the injection study where there were no treatment differences in steroid hormone profiles at 164 days. There were no differences (P>.05) in concentrations of 16-androstene steroids in fat between any of the treatment groups within the two studies. Skatole concentrations in the 100ug/g and 200ug/kg depot treatment groups were significantly lower (P<.05) than that found in the intact control, however these differences were not observed in the injection study. Testicular development showed a significant suppression during Leuprolide treatment, however by day 164 testicular size and weight were at control levels. The results of these studies indicate that administration of Leuprolide in either a depot formulation or multiple injection significantly decreases testicular development and steroidogenesis in neonatal male pigs, but this did not affect growth performance or steroid hormone levels at 6 months of age.

Key Words: GnRH Agonist, Boar Taint, Androstenone

475   Relationship between maternal protein loss and ovarian function in lactating first-litter sows. E. J. Clowes*, G. R. Foxcroft, V. E. Baracos, and F. X. Aherne, *University of Alberta, Edmonton, Canada.*

First-litter Camborough sows were fed to lose three levels of protein during lactation to test whether ovarian function declines upon mobilization of a threshold level of body protein. Twenty-five sows were randomly allocated to be fed an isocaloric diet (62 ± 2.6 MJ DE/d) containing either high (HP; 868 g CP/d & 50 g lys/d; n = 8), moderate (MP; 650 g CP/d & 35 g lys/d; n = 7), or low (LP; 519 g CP/d & 26 g lys/d; n = 10) levels of protein and lysine. Sow weight and backfat depth were measured every 5 d, and feed intake daily during lactation. Sows were slaughtered on d 23 of lactation, and the reproductive tract was recovered. The number and diameter of all follicles > 2 mm were recorded and follicular fluid (FF) from the largest 16 follicles was collected and weighed. Standardized batches of oocytes were matured in vitro in culture media containing 10% pooled FF from each sow. There was no difference (P = .20) in backfat loss (-1.3 ± .29mm) among treatments, however LP sows lost more weight (P = .002) than MP and HP sows suggesting that LP sows lost more body protein. LP sows had fewer (P < .05) 4 to 6 mm ovarian follicles, less FF/follicle, and lower FF IGF-1 levels compared to MP and HP sows. Nuclear maturation was less advanced in oocytes cultured in FF from LP sows as evidenced by a higher proportion (P < .05) of oocytes arresting at the Metaphase I (MI) stage of development. In conclusion, the sharp decline in ovarian function seen between LP sows and MP and HP sows suggests that mobilization of greater than a threshold level of body protein during lactation has an adverse affect on ovarian follicle maturation at weaning.

	Treatment				
	HP	MP	LP	√EMS	P
Weight loss, kg	-12.7[a]	-17.0[a]	-28.2[b]	6.8	.002
Ovarian Parameters					
No. 2 to 4 mm follicles	45.6	39.8	25.9	23.5	.363
No. 4 to 6 mm follicles	24.7[b]	23.7[b]	7.6[a]	10.7	.023
FF/follicle, µg	58.1[b]	53.8[b]	27.7[a]	16.0	.014
FF IGF-1, ng/ml	94.1[b]	94.4[b]	72.8[a]	14.0	.041
Nuclear Maturation					
M II, %	52.9	39.4	37.5	29.6	.628
M I, %	7.6[a]	13.6[ab]	25.4[b]	10.8	.044
GV Breakdown, %	23.8	39.4	21.9	26.6	.477
Germinal Vesicle (GV), %	15.7	7.5	15.2	10.8	.366

Key Words: Sow, Lactation, Ovary

476   Effect of source of Romosinuano germplasm and preweaning creep grazing on postweaning growth and puberty in bulls. C. C. Chase, Jr.*[1], R. E. Larsen[2], M. J. Williams[1], A. C. Hammond[1], and T. A. Olson[2], [1]USDA, ARS, Brooksville, FL, [2]University of Florida, Gainesville.

Postweaning growth and sexual development were determined for Romosinuano bulls from germplasm collected in Costa Rica (CR; n = 13) and Venezuela (VE; n = 31) that, prior to weaning (98 d), were either allowed to creep graze rhizoma perennial peanut (*Arachis glabrata*; RPP; n = 23) or no creep grazing (n = 21). Postweaning, bulls were managed as a single group on mixed bahiagrass (*Paspalum notatum*) and RPP pastures (and hay) and fed 4.5 kg/d concentrate. Growth measurements were collected at the start of the study and at 28-d intervals for 357 d. Simultaneously, semen collection was attempted by electroejaculation when the scrotal circumference (SC) of a bull was ≥ 23 cm. Traits were evaluated when first sperm was detected in an ejaculate (FS), when 50 million sperm with at least 10% motility were detected (PU), and when 500 million sperm with at least 50% motility were detected (PP). At the start of the study, Romosinuano bulls from CR were older (243 vs 211 d; P < .01), heavier (250±10.2 vs 205±6.2 kg; P < .001), taller (P < .01), and had larger SC (21.6±.65 vs 18.2±.42 cm; P < .001) than bulls from VE. At the end of the study, Romosinuano bulls from CR were heavier (512±14.0 vs 452±8.9 kg; P < .001) and had larger SC (33.5±.59 vs 31.3±.38 cm; P < .01) than bulls from VE, but hip height did not differ. There was no effect of preweaning treatment on postweaning growth. Analysis of the difference between final and initial growth measurements revealed that Romosinuano bulls from CR and VE had similar gains in BW and growth in hip height with a tendency (P < .10) for larger growth in SC of bulls from VE than CR. At FS, age,

BW, hip height and SC were similar between bulls from CR and VE. At PU, bulls from CR and VE did not differ in age (381 ± 11.6 vs 361 ± 7.5 d) and hip height, but bulls from CR were heavier (348 ± 13.9 vs 312 ± 9.0 kg; $P < .05$) and had larger ($P < .05$) SC ($28.4\pm.63$ vs $26.6\pm.41$ cm) than bulls from VE. By PP, bulls from CR were 53 d older ($P < .01$), 69 kg heavier ($P < .01$), tended ($P < .10$) to be taller (3.2 cm) and had 2.6 cm larger ($P < .01$) SC than bulls from VE. In conclusion, postweaning growth performance was similar between Romosinuano bulls from CR and VE, and was not influenced by preweaning creep grazing. However, Romosinuano bulls from VE may reach sexual maturity sooner and at a smaller body size and SC.

Key Words: Bulls, Tropics, Puberty

477   Effect of mifepristone (M) and/or $PGF_{2\alpha}$ on 90 day ovariectomized (OVX) pregnant ewes. C. Weems*, Y. Weems, P. Bridges, B. LeaMaster, and D. Vincent, *University of Hawaii, Honolulu, Hawaii*.

Trilostane, a 3-OH-steroid dehydrogenase inhibitor, decreases progesterone (P_4), increases estradiol-17 (E_2), increases $PGF_{2\alpha}$ and aborts 90 day OVX pregnant ewes but does not affect prostaglandin E (PGE) secretion (C. Weems etal. Biol. Reprod. 58 (Suppl.1): 123, 1998). Ninety day OVX pregnant ewes were treated with M, a P_4 receptor antagonist, PGF_2 or both M and $PGF_{2\alpha}$ to determine the effect on pregnancy and placental secretion of P_4, E_2, $PGF_{2\alpha}$ and PGE. Ewes were treated with vehicle (V), $PGF_{2\alpha}$ (8 mg/58 KG/BW) M (50 mg), M (100 mg), M (50 mg) + PGF_2 or M (100 mg) + $PGF_{2\alpha}$. Mifepristone was given intrajugular at 72, 84, 96 and 102 hr and $PGF_{2\alpha}$ was given IM at 84 hr post OVX. Jugular vein plasma was collected at 0, 24, 48, 78 hr; every 6 hr from 72-102 hr; every 20 min from 107-110 hr; 114 hr and every 6 hr from 114-168 hr for analysis for P_4 and E_2 by RIA. Inferior vena cava plasma was collected via a catheter 5 cm anterior to the juncture of the ovarian vein and vena cava for analysis for $PGF_{2\alpha}$ and PGE by RIA at the same times for jugular vein plasma collection. Uterine venous plasma was collected at 0 and 168 hr for analysis for P_4, E_2, $PGF_{2\alpha}$ and PGE by RIA. Data for pregnancy status were transformed and analyzed by a factorial ANOVA; data for P_4, E_2, $PGF_{2\alpha}$ and PGE in uterine venous plasma were analyzed by a factorial ANOVA, and profiles of P_4, E_2, $PGF_{2\alpha}$ and PGE in jugular or vena cava plasma were analyzed by a split plot design for ANOVA for repeated measures. Abortion by treatment was: V (0/5), $PGF_{2\alpha}$ (0/5), M-50 mg (3/5), M-100 mg (3/5), M-50 mg + $PGF_{2\alpha}$ (4/5) and M-100 mg + $PGF_{2\alpha}$ (5/5) ($P<0.05$). $PGF_{2\alpha}$ in uterine venous plasma was increased ($P<0.05$) at 168 hr but not P_4, E_2 or PGE ($P>0.05$). Profiles of $PGF_{2\alpha}$ in M-treated ewes were increased ($P<0.05$) but not profiles of P_4, E_2 or PGE ($P>0.05$). It is concluded that M induces abortion by increasing endogenous secretion of $PGF_{2\alpha}$.

Key Words: Pregnant, Sheep, Mifepristone

PRODUCTION AND MANAGEMENT

478   Performance measures and pulmonary lesions at slaughter in feedlot cattle. E. M. Whitley*[1], F. T. McCollum, III[1], D. L. Montgomery[1], R. W. Sprowls[1], and G. J. Vogel[2], [1]*Texas A&M University System,* [2]*Elanco Animal Health*.

At slaughter lungs were collected from 371 steers in the Texas A&M Ranch to Rail program to evaluate the relationship between pulmonary lesions, medical history, feedlot performance and carcass traits. Lungs were examined by a veterinary pathologist and assigned a score based upon lesion type and severity, and the amount of total lung capacity involved. For purposes of analysis, steers were assigned to one of six categories based upon severity of the lung score (0=no lesions, 6=most severe). Thirty-one percent of the steers (n=32) with no lung lesions had been pulled and treated at least once during the finishing period. Of the steers with mild lesions (categories 1and 2; n=170) and moderate lesions (categories 3 and 4; n=121) 35.9 and 51.2% had been pulled and treated, respectively. Twenty-four percent of the steers (n=48) with the most severe lesions (categories 5 and 6) had never been pulled and treated. Performance data were analyzed using general linear models. The model included lung category and when appropriate ($P< .05$) initial weight as a covariate. Days on feed was fewer (182; $P<.05$) for steers in lung category 2. Days on feed was greatest for lung category 5 (199) but not different than ($P>.05$) categories 1, 4, and 6 (mean = 193.5). Pulls were not different for categories 0, 1, 2, 3 and 5 ($P>.05$; mean=.61/hd), while category 6 had the highest frequency of pulls (1.67/hd; $P<.05$). Medical cost tended to reflect pulls with category 6 having the highest cost ($40.35/hd; $P<.05$). Days treated was highest for categories 4 and 6 ($P<.05$; 3.1 and 3.9 days/hd, respectively). Daily weight gain was highest for steers in lung categories 0, 2, and 3 (mean= 1.37 kg; $P<.05$) and least for steers in categories 1, 4, 5 and 6 (mean = 1.29 kg; $P<.05$). Calculated yield grade did not differ among lung score categories (mean= 2.6; $P>.05$). Marbling score decreased as the severity of lung lesions increased. Lung lesions at slaughter were associated with performance and carcass measurements.

Key Words: Pulomonary Lesions, Feedlot Cattle

479   Delayed implant strategies using Synovex Plus for finishing yearling steers. C. T. Milton*[1], R. J. Cooper[1], and F. L. Prouty[2], [1]*University of Nebraska, Lincoln, NE,* [2]*Fort Dodge Animal Health, Overland Park, KS*.

Two hundred twenty-five crossbred steers (avg. BW 301 kg) were allotted to five weight blocks and stratified to one of five implant strategies in a 152-d finishing trial to evaluate a single initial versus two delayed, single implant strategies and two reimplant strategies on performance and carcass traits. Implant strategies were Synovex® Plus™ d 1 (SP1), 35 (SP35), or 70 (SP70), or Ralgro® d 1 followed by Synovex Plus d 70 (RSP), or Synovex® S d 1 and 70 (SS). The finishing diet contained 64.5% corn (70% high-moisture:30% dry-rolled), 20% wet corn gluten feed, 7.5% alfalfa hay, 3% fat, and 5% supplement, and was formulated to contain 13% CP, .7% Ca, .4% P, .7% K, 27 g/t Rumensin®, and 10 g/t Tylan® (DM basis). Treatment means were separated using t-tests with a protected F-test. Contrasts were used to test linear and quadratic effects of delaying Synovex Plus and SS vs other strategies. Steers implanted with SP70 had a lower ($P < .10$) DMI than other implant strategies (10.5 vs 11.0 kg/d). Daily gain (kg) of steers implanted with SP35 (1.85) was higher ($P < .10$) than steers implanted with SP70 (1.73) and SS (1.75), but similar to those implanted with SP1 (1.80) and RSP (1.80). Gain/feed was similar among Synovex Plus implant strategies, but improved 3.7% ($P = .01$, .165 vs .159) compared with SS. Yield grade ($P = .03$), 12th rib fat ($P = .05$), and maturity score ($P = .01$) were decreased linearly by delaying Synovex Plus. Steers implanted with SS had a smaller ($P < .01$) ribeye area and higher yield grade ($P = .02$) and marbling score ($P = .10$) than other strategies. Dressing percent and percentage of Choice carcasses were unaffected. However, SP70 reduced the percentage of Choice carcasses by 10 percentage units compared with SP1, SP35, and RSP. Performance and carcass traits were similar for a single implant of Synovex Plus on d 1 or 35 or a reimplant program using Ralgro and Synovex Plus for steers fed 150 d. Delaying a single implant of Synovex Plus until d 70 appears to reduce ADG, but maintains feed efficiency.

Key Words: Implants, Feedlot, Steers

480   Explanting to determine the response-life of a combination implant. B. A. Gardner*[1], H. G. Dolezal[1], F. N. Owens[1], and B. Freking[2], [1]*Oklahoma State University,* [2]*Kerr Center for Sustainable Agriculture*.

To evaluate the response-life of a combination (120 mg TBA + 24 mg estradiol 17b; REV) anabolic implant, Angus x Senepol yearling steers (n=100, 333 kg), that had received no prior implants, were assigned to one of five implant regimes during a 140-d feeding trial. Treatments consisted of 1) no implant during the finishing period; 2) a single implant of REV on day zero; 3) as 2 but removal of that implant on day 56 and replacement with a second REV; 4) as 3 but replacement on day 84, 5) as 3 but replacement on day 112. Steers had ad libitum access to a corn based concentrate diet (2.12 Mcal/kg NEm and 1.36 Mcal/kg NEg). Steers were weighed at 28-d intervals to determine whether implant replacement improved performance. Throughout the trial, implanted steers, regardless of implant regime, had greater ($P<.05$) daily gains (1.52 vs 1.05 kg/d), consumed more DM (9.01 vs 7.56 kg/d), and converted DM to live weight more efficiently than non-implanted cattle (.16 vs .13 gain/feed). Subsequently, implanted steers yielded heavier

(P<.01) carcasses (334 vs 294 kg) that had more advanced (P<.01) skeletal maturity scores (A^{48} vs A^{20}) and larger (P<.01) longissimus muscle areas (LMA) but not when expressed per unit carcass weight (P=.67). No differences (P>.10) in marbling score (377 vs 396), percentage U.S. Choice (28.4 vs 41.7%), or YG (3.3 vs 3.4) were detected among implanted vs non-implanted treatments. No differences (P>.10) in performance or carcass characteristics were detected among single vs any of the multiple implant regimes. A single implant administered at the beginning of the finishing period enhanced gain, gain:feed, carcass weight, and skeletal maturity without negatively affecting quantitative carcass traits or marbling score. Because replacement of implants at up to 112 days on feed did not improve performance, implant lifespan must have exceeded 112 days. Performance responses often seen with re-implanting may be due to hormone stacking, not to exhaustion of previous implants.

Key Words: Beef, Implant, Performance

481 A comparison of feedlot bunk management strategies and their influence on cattle performance. R. J. Lawrence*, .

To determine the effect of bunk management strategies on performance in a commercial feedlot during the Australian summer, 6000 Hereford and Hereford cross two year old steers, average initial weight 430 kg and fed for an average of 162 days were selected and randomly allocated to four bunk management treatments. The four treatments, each replicated six times, consisted of (1) ad libitum feeding with four deliveries daily, (0800, 1000, 1400 and 1730), (2) ad libitum feeding with one delivery am (0730), (3) clean bunk at midday with one delivery pm (1530) and (4) clean bunk at midday with two deliveries daily, (0530 and 1600) divided into proportions of 30% am and 70% pm. The bunks of the ad lib treatments were assessed in the morning and the clean bunk treatments assessed at midday. All steers were fed a concentrate diet based on 74% steam flaked barley. The frequency with which feed bunks required cleaning, feed wastage and feeding cost were all significantly greater (P<0.05) for the ad lib treatments than the clean bunk treatments. Frequency of cleaning for the trial period were 32.0, 31.0, 2.0 and 1.0 ; feed wastage in tonnes dry matter were 7.5, 7.3, 0.2 and 0.2 and feeding costs (A$/hd/d) were $2.12, $2.17, $2.06 and $2.03 for treatments 1, 2, 3 and 4 respectively. Animal performance was not significantly different between bunk management strategies. A clean bunk at midday management strategy encouraged animals to clean the bunk of feed by midday and was designed to provide delivery of feed in proportions which meet animals natural feeding activity pattern, ie. initiation of feeding corresponded closely with sunrise and sunset with minimal feeding activity during the midday period. Bunk management incorporating a clean bunk at midday has the potential to reduce feeding cost and maintain animal performance compared to ad lib feeding, particularly during the summer period when these aspects can be compromised due to environmental stress.

Key Words: Cattle, Feedlot, Bunk management

482 Validation of a radio frequency identification system used to monitor patterns of feeding by feedlot cattle. K. S. SchwartzkopfGenswein*[1], C. Huisma[2], and T. A. McAllister[3], [1]*Alberta Agriculture, Food and Rural Development, Lethbridge, AB,* [2]*GrowSafe Systems Ltd., Airdrie, AB,* [3]*Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB.*

Feed bunk attendance data collected using radio frequency (RF) technology (GrowSafe Systems Ltd.) were compared against videotape surveillance data and across multiple transponders borne by individual animals, to assess the validity of the RF methodology. Feed bunk attendance by six heifers (481±22 kg) and six steers (471±44 kg) fed 80% steam-rolled barley grain, 15% barley silage and 5% supplement was monitored for 52 d by RF and by videotape. In addition, the relationship between bunk attendance and actual feeding time was analyzed. Total daily error of the RF system over 24 h (including time present and time absent) was 6%, compared to videotaped data. Incidence of errors due to RF interference and false antennae readings were 2.4 and 3.6%, respectively. The RF system was concluded to be highly effective for documenting bunk attendance. Feeding durations recorded by duplicate transponders borne by individuals were highly correlated, averaging 88.4±1.5 and 84.5±1.5 min d 1 ($R^2 = 0.96$). Frequency of bunk visits was also highly correlated ($R^2 = 0.96$). Attendance at the bunk comprised 84% eating time and 16% non-feeding activity. Visits per day averaged 29±11.8, with 55.8% associated with feeding activity and 44.2% with non-feeding activity. Thus, duration of attendance at the bunk may be a better indicator of an animal's feed intake than frequency of attendance. Future studies with GrowSafe or other RF systems that do not record feed intake simultaneously with detecting attendance should incorporate a correction factor to relate attendance to feeding time. This study identified factors, such as non-grounded, metal material (connected in a loop configuration) that could introduce error into the GrowSafe system, particularly when associated with the feed bunk area. Consideration of these factors may impact decisions taken during installation of the system in other facilities.

Key Words: Feeding behaviour, Radio frequency, Feedlot cattle

483 The effect of value-added calf programs on morbidity rates and feedlot performance through the reimplant period. J. G. Gentry*[1], N. C. Speer[2], G. F. Jones[2], C. D. Smith[3], and J. C. Whittier[3], [1]*Texas Tech University, Lubbock, TX,* [2]*Western Kentucky University, Bowling Green, KY,* [3]*Colorado State University, Ft. Collins, CO.*

Feeder cattle from three separate value-added calf (VAC) programs were evaluated for feedlot performance from arrival through the reimplant period. Two loads originated from programs sponsored by the Kentucky Cattlemanıs Association including Certified: Preconditioned for Health (CPH) (n=95, 253 kg), KCA Gold Tag (GT) (n=90, 256 kg); requirements are similar to VAC45 and VAC34 programs, respectively. A third load included cattle purchased from local sale barns (SB) with no known history (n=88, 250 kg). Cattle were fed in adjacent pens in a commercial feedlot and were weighed, implanted and enrolled in the Rocky Mountain Ranch-to-Rail program following a three week warm-up period. Morbidity rates were 31.6%, 36.7% and 78.4% while medical costs (P<.05) were $8.78, $9.30 and $10.27 per head for CPH, GT and SB, respectively. Mortality rates were 0%, 1.1% and 10.2%, respectively. Reimplant weight (RW) corresponded to VAC program hierarchy (P<.05) being 386, 367 and 350 kg, respectively. VAC program did not affect average daily gain (ADG) (P>.10) during the first implant period indicating that differences in RW were largely affected by initial adaptation and gain during the warm-up period. Steers were categorized by VAC program and number of hospital visits (HOSP: zero (H0), one (H1) and two or more (H2+); RW and ADG trends differed among these categories. RW and ADG was higher for SB and GT with H1 versus H0 or H2+. When considering CPH cattle, RW and ADG decreased with increasing HOSP, as such, H0 had the highest RW and ADG. These trends suggest that subclinical illness is increasingly detrimental with non-preconditioned cattle. Results indicate that VAC programs reduce morbidity and mortality rates while simultaneously improving performance. However, important differences exist among VAC programs with respect to morbidity rates, response to antibiotic therapy and subsequent performance.

Key Words: Cattle, Morbidity, VAC Programs

484 Performance of steer calves fed normal or high oil corn harvested as grain or whole plant silage. K. S. Hendrix* and D. L. Lofgren, *Purdue University, West Lafayette, IN.*

The objective was to evaluate performance of steers fed two corn types (Normal (N) vs High Oil (HO)) with two feeding regimes (High Grain (HG) vs High Silage (HS)). On a 15% moisture basis, HO corn contained 8.2% oil compared to 3.9% oil for N corn. Thirty days postweaning, 84 Angus or Simmental sired calves (304 kg) were randomly allotted by weight and breed type into 12 pens of 7 hd. The HG diet consisted of 75% corn, 15% corn silage and 10% supplement. The HS diet consisted of 90% corn silage and 10% supplement. The grain or silage in each diet was either HO or N. After 90 days, cattle on the HS diet were gradually converted to the HG diet. Diets were fed until it was estimated by visual appraisal that a minimum of 75% of cattle would grade low-choice or higher. Cattle on the HG diet were fed an average of 182 d vs 206 d for HS cattle. Live weights at 90 days and at harvest were shrunk 4% for computation of gain, feed/gain and carcass dressing percent. There was no significant (P>.10) effect of corn type and no significant (P>.10) interaction between feeding regime and corn type for parameters measured. Daily gain (kg) for days 1-90 and 1-harvest were significantly affected (P<.01) by feeding regime (1.31 vs 1.06 and 1.39 vs 1.30 respectively for HG and HS cattle). Feed/gain was significantly affected

by feeding regime for days 1-90 (6.93 vs 7.95 for HG and HS cattle, P<.05) and days 1-harvest (7.12 vs 7.81 for HG and HS cattle, P<.10). Cattle fed HS for 90 days had heavier carcasses (373 vs 362 kg, P<.05) and less backfat (.21 vs .26 cm, P<.05) compared to cattle fed HG. Dressing percentage, rib eye area, yield grade, and marbling were not significantly influenced by feeding regime. Feeding regime (high silage for 90 days vs high grain feeding throughout the feeding period) had a greater influence on feedlot performance than did oil level of corn grain. There was a trend for cattle fed HO corn to have slightly more rapid and efficient gains than cattle fed N corn, but performance differences were not significant in this study.

Key Words: High Oil Corn, Corn Silage, Beef

485   Effect of corn harvest technique on harvest yield and costs, beef yield, feeding costs and price received for corn when fed to beef steers. T. M. Vanzant* and K. S. Hendrix, *Purdue University, West Lafayette, IN.*

Corn acreage was harvested as four different corn products: 1) Whole-plant corn silage (CSP), 2) High-moisture snapped corn (SCP), 3) High-moisture ground ear corn (GECP) and 4) High-moisture shelled corn (HMCP). Dry matter yield as a percent of corn grain yield was 204, 119, 104.5 and 100 percent for CSP, SCP, GECP and HMCP, respectively. Harvest cost (labor and fuel) per dry ton was highest for the CSP followed by the GECP, SCP and least for the HMCP in both experiments. Harvested products were ensiled and fed to weanling, medium-framed, crossbred steers with 96 head in Experiment 1 and 128 head in Experiment 2. In both experiments, steers were blocked by weight and randomly allotted to 1 of 4 treatments in a complete randomized block design. The treatments were: 1) corn silage grower diet followed by high-moisture corn finisher diet (CS/HMC), 2) snapped corn diet (SC), 3) ground ear corn diet (GEC) and 4) high-moisture corn diet (HMC). Cattle were fed to a common end-point of visually estimated 75% choice. Days on feed were 207, 198, 188 and 179 days for cattle fed the CS/HMC, GEC, SC, and HMC diets, respectively. Feeding costs (supplement and non-feed costs) were highest for the cattle fed the CS/HMC diet followed by GEC, SC and lowest for HMC fed cattle. Beef gain was 16.4%, 14.1%, and 9.9% higher for corn harvested and fed as the CS/HMC diet vs. the HMC, SC and GEC diets, respectively. Using 10-year average USDA feeder calf and carcass prices, price received on a dry shelled corn equivalent basis (DSCE) basis was similar (P>.05) for corn acreage harvested and fed as HMC, CS/HMC and GEC at $84.66, $92.14, and $95.29 per metric ton, respectively and significantly lower (P<.05) for corn acreage fed as SC at $71.27 per metric ton. These results are particularly applicable to Midwest farmer-feeders in evaluating the potential value added to the corn crop by feeding to beef cattle.

Key Words: Cattle, Harvest Methods, Economics

486   Evaluation of cattle breeds for an IgG assay specific to venom of the red imported fire ant (*Solenopsis invicta* Buren). J. E. Powell*[1], A. D. Herring[1], G. P. Austin[1], L. J. Gershwin[2], S. P. Jackson[1], and J. O. Sanders[3], [1]*Texas Tech University, Lubbock,* [2]*University of California, Davis,* [3]*Texas Agricultural Experiment Station, College Station.*

The objective of this study was to evaluate possible differences across genetic types of cattle in regard to immune response related to the red imported fire ant (RIFA). A bovine IgG ELISA specific to fire ant venom was developed to assess immune response. Blood serum was collected from cows of five genetic types (n=150) at one location at calf weaning in 1998. Cows were Angus (A), Hereford (H), Brahman-British F1 (BRF1), Boran-British F1 (BOF1) and Tuli-British F1 (TUF1). On each ELISA plate, fetal bovine serum was run as a negative control (NEG) and an aggregate of bovine sera from several different crossbred cows exposed to RIFA was run as a positive control (POS). On each plate, optical density (OD) was recorded for each cow along with that of the NEG and POS. Two corrections were calculated to account for variation between plates, one relative to NEG and one relative to POS. Each cow IgG OD value was multiplied by the ratio of the overall POS to the POS of that plate and analyzed (IGGP). Also, each animal IgG OD was deviated from the NEG for its plate and analyzed (IGGN). IGGP and IGGN were analyzed by analysis of covariance with breed and the regression on cow age (in years) as independent variables. Breed differences were seen for IGGP (P < .01) and IGGN (P < .001). Regression on cow age was significant for IGGP and IGGN with increasing OD values as age increased. Across

all cows, the simple correlation between IGGN and cow age was .33 (P < .001). Correlations of cow IGGP and IGGN with calf weaning weight (WWT) and adjusted weaning weight (ADJWWT) were not significant in A, H, and BRF1 cows, but had negative signs. Correlations of cow IGGP and IGGN with WWT and ADJWWT were positive in BOF1 and TUF1 cows, but only significant in TUF1 cows. These results indicate possible genetic differences among cattle for RIFA immune response.

Key Words: Red Imported Fire Ant, Immune Response, Cattle

487   Recruitment of the red imported fire ant (*Solenopsis invicta* Buren) by different livestock feeds. G. P. Austin*, A. D. Herring, J. E. Powell, S. P. Jackson, and H. G. Thorvilson, *Texas Tech University, Lubbock.*

The objective of this study was to evaluate recruitment of red imported fire ants (RIFA) to various livestock feeds. Recruitment was investigated in three areas of Texas with one site in Taylor, Smith and McLennan counties. Feeds evaluated were extruded whole cottonseed (EWC), cottonseed meal, a horse and mule ration, a cow range cube, a calf creep ration and a commercial cat food (CAT) previously used by researchers for RIFA recruitment. One-g samples of each feed were placed into plastic bait cups. At each location bait cups were placed in a 6 x 6 latin square arrangement with two cups of each feed placed on their sides. Bait cups were recovered after 15 and 30 minutes. After all cups were collected, each site was evaluated for ant mound density and activity. To approximate a normal distribution, the log of ant count per cup was the dependent variable. Data were analyzed through analyses of variance where feed, pasture, feed x pasture, row within pasture and column within pasture were independent variables. Row within pasture was used as the error term to test pasture differences. Differences were observed for feed (P < .001), pasture (P < .001) and feed x pasture (P < .05) for ant count after 15 (AC15) and 30 minutes (AC30). CAT had the highest AC15 per cup in five of seven pastures (20.3 to 74.5), and EWC had highest AC15 in the other two (24.2 to 67.7). EWC had the highest AC30 in six of seven pastures (69.3 to 236.2), and CAT had the highest count in one pasture (17.5). Across all pastures, CAT and EWC had similar AC15 (36.6 and 35.7, respectively) with others ranging from 3.2 to 9.5 ants per cup. For AC30, EWC averaged 114.0, CAT averaged 56.2 and the rest ranged from 1.7 to 15.8. All pastures had higher ant counts at 30 minutes versus 15 minutes except one. AC15 per pasture ranged from 6.0 to 32.2, whereas AC30 per pasture ranged from 3.8 to 57.5. Density of RIFA mounds across pastures ranged from 64 to 197 per ha, but did not match exactly with AC15 or AC30.

Key Words: Red Imported Fire Ant, Recruitment, Livestock Feed

488   Evaluation of genotype, therapeutic antibiotic and health management effects on swine carcass characteristics and pork quality. D. C. Kendall*[1], B. T. Richert[1], J. W. Frank[1], B. A. Belstra[1], S. A. Decamp[1], A. P. Schinckel[1], and M. Ellis[2], [1]*Purdue University, West Lafayette, IN,* [2]*University of Illinois, Urbana, IL.*

Two hundred eighty eight pigs from two genetic populations differing in percent lean and ancestry were used to evaluate carcass characteristics and pork quality under two rearing environments and two vaccination/antibiotic treatments. Yorkshire-Landrace sows were bred to U.S. Duroc sires selected for high liveweight gain/day EPDs (YL/Dur). European Landrace-Large White/Duroc sows were mated to European Duroc-Hampshire sires (EUR). Four pigs per litter were cross-fostered within genotype and early-weaned into an isolated three site environment (SEW) or conventionally weaned in a continuous flow environment (CON). All pigs received medication up to 51d of age. Half of the pigs were vaccinated (VAC) for mycoplasma hyopneumonia at 30 and 44d of age and fed antibiotics throughout the finishing period (Pulmotil®, Tylan®), or received no vaccination nor medication during finishing (CT). At slaughter, measurements of loin eye area, backfat thickness and visual quality scores were reported for each pig. Loins from 144 pigs were recovered for Hunter Color Lab scoring, driploss and taste panel analysis. The CON environment pigs had less 10th rib backfat (19.8 vs. 21.3 mm; P<.05), and less loin eye area (46.5 vs. 47.7 cm^2; P<.05) but similar percent lean when compared to the SEW pigs. YL/Dur pigs had higher 24-hour pH (5.58 vs. 5.48; P<.01), lower percent driploss (1.9% vs. 3.6%; P<.01) and .32% increase in intramuscular fat (IMF; 2.08 vs. 1.76) content than the EUR pigs (P<.01). The SEW environment had lower 24-hour pH readings (5.47 vs. 5.60; P<.01) and showed

a .33% increase in IMF over the CON pigs. Taste panel evaluation showed an increase in tenderness (P<.05) and juciness (P<.001) scores for the EUR genotype. The EUR pigs required less shear force (5.25 vs. 5.66; P<.01), but did have higher percent cooking loss (32% vs. 29%; P<.001). Tenderness and juciness scores had a genetic by environment interaction with the EUR pigs improving eating quality in the SEW environment and the YL/Dur pigs decreasing (P<.01). This study illustrates the current similarity between the two genotypes and the influence environment and management has on carcass characteristics and pork quality.

Key Words: Pigs, Carcass, Genotype

489   Feed withdrawal 24 h prior to slaughter improves measures of pork muscle quality. M. T. See*, W. E. M. Morrow, J. H. Eisemann, P. Davies, and K. Zering, *North Carolina State University, Raleigh, NC.*

National Pig Development barrows (n = 1,133) from an off-site Salmonella positive nursery were weighed, individually identified and assigned, by weight, to 36 pens. Each pen of 29 to 32 pigs had pigs of similar minimum and maximum weight and similar variation among pens. Maximum variation within a pen, rather than minimum, allowed progressive selection of the heaviest one-third of pigs for slaughter from each pen simulating the slaughter close-out of a barn of pigs where the heaviest third in the barn are sequentially taken to slaughter. Treatments were allocated in a 3 by 3 factorial arrangement of 0, 12, or 24 hours feed withdrawal either once, twice, or three times, prior to shipment, were allocated at random, blocked on pen prevalence of Salmonella spp. as determined from fecal sampling in May and June. At slaughter carcasses (n = 633) were evaluated for muscle quality, gastrointestinal tract weight, gastrointestinal tract lacerations, salmonella, and gastric ulcers. Carcasses were identified by tattoos and evaluated for ultimate pork quality at 24 h post slaughter. Muscle quality measures included ultimate pH (pH$_u$), Japanese Color Score, (JCS), Minolta Color (L*, a* and b*) and water holding capacity (WHC) as evaluated by filter paper absorption of excess fluids determined by weight increase. One chop was collected from each carcass at the tenth rib location. Withdrawal of feed for 0, 12, and 24 h prior to slaughter resulted in linear improvements in pH$_u$ (5.63, 5.65, and 5.66 ± .01; P < .05), JCS (2.99, 3.17, and 3.14 ± .06; P < .1), WHC (894, 915, and 819 ± 30 mg; P < .1), and Minolta L* (53.1, 52.9, and 52.3 ± .2; P < .05). However, repeated feed withdrawal over one, two, and three weeks resulted in linear (P < .01) and quadratic (P < .01) reductions in muscle quality as measured by pH$_u$ (5.70, 5.63, and 5.61 ± .01), WHC (628, 1,094, and 909 ± 31 mg) and Minolta L* (50.5, 54.3, and 53.5 ± .3). These results suggest that on-farm withdrawal of feed for 24 h prior to slaughter enhances ultimate pork quality. However, in a graded marketing situation repeated withdrawal of feed over time can reduce ultimate muscle quality.

Key Words: Pigs, Meat Quality, Feeding

490   Applications of SEW system in Taiwan after FMD outbreak. E.-C. Lin*, H. T. Liu, H. L. Li, H. L. Tsou, P. C. Yang, and H. D. Yen, *Pig Research Institute Taiwan, Chunan, Miaoli, Taiwan, R.O.C.*

Biosecurity issue became very critical after the outbreak of Foot-and-Mouth disease in Taiwan March 1997. A thorough review of segregated early weaning (SEW) procedure was carried out by Pig Research Institute Taiwan. To prevent spread of diseases among the pigs in northern central test station, a SEW system with very strict conditions was set up as entrance procedure in October 1997. The performance results collected from 191 of testing piglets (months starting test from December 1997 to April 1998) were compared with 430 pigs tested before FMD outbreak (months starting test from December 1994 to April 1995). The average daily gain, feed efficiency, backfat thickness, and days to 110 kg in those young boars tested with SEW entrance procedure were 1.050±O0.101 kg, 2.11±O0.21, 1.67±O0.27 cm, and 146.2±O10.1 days, respectively. These performance records were significantly better than those pigs tested before FMD outbreak (0.892±O0.100 kg, 2.29±O0.25, 1.38±O0.14 cm, and 167.1±O12.5 days for average daily gain, feed efficiency, backfat thickness, and days to 110 kg, respectively). The average number of medication in SEW tested pigs was half of that in tested pigs before FMD, especially for respiratory problems. After these encouraging results in central test station, SEW methods with multi-site production system has been suggested to producers. An experiment has been conducted to compare the performance in producers with three traditional farrowing-to-finishing farms and their piglets sent to our Institute using SEW procedure. Till this moment, the results of average weight of 8 week were 14.9 kg for pigs weaned traditionally and 17.0 kg for pigs weaned at 14 to 18 days of age and sent to our Institute. SEW procedure with multi-site production system has been applied successfully in Taiwan under humid and hot weather. The keys to such improvement in production is strict requirements for SEW and better biosecurity in farms involved.

Key Words: Segregated early weaning, Biosecurity, Taiwan

491   Impact of wean-to-finish facility management on weaned pig performance in the nursery phase. M. C. Brumm*[1], A. K. Baysinger[2], E. T. Clemens[1], and R. W. Wills[1], [1]*University of Nebraska, Concord, NE,* [2]*Alpharma, Inc., Ft. Lee, NJ.*

An experiment was conducted to determine the impact of a wean-to-finish housing system on pig performance during the nursery phase. Treatments (four replicates in each of two trials) were 1) wean-to-finish (WF) in 2.4 m x 4.3 m pens (15 pigs/pen), b) double stock (DS) in 2.4 m x 4.3 m pens (30 pigs/pen), and c) nursery (N) at .35 sq m/pig (15 pigs/pen). The WF and DS pens were randomized in a fully slatted, naturally ventilated finishing facility with cement slats. Supplemental heat was provided by means of floor mats and suspended heat lamps in the desired sleeping area of the pen. The N pigs were on 5 ga woven wire flooring in a mechanically ventilated nursery facility with heat provided by unvented propane fired furnaces. The 15 pig pens were provided with two feeder spaces, each measuring 35.6 cm wide, and one cup drinker. The DS pens had four feeder spaces and two drinkers. PIC barrows (4.8 kg initial wt) from a single source weaned at 14-18 days of age were transported to the research site at weaning for the 8-wk trial. Commercially available nursery diets were fed. WF pigs were heavier at 8 wk (27.0 vs 25.5 kg, P<.05), grew faster (.397 vs .370 kg/d, P<.05) and ate more feed (.654 vs .605 kg/d, P<.01) with no difference in feed conversion compared to DS pigs. N pigs were intermediate for live weight, daily gain and daily feed (26.2 kg, .382 kg/d, .633 kg/d respectively). There was no effect of treatment on weight variation at 8 wk as measured by CV of within pen weight for any treatment.

Key Words: Pigs, Weaning, Growing

492   Ten-year (1986-1995) breeding productivity of U.S. commercial swine recorded in PigCHAMP database. J. L. Xue*, *University of Minnesota, St. Paul, MN.*

Ten-year (1986-1995) breeding data recorded in PigCHAMP were used for investigation of herd productivity of U. S. commercial swine. The data included 1,476,631 sow-year (average female inventory) and 4,409 herd-year. An observational unit was a herd. Pearson correlation (CORR) and general linear model (GLM) in SAS were used to determine relationships between production parameters in the 10-year period. Year, pigs weaned per litter (PL), and litters per sow per year (LSY) were included in the model as independent variables for pigs weaned per sow per year (PSY) (a dependent variable). Year, born alive litter size (BA), and preweaning mortality (PWM) were included in the model for PL. Year, farrowing rate (FR), average herd weaning age (WA), and average nonproductive sow days (NPD) were included in the model for LSY. All other variables were continuous. Year was treated as a categorical variable. Correlation coefficients between PSY and PL and between PSY and LSY were .5905 (P < .0001) and .8574 (P < .0001), respectively. Correlation coefficients between PL and BA and between PL and PWM were .6003 (P < .0001) and -.4818 (P < .0001), respectively. Coefficients between LSY and FR, between LSY and WA, and between LSY and NPD were .4520 (P < .0001), -.3545 (P < .0001), and -.5000 (P < .0001), respectively. There was a trend that PSY (mean = 19.2) decreased (P < .05) in the 10-year period though no decreased PL (mean = 8.9), BA (mean = 10.0), and PWM (mean = 13.2%) were observed (P > .05) in the period. There was a trend that LSY (mean = 2.2) was decreased (P < .05) in the 10-year period. Accordingly decreased (P < .05) FR (mean = 79.2%) and AW (mean = 22.5 d) and increased (P < .05) NPD (mean = 86.5 d), percentage of repeated service (mean = 9.3%), and sow mortality (mean = 3.7%) were observed in the 10-year period. Herd size (mean = 345 sows) continued to increase in the 10-year period. This study demonstrated that during the period of 1986-1995

PSY was not increased although there was a significant change in the U. S. swine industry.

493   Feed withdrawal 24 h prior to slaughter does not increase prevalence of ulcers. J. H. Eisemann*[1], W. E. M. Morrow, T. See, P. Davies, and K. Zering, .

The objective was to determine the effect of feed withdrawal on ulceration of the pars esophagea in swine. National Pig Development barrows (n=1133) were weighed and assigned by weight to 36 pens (29-32 pigs/pen of similar maximum and minimum weight) with similar variation among pens. The design was a 3x3 factorial with treatments of 0, 12 and 24 h of feed withdrawal either 1, 2 or 3 times (1x, 2x and 3x, respectively) prior to shipment. Shipments from each pen were about 1 week apart. The third heaviest pigs in each pen, assessed visually, were selected for slaughter on the first week, the next heaviest on the second week and the lightest pigs on the third week. Transport and lairage time were constant for all groups (about 5 h). Gastrointestinal tracts (n=752) were identified before evisceration. The pars esophageal region was scored from 1 (normal) to 7 (completely ulcerated) and evaluated for presence of chronic ulcers and constrictions of the esophagus. The average ulcer scores for 0, 12 and 24 h withdrawal were 3.8, 3.6 and 4.0 (P<.005), respectively; however, there was no difference between stomachs from pigs on 0 vs 12 and 24 h withdrawal. The average scores for 1x, 2x and 3x were 3.6, 3.8 and 4.1 (P<.001), respectively. Overall, prevalence of chronic damage was 17.6% with 59.9% of chronic damage in stomachs from animals on the 3x treatment. Overall, prevalence of esophageal constrictions was 9.6% with 72.2% of esophageal constrictions in stomachs from animals on the 3x treatment. Prevalence of chronic damage and esophageal constrictions was not affected by the length of feed withdrawal. Ulcer scores were grouped as mild (1-3.5), moderate (4-5.5) and severe (6-7). Prevalence of severe ulcers was 13.7%. There was an interaction (P<.01) between the effect of length of feed withdrawal and number of times for carcass weight. Both chronic damage (P<.01) and esophageal constrictions (P<.001) increased as carcass weight decreased, most notably for the lowest quartile. Feed withdrawal prior to slaughter did not increase ulcers.

494   Development of a generalized selection index for profit in Angus sires. W. O. Herring*[1], V. Pierce[1], M. D. MacNeil[2], and L. L. Benyshek[3], [1]University of Missouri, [2]USDA Agricultural Research Service, [3]University of Georgia.

While EPDs have been used for improvement in single traits, strategies are needed to aid producers in multiple-trait selection. Therefore, the objective of this study was to develop a multiple-trait selection index to improve profit for a defined production scenario. Twenty-six Angus sires were randomly mated to commercial Angus females resulting in 675 steer progeny production and carcass records after edits. EPDs were calculated for birth weight, weaning weight, post-weaning average daily gain, marbling score, yield grade and fertility. To estimate relative economic values (REV) for each trait, a bio-economic simulation was performed using the software SIMUMATE 3.0. Cost estimates were derived from enterprise budgets developed over the last ten years from The University of Missouri Extension for a cow/calf operation. Cull cow price estimates were determined from USDA Market News 10 year average from Sioux Falls and FAPRI 10 year forecast for utility cows. Feeder steer price estimates were determined from 10 year average Oklahoma City price estimates and forecasted 10 year averages based on USDA Market News reports. Carcass quality grade, yield grade, and off-grade price estimates were based on National Carcass Premiums and Discounts For Slaughter Steers And Heifers as reported by USDA Market News service. Backgrounding and feeding cost estimates were based on 10 year average Kansas State University Extension Monthly Performance, Cost of Gain, and Breakeven Prices. The REV estimation procedure included simulating a base herd and then comparing outputs to subsequent simulations driving the variable of interest up by one unit and comparing the differences in profit. Sire differences in profit per progeny were then estimated as the product of each trait EPD with its respective REV. From the twenty-six sires, there was a range of $39.81 from the top to the lowest ranking bull. If these bulls typify the average

genetic profile that exists within the Angus breed, differences exist in profit potential.

495   Effects of trainer cows on the health, performance and behavior of newly weaned calves. D. J. Gibb*[1], K. S. SchwartzkopfGenswein[2], J. M. Stookey[3], T. A. McAllister[1], and R. D. Wiedmeier[4], [1]Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, [2]Alberta Agriculture, Food and Rural Development, Lethbridge, AB, [3]University of Saskatchewan, Saskatoon, SK, [4]Utah State University, Logan, UT.

Experiments were conducted to investigate the effects of cow presence on performance, health, behavior and feeding patterns of newly weaned calves. Trial 1 included 297 recently weaned calves (258 ± 17 kg) placed in 22 pens and assigned to trainer cow (TC; one cow/pen) or no cow (NC) treatments. Antibiotic treatments were monitored throughout the trial; weights and rectal temperatures were recorded on d 0, 3, 7, 14, 21, and 28. Blood was drawn on d 0, 3 and 7 for analysis of haptoglobin, white blood cells (WBC) and neutrophil:lymphocyte (NL) ratios. Visual observations were made at 10-min intervals between 0730 and 1700 on d 1, 2, 4, 5 and 6 to monitor calf behavior. Trial 2 included the same measurements as trial 1 (excluding haptoglobin) and used radio frequency technology to monitor bunk attendance of 60 newly weaned calves (269 ± 17 kg). Trainer cow presence did not influence rectal temperatures or antibiotic treatment rates. Haptoglobin levels, WBC counts and NL ratios differed ($P < .05$) between days but were unaffected by cow presence. Significant but inconsistent treatment responses in ADG were observed among weighing periods, but there was no effect over the 28-d trials. Differences in frequency or duration of bunk visits between NC and TC were not detected, although one TC calf did not attend the feed bunk until d 11. Visit frequency and duration differed among weighing periods; they increased ($P < .001$) from 9.6 visits/d and 56.7 min/d between d 0 and 3, to a high of 12.3 visits/d and 108.9 min/d between d 15 and 21. Calves in TC pens were observed lying less frequently ($P < .01$) and standing more frequently ($P < .001$) than NC calves. Although trainer cow presence modified calf behavior, it did not enhance calf health, frequency or duration of bunk visits, or growth rate through the trials.

496   Effects of feeding supplemental fat during gestation on reproduction in primiparous beef heifers. R. A. Bellows*[1], D. D. Simms[2], E. E. Grings[1], D. A. Phelps[1], S. E. Bellows[1], N. R. Bellows[1], R. E. Short[1], R. N. Funston[1], and T. W. Geary[1], [1]USDA-ARS and Montana Agric. Expt. Sta., Miles City, MT, [2]Consolidated Nutrition, Omaha, NE.

Primiparous, crossbred beef heifers (n = 149) calving in three calving seasons (February, April, or June) were assigned randomly to one of four gestation diets: Control or added safflower seeds, soybeans, or sunflower seeds. Oil seeds were processed through a roller mill to crack hulls in approximately 90% of seeds but without oil loss. Diets were isocaloric-isonitrogenous and contained 2.0, 4.2, 3.3, or 4.5% fat, respectively. Diets were group fed in dry lot and were fed for an average of 65.3 d precalving. Heifer weights and body condition scores (1-10) were obtained throughout the study; estrous cycling activity was based on progesterone content of blood samples obtained at begin breeding; pregnancy was determined by ultrasound at 60-90 days following 35-37 d estrous-synchronized breeding seasons. Calf data included birth weight, calving ease, sex, and weaning weight. Data were analyzed by SAS-GLM within and pooled over calving seasons. Effects of fat supplementation on dam weight or condition scores throughout the study were nonsignificant as were effects on birth weight, calving ease, and dam estrous cyclicity at begin breeding. Heifers from fat supplemented groups had greater pregnancy rates (P<.05) and calf weaning weights (P=.09): Control, 79%, 182.4 kg; safflower seeds, 94%, 193.6 kg; soybeans, 90%, 197.7 kg; sunflower seeds, 91%, 196.8 kg (mean values pooled over calving seasons). We conclude fat supplementation of the gestation diet in primiparous heifers resulted in positive increases in dam pregnancy rates and tended to increase calf weaning weights.

497 Predicting Calving Ease Peri-Partum. P. R. Tozer*[1], D. L. Scollard[2], T. L. Marsh[3], and T. J. Marsh[4], [1]The Pennsylvania State University, [2]Absarokee, Montana, [3]Kansas State University, [4]Pharmco Animal Hospital.

The purpose of this study is to test the hypothesis that readily available information to cow-calf producers, including dam pelvic width (PW), pelvic height (PH), and the fetal coronet band (CB) measurements, can be used to better predict calving ease (CE) scores of first-calf heifers. Data were collected over a 3-year period (684 observations) from heifers on a commercial cow-calf operation, under supervision of a practicing D.V.M. For quality assurance, when feasible, descriptive statistics of the data were compared to, and found to be consistent with, published results. A recursive systems model of two equations was estimated, consisting of a linear model used to predict birth weight (BW) based on the CB measurement and an ordered logit model used to predict a calving ease score from BW and pelvic dimensions of the dam. The linear model demonstrated that BW could be predicted using the CB measurement, where the intercept and slope coefficients were significant at p = 0.001, the model $R^2 = 0.57$, and the standard error of the predicted BW was equal to 2.77kg. To account for unordered categorical data in the CE variable an ordered logit model was estimated, which correctly predicted 468 of 684 (68.4%) of the CE scores. Consistent with previous research, male calves significantly increased the probability of calving difficulty. New findings indicate that BW and PW, and the interaction between them, were statistically significant and nonlinearly related to CE. These findings have the potential to provide information that helps producers better balance the economic tradeoffs existing during the birthing process. The technique adopted by several large-scale cow-calf operations in Montana is to predict the level of calving difficulty of a first calf heifer using CB and PW measurements, early in the second stage of parturition. Then, use this information to make more timely and informed decisions that may include obtaining veterinarian assistance. Such information can reduce the negative effects of calving difficulty on both dam and calf and enhance the economic benefits to the producer.

Key Words: Beef heifers, Dystocia, Ordered logit

498 Fixed-time insemination in beef heifers after synchronization of estrus with melengestrol acetate and prostaglandin F2α. D. J. Patterson*, F. N. Kojima, and M. F. Smith, University of Missouri, Columbia, MO.

Understanding the limitations and problems associated with fixed-time insemination is essential in view of the potential for controlling estrus in various insemination programs. Improvements in estrous response and synchrony of estrus were recently reported for heifers whose estrous cycles were synchronized with melengestrol acetate (MGA) and prostaglandin F2α (PG) and when PG was administered on d 19 instead of d 17 after MGA withdrawal. The objective of this experiment was to compare conception rates of heifers after a 14-19 d MGA-PG treatment that were inseminated a single time at 72 h (SI; n=35) or double inseminated at 65 and 85 h (DI; n=35) after PG. Heifers in each treatment were fed MGA ($0.5mg \cdot hd^{-1} \cdot d^{-1}$) for 14 d followed by an injection of PG (25 mg Lutalyse[®]) 19 d after MGA withdrawal. MGA was delivered in a ground corn carrier of $1.8 kg \cdot hd^{-1} \cdot d^{-1}$. Heifers were assigned to treatment based on age, weight and pubertal status. Blood samples were collected from all heifers 7 d before and on the day PG was administered. Fertile bulls were introduced beginning 2 wk after the AI period for 60 d. Concentrations of progesterone in serum were elevated (> 1 ng/ml) at PG in 89% (31/35) of SI heifers and 86% (30/35) of DI heifers. Heifers were inseminated with semen from a single ejaculate from the same bull. Although insemination was performed at a fixed-time, heifers were observed for signs of behavioral estrus for 6 d after PG. Estrus was observed in 83% (58/70) of the heifers from 48 to 84 h after PG, with the peak occurring from 60 to 72 h. Pregnancy rate after fixed-time AI did not differ between treatments [P > .1: SI = 53%, 19/35; DI = 49%, 17/35]. In summary, pregnancy rates after fixed-time AI did not differ for heifers SI 72 h after PG compared with heifers DI at 65 and 85 h. These data suggest that additional cost of labor and semen for DI may not be warranted in estrous synchronization programs that require fixed-time insemination.

Key Words: Progestin, Prostaglandin F2α, Fixed-time AI

499 Use of hCG or GnRH with the Select Synch Protocol in beef cows. R. R. Salverson*, G. E. Seidel, Jr., and T. W. Geary, Colorado State University, Fort Collins, Colorado.

The objectives of this study were to compare hCG to GnRH for synchronization and conception rates of cows synchronized with the Select Synch protocol. Data were collected at one location over a two-year period where cows were bred AI or received embryos (ET). Beef cows (n = 413) were randomly assigned to receive either 2000 IU of hCG (n = 197) or 100µg of GnRH (n = 208) i.m. on d 0 and PGF2α on d 7. Visual observation (3 x daily) was used to identify estrual cows from d 7 to d 12. Cows that exhibited estrus were artificially inseminated (n = 112) approximately 12 hr after initial observation of estrus or received frozen embryos 7 days after estrus (n = 98). Transrectal ultrasound was used prior to ET to determine the presence of corpora lutea. Cows without a corpus luteum (n = 8) did not receive an embryo. Seven of the eight cows without corpora lutea were hCG treated. Body condition scores were recorded for cows at time of breeding. Bulls were placed with cows in breeding pastures 10 d after the last insemination. Peak estrous response occurred 3 d after PGF2α for both GnRH and hCG treated cows; however, a higher (P < .05) percentage of GnRH treated cows (58%) were observed in estrus than hCG treated cows (46%). Body condition scores did not differ (P > .1) among drug treatment groups, but cows that displayed estrus to either synchronization treatment had a higher (P < .05) body condition score. Conception rates of GnRH (68%) and hCG (62%) treated cows receiving AI were not different (P > .1) nor were conception rates of GnRH (42%) and hCG (35%) treated cows receiving frozen embryos. Conception rates tended (P > .1) to be lower among hCG treated cows than GnRH treated cows. We conclude that hCG is not an effective replacement for GnRH to induce estrus and does not increase conception rates to the Select Synch protocol when used with AI or ET.

Key Words: Artificial Insemination, Estrous Synchronization, GnRH

500 Comparison of three synchronization protocols designed to control estrus and ovulation for timed AI in southern beef herds. S. W. Williams*[1], R. L. Stanko[1,2], M. Amstalden[1], C. D. McKown[3], and G. L. Williams[1], [1]Texas A&M University Agricultural Research Station, Beeville, [2]Texas A&M University-Kingsville, Kingsville, [3]Texas Agricultural Experiment Station-La Copita Research Area, Alice.

Objectives of these studies were to compare the relative efficacies of three protocols designed to synchronize estrus and ovulation for timed artificial insemination (AI) in beef cows and heifers. In Expt.1, 273 Brahman x Hereford (F-1) cows at 3 locations were stratified by weight, body condition score (BCS), age, and days postpartum, and assigned randomly to one of three treatment groups: 1) SYNCRO-MATE-B (SMB); 2) Norgestomet-prostaglandin (NP); or 3) Ovsynch . The management approach required that cows have a minimum BCS of 5 and be at least 36 days postpartum at treatment onset. In Expt. 2, 286 pubertal beef heifers (Brahman x Hereford, F-1; Santa Gertrudis; Santa Cruz; Hereford) were stratified by weight and BCS and allocated randomly to the three synchronization treatments. SMB consisted of the standard 9-d norgestomet ear implant plus an estradiol valerate/norgestomet injection on d 0. NP females were implanted with the same 9-d implant, but received 25 mg prostaglandin F2α (PG) i. m. two days before implant removal. Ovsynch treatment consisted of 100 µg gonadotropin releasing hormone (GnRH) i. m. on d 1, 25 mg PG i. m. on d 8, and a second GnRH injection on d 10. Beginning on d 9, calves were removed for 48 h in cows (Expt. 1). Cattle were timed-inseminated 48-54 h after implant removal or 12 to 24 h after the second GnRH injection. Average days postpartum for cows at the time of treatment was 61.4 ± .8 d. Timed AI conception rates did not differ between SMB, NP and Ovsynch in Experiment 1 (45.1, 31.1, and 42.4 %, respectively), although NP tended (P < .12) to be the least satisfactory. Conversely, timed-AI conception was greatest (P < .056) in NP (54.7%) compared to SMB (40.4%) and Ovsynch (39.1%) for heifers in Expt. 2. Conception rate was not affected (P > .20) by breed type. We conclude that in mature suckled beef cows, SMB, Ovsynch and NP perform similarly when cow eligibility is based soley on BCS and minimum days postpartum. When confirmed cyclicity was required in nulliparous heifers, NP appeared superior to the other two treatments for timed AI.

Key Words: Estrous synchronization, Timed AI, Beef cows

501   The effects of reproductive management systems on luteinizing hormone, estradiol 17-β, cortisol and β-endorphin in mares. C. M. Brady*[1], C. D. Corn[2], J. E. Shelle[2], A. J. Zanella[2], J. V. Marteniuk[2], P. Hitzler[2], and R. L. Fogwell[2], [1]*Purdue University, W.Lafayette, IN,* [2]*Michigan State University, E.Lansing, MI.*

Feral mares have greater reproductive success than domestic mares. Among domestic mares, reproductive success is associated negatively with increased cortisol and β-endorphin. We hypothesized that management systems with high human involvement would increase secretion of cortisol and β-endorphin to mediate decreased secretion of estradiol 17-β (estradiol) and luteinizing hormone (LH) in mares. Our objective was to determine if different reproductive management systems affect estradiol, LH, cortisol and β-endorphin in mares. Twenty-four Arabian mares were assigned to one of three management systems. Pasture bred mares were maintained on pasture with an experienced stallion. Hand mated mares were bred every other day throughout behavioral estrus. Artificially inseminated mares were examined every other day with ultrasonography until the largest follicle was greater than 35mm. Mares were then examined by ultrasonography and artificially inseminated daily until ovulation. Cortisol, β-endorphin, estradiol and LH in plasma were quantified by radioimmunoassay. β-endorphin concentrations did not differ among treatment groups. Cortisol concentration tended (P<.07) to be higher in hand mated and pasture bred mares than in artificially inseminated mares. LH concentration was higher (P<.0005) in hand mated mares than in artificially inseminated or pasture bred mares. Estradiol concentration in artificially inseminated was higher (P<.05) than in pasture bred mares. Estradiol concentrations in hand mated mares did not differ from artificially inseminated or pasture bred mares. Among treatment groups, cortisol concentrations were not correlated (P<.08) with LH or estradiol concentrations. Management system caused changes in estradiol and LH, but cortisol or β-endorphin apparently does not mediate these changes. These changes in LH and estradiol probably do not explain the differences in reproductive success between domestic and feral mares.

Key Words: Mare, Reproductive Management, Fertility

502   Parasite resistance and physiological responses of hair and wool X hair lambs in a tropical environment. R. W. Godfrey*, H. A. Buroker, and B. M. Pannagl, *Agricultural Experiment Station, University of the Virgin Islands, St. Croix.*

Parasite resistance and packed cell volume (PCV) were evaluated in St. Croix White (n = 12; SCW) and Polypay x SCW (n = 13;PSC) lambs while on pasture. Lambs were placed in a .5 ha guineagrass pasture 2 wk after weaning (63 d). Anthelmentic was administered 10 d prior to entering the pasture and 50 d later. Fecal samples were collected weekly for 56 d to determine fecal egg count (FEC). Prior to analysis data was transformed using log10(FEC + 1) (FEC10). On the days of fecal collection a blood sample was collected to determine PCV. At 128 d of age, 6 lambs per breed were subjected to behavior tests. Lambs were placed in partially shaded pens at 0900 and water was withheld for 4 h. Lambs were then placed individually in 3 X 6 m pens with 30% of the pen shaded. Water (3 L) was placed in the shaded portion of the pen. Lambs were observed for 2 h, and animal location in pen was recorded at 5-min intervals. Immediately prior to and after the 2 h test, rectal temperature (RT) was measured in each lamb. Data were analyzed using SAS procedures. Crossbred lambs were heavier than SCW lambs throughout the entire grazing period (P < .0007). There was no breed effect (P > .10) on either FEC10 or PCV. Both groups of lambs had an increase (P < .0001) in FEC10 by 35 d after the first anthelmentic treatment. Values for PCV began decreasing (P < .0001) by 28 d after anthelmentic in both groups. At 7 d after administration of a second anthelmentic FEC10 declined (P < .0001) and PCV increased (P < .0001) in both groups. Hair lambs had lower RT (P < .005) than PSC lambs (39.6 ± .1 vs 40.1 ± .1°C, respectively). Crossbred lambs consumed less water (P < .05) than SCW lambs (189.2 ± 53.1 vs 355.8 ± 53.1 mL, respectively) and spent a higher (P < .001) proportion of time in shade. These data show that neither SCW nor PSC lambs are parasite resistant under pasture conditions found in the tropics. The elevated RT of crossbred lambs may be due in part to their lower water intake and heavier fleece.

Key Words: Sheep, Parasites, Breed

503   Effects of supplementing ewes with D-α-Tocopherol on lamb serum and ewe colostrum immunoglobulin concentration, and preweaning lamb growth. C. L. Schultz*, T. T. Ross, M. W. Salisbury, and L. Melton, *New Mexico State University, Las Cruces, NM USA.*

Two experiments were conducted to determine if supplemental d-α-tocopherol (Vi t. E) given to ewes prepartum would enhance lamb serum or colostrum immunoglobulin (IgG) concentrations or lamb preweaning growth. In experiment 1, 86 Suffolk ewes received either no supplemental Vit. E (controls) or 1500 IU Vit. E administered subcutaneously 28 days prior to parturition. At parturition, 25 ewes (12 control and 13 Vit. E) were selected for intensive sampling. Immediately following parturition, a blood sample was taken from the 25 ewes and neonatal lambs via jugular veinpuncture. Subsequent samples were taken from the lamb and colostrum from the ewe hourly through 12 h postpartum. Immediately following birth, lambs were dosed via stomach tube with 60 mL of colostrum from the dams to ensure initial equal consumption. All lambs were weighed at birth, 14, 28, and 42 d postpartum. Supplemental Vit. E did not alter colostrum (P = .25) or ewe serum (P = .16) or lamb serum (P = .64) IgG concentrations. Also, supplemental Vit. E did not influence (P = .97) gain in lambs preweaning. However, when the 25 lambs used in the intensive collection were evaluated separately, those born to Vit. E ewes had higher (P = .02) average daily gain through 60 days than lambs born to control ewes. Experiment 2 was conducted at the Corona Range and Livestock Research Ranch and included 200 pregnant Western White Face ewes. Ewes were assigned to two treatments previously described with ewes receiving the Vit. E at approximately 40 d prepartum (shearing). Lambs were gathered and weighed at 45 d postpartum (flock average). Lambs from Vit. E ewes were heavier (P = .03) at 45 d compared to lambs born to control ewes. However, this advantage was lost by 90 d postpartum. Therefore, vitamin E supplementation prepartum may improve early preweaning growth of lambs, especially when lambs have been stressed by intensive handling or environment under range conditions. However, 90 d weights are unaffected.

Key Words: Sheep, immunoglobulins, growth

504   Weaning and rearing systems for American dairy sheep. B. C. McKusick*[1], Y. M. Berger[1], and D. L. Thomas[1], [1]*University of Wisconsin-Madison.*

A flock of 132 East Friesian (EF) crossbred ewes and their lambs were used to study the effects of three weaning / rearing systems on milk production and lamb growth. During the first 30 d of lactation, ewes were either weaned from their lambs at 24 hr and then machine milked twice daily (DY1), separated from their lambs for 15 hours during the evening and machine milked once daily in the morning (MIX), or not machine milked and allowed unlimited access to their lambs (DY30). After 30 d, MIX and DY30 ewes were weaned, and ewes in all three groups were machine milked twice daily. Commercial milk yield and milk composition were recorded weekly until mid-lactation and then twice monthly until dryoff. Average lactation length (suckling + milking periods) was 176 d and was similar between weaning systems. Total commercial milk production differed (P < .05) between weaning systems (240, 205, and 149 L/ewe for DY1, MIX, and DY30 systems, respectively). During the first 30 d of lactation, commercial milk production, percentage of milk fat and protein, and log-transformed somatic cell count (SCC) were lower (P < .05) for MIX ewes than for DY1 ewes (42 and 70 L/ewe of milk; 3.24 and 4.88% milk fat; 5.36 and 5.52% milk protein; 4.65 and 4.91 log SCC, respectively). Litter size was a significant source of variation for most lactation traits, however parity and proportion of EF breeding tended not to be significant. Ewes put on a legume-grass pasture in mid-lactation had greater (P < .05) milk production than ewes fed in drylot. Growth traits of 272 twin-or-greater-born lambs sired by EF or Texel rams were estimated for three rearing systems. Lambs were either raised artificially (ART), allowed access to their dams for nine hours per day (LMIX), or allowed unlimited access to their dams (TRAD) for approximately the first 30 d of age. Lamb weights at 30 d were similar, however at 120 d, TRAD lambs were heaviest (P < .05) compared to ART and LMIX lambs (47.8, 43.6, and 45.5 kg, respectively). Sex, birth type, sire breed, dam breed, and dam age were significant sources of variation for at least one growth trait. From a simplified economic analysis, the MIX/LMIX system produced the greatest financial returns from milk and lamb production.

Key Words: Dairy Sheep, Milk Production, Lamb Growth

505 Improving ewe lactational performance with administration of recombinant bovine somatotropin. D. K. Aaron*, D. G. Ely, W. P. Deweese, and E. Fink, *University of Kentucky/Lexington, Kentucky/USA.*

Lactational performance of 16, fall-lambing Polypay ewes (75 kg), each nursing twin lambs and treated with 240 mg of recombinant bovine somatotropin (bST, sometribove, n=8) or an oil placebo (CON, n=8), was evaluated in a 66-d experiment. Preweaning lamb growth was also measured. The lactation diet contained 62.5% roughage and 37.5% concentrate. Ewes were fed at 0800 and 1600 so daily intake equaled 5.2% BW. Lambs, separated from ewes, were allowed ad libitum access to a creep diet during the same times. Ewes and lambs were individually weighed and ewes condition-scored and machine milked every 7 d beginning on d 10 of lactation. Ewes received s.c. injections of either bST or the placebo on d 24, 38, and 52. Estimated 24-h milk production was higher for bST ewes than for CON ewes by d 45 (2685 vs 2005 g; P < .01). The bST ewes continued to produce more milk on each of the remaining collection days [d 52: 2685 vs 2005 g (P < .08); d 59: 2349 vs 1609 g (P < .01); d 66: 2002 vs 1331 g (P < .01)]. Total milk production (d 24 through 66) was 14.4 kg greater (P < .05) for the bST ewes. Milk production was more efficient for bST ewes on d 45 (.68 vs .51; P < .05), 59 (.58 vs .41; P < .01), and 66 (.49 vs .34; P < .05). With respect to lactation persistency, milk yield decreased at a slower rate for bST ewes (123 vs 207 g/7-d period; P < .05) from d 24 through 66. Milk fat and DM contents were similar for both groups; however, milk protein content was lower (P < .01) for bST ewes on d 45 and 59. Neither ewe weight nor body condition was affected by bST treatment. Creep feed intakes tended to be higher for lamb pairs nursing bST-treated ewes. These same lamb pairs were heavier (P < .08) on d 52 (38.4 vs 34.5 kg), 59 (42.8 vs 38.6 kg), and 66 (47.2 vs 42.6 kg).
Ewes, Somatotropin, Lactation

Key Words: Ewes, Somatotropin, Lactation

506 Factors affecting sale price of performance tested Dorper pasture rams: A South African experience. P. J. Fourie*[1], F. W. C. Neser[2], and C. van der Westhuizen[1], [1]*Technikon Free State, Bloemfontein, South Africa,* [2]*University of the Orange Free State, Bloemfontein, South Africa.*

The importance placed on hardiness in the Dorper breed in South Africa has led to the creation of veld ram clubs. In these clubs Dorper rams are performance tested under extensive condition from just after weaning. Animals are sold at an age of about 12 months. At these auctions breeders remain anonymous. The question that arises is, how much does the performance of the animals in the veld ram club influence the prices buyers paid for these animals? The auction prices of 1265 Dorper rams sold from 1990 to 1997 were used. Analyses of variance were carried out in order to determine which variables influenced the auction price significantly. The performance data collected included: the scrotal circumference, Kleiber ratio, auction mass, rating (stud or commercial), coat type, final mass index and growth per day of age. It was found that the following factors influenced sale price significantly (P<0.01): auction mass, coat type, Kleiber ratio, scrotal circumference and final mass index. Stud rams and rams (stud and commercial) that were larger at the time of the auction fetched higher prices than smaller rams. Buyers also put a premium on coat type, as there was preference for animals with hair and a mixture of hair and wool over those with predominantly wool coats. However, performance seems to have become more important in determining price from 1995 most likely because buyers are getting use to the concept of performance testing.

Key Words: Dorper rams, Performance testing, Auction prices

507 Growth and carcass traits of St. Croix White (SCW) and Barbados Blackbelly x SCW (BBSC) lambs in the tropics. R. W. Godfrey*, H. A. Buroker, and B. M. Pannagl, *Agricultural Experiment Station, University of the Virgin Islands, St. Croix.*

The geographic isolation of the US Virgin Islands inhibits the transport of animals from other regions for the purpose of expanding the genetic base of local livestock. Because of this it is necessary to utilize locally produced breeds of hair sheep for lamb production. St. Croix White and BBSC lambs were used to evaluate the postweaning performance of hair lambs under tropical conditions. St. Croix White (n =15) and BBSC

(n = 13) lambs were weaned at 63 d of age and fed a complete pelleted ration (14% crude protein) at 4% BW·hd^{-1}·d^{-1}. Lambs had ad libitum access to guineagrass hay and water and were slaughtered at a weight of 30 kg. Hot and cold carcass weight, fat thickness over the 12th rib, rib eye area (REA) and percentage kidney-heart-pelvic (KPH) fat were measured. All data were analyzed by SAS procedures. St. Croix White lambs were on feed longer (P < .07) than BBSC lambs (112.2 ± 5.4 vs 97.2 ± 5.8 d, respectively). Average daily gain was not different (P > .10) between breedtype, but wethers (n=14) gained faster (P < .001) than ewes (n=14) (164.4 ± 3.9 vs 137.1 ± 3.9 g/d, respectively). Feed efficiency was not different (P > .10) between breedtype or sex of lamb. St. Croix White ewes had the highest (P < .05) cost of gain and BBSC ewes had the lowest (3.21 ± .2 vs 2.35 ± .24/kg, respectively). Cold carcass weight was greater (P < .02) in ewes than in wethers (15.3 ± .2 vs 14.4 ± .2 kg, respectively). Percentage KPH was higher (P < .005) in SCW than in BBSC lambs (5.7 ± .3 vs 4.5 ± .3%, respectively) and higher (P < .0001) in ewes than in wethers (6.4 ± .3 vs 3.8 ± .3%, respectively). Fat thickness was greater (P < .01) in SCW than in BBSC lambs (.32 ± .02 vs .24 ± .02 cm, respectively) and greater (P < .01) in ewes than in wethers (.32 ± .02 vs .24 ± .02 cm, respectively). There was no difference (P > .10) in REA between breedtype or sex. These data show that crossbred lambs reached slaughter weight earlier and had leaner carcasses than purebred St. Croix White lambs.

Key Words: Sheep, Crossbreeding, Growth

508 Carcass characteristics and composition for Spanish and Boer crossbred goat kids. M. R. Cameron[1], T. Sahlu*[1], G. Detweiller[1], S. Hart[1], and S. Coleman[2], [1]*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK,* [2]*USDA/ARS Grazinglands Research Lab, El Reno, OK.*

Eighteen Spanish (S), Boer x Angora (BA), and Boer x Spanish (BS) castrates were used to investigate the effects of genotype on carcass characteristics, body composition and distribution of carcass tissues. Kids were offered ad libitum a concentrate diet (25% CP, 2.71 Mcal DE/kg, 34.7% NDF, and 18% ADF). Animals were slaughtered at 212 ± 5 d of age. Live body weight (BW), empty BW, hot carcass weight, and dressing percentage were similar (P > .05) among genotypes (32.4, 30.1, and 25.4 ± 2.1 kg; 27.5, 27.7, and 23.3 ± 3.0 kg; 15.0, 14.1, and 11.9 ± 1.0 kg; and 50.6, 51.2, and 51.6 ± 1.3% of empty BW for BS, BA, and S, respectively). Boer x Spanish had greater(P < .005) bone:lean ratio than either BA or S (.45, .50 and .50 ± .01, respectively). Genotype had no effect (P > .05) on carcass scores, backfat thickness, or longissimus muscle area. Internal fat was not affected by genotype (P > .05), averaging 1.94 ± .3 kg (7% of empty BW). Chemical composition of the carcass, noncarcass and the empty body were similar among genotypes (57.6 ± 1.5%, 17.6 ± 1.4%,and 20.2 ± .5%; 55.6 ± 1.7%, 19.5 ± 1.5%, and 19.0 ± 1.1%; 57.1 ± 1.4%, 16.8 ± 1.1%, and 21.1 ± .7% for moisture, fat and protein, respectively). The proportions of separable lean and fat in the primal breast, rack, loin, shank and flank were similar (P > .05) among genotypes (averaging 42.3 ± 3.2 and 29.0 ± 3.6%; 43.6 ± 2.2 and 14.5 ± 2.0%; 56.2 ± 1.8 and 17.5 ± 1.6%; 64.9 ± .9 and 5.5 ± 1.1%; 60.1 ± 4.0 and 39.9 ± 4.0%, respectively). Lean composed a greater (P < .05) proportion of the cut in both BS and S than in BA in the primal shoulder(61.6, 63.5, and 58.0 ± .9%, respectively). Boer crosses had a lower (P < .05) proportion of bone than S in the primal leg (22.5, 23.8, and 26.5 ± .92% for BS, BA, and S, respectively). Genotype had no effect on percentage of lean or fat in the primal leg (averaged 66.9 ± 1.8% and 6.83 ± .97%, respectively). Genotype had little effect on carcass characteristics or body composition in growing kids fed a high concentrate diet. Results indicate that Angora producers can as effectively produce goats with a high quality carcass as Spanish producers when Boer buck are used as a terminal sire breed.

Key Words: Goat, Boer, Carcass

509 Effects of estradiol benzoate and trenbolone acetate, alone or combined, on performance by feedlot heifers: a multi-site study. R. M. Cleale*, L. A. Kraft, D. A. Peterson, R. L. Hale, A. N. Sinha, G. K. Jim, T. TerHune, E. G. Johnson, T. L. Mader, and T. H. Montgomery, *Fort Dodge Animal Health, Princeton, NJ.*

We conducted a four-site trial to study effects of estradiol benzoate (EB) and trenbolone acetate (TBA), singly or combined, on performance and carcass traits of finishing beef heifers. The design at each site was a

randomized complete block with a 2 x 2 factorial arrangement of treatments. Study sites were in Alberta (n = 432, 12/pen), California (n = 288, 8/pen), Idaho (n = 360, 10/pen), and Nebraska (n = 288, 8/pen). At each site heifers were blocked on BW (initial BW = 371 kg), yielding nine blocks of four pens; within blocks, treatments were randomly assigned to pens. Heifers were sham-implanted, or received implants containing 28 mg EB, 200 mg TBA, or 28 mg EB + 200 mg TBA (Synovex Plus). Performance was measured for 105 to 112 d following treatment, then cattle were killed and carcass data were collected. Analysis of pooled data showed ADG by cattle implanted with Synovex Plus (1.56 kg/d) was superior (P < .05) to that by cattle implanted with EB (1.46 kg/d) or TBA (1.48 kg/d). The ADG by all implanted groups were greater than sham-implanted heifers (1.38 kg/d; P < .05). Compared to sham (.142) or EB (.146), gain/feed by heifers was improved (P < .05) by TBA (.154) or Synovex Plus (.158). Carcass weights (323 kg) and ribeye areas (85.6 sq. cm) were greater (P<.05) among cattle given Synovex Plus than other implants (EB: 315 kg and 82.2 sq. cm; TBA: 315 kg and 83.5 sq. cm), and implanted groups had higher (P <. 05) carcass weights and ribeye areas than sham-implanted cattle (309 kg and 80.2 sq. cm, respectively). Marbling was reduced by all implant treatments (P < .05). Longissimus muscle color was highest among cattle implanted with Synovex Plus (P < .05), but incidence of dark cutters was uniform across treatments. Compared to controls, Synovex Plus reduced (P < .05) the portion of carcasses grading Choice and increased (P < .05) proportions grading Select and Standard. Study results showed both EB and TBA contributed to the overall effects of Synovex Plus on ADG, carcass weight and ribeye area.

Key Words: Cattle, Anabolic, Implants

510   Whole vs. cracked corn in growing rations for steer calves. I. G. Rush*, B. A. Weichenthal, and B. G. Van Pelt, *University of Nebraska, Scottsbluff, Nebraska, USA*.

Crossbred steer calves averaging 256 kg initially were fed growing rations formulated for 13.0% CP and 1.01 Mcal/kg of NEg in the DM. Ingredients (DM basis) were: 22.8% corn silage, 48.7% alfalfa hay, 1.9% of a supplement to supply Rumensin at 23 g per ton, and 26.6% dry corn (85% DM) fed whole or cracked and fed in a total mixed ration or fed separately and cleaned up before feeding the other ingredients in the ration. The cracked corn was coarsely broken with a roller mill. Ration intakes were managed to be the same among treatments, with the mixed rations fed ad lib and setting the intake for the ration fed separate. Corn DMI averaged 2.3 kg/day. There were 3 pens per treatment and 9 or 10 steers per pen during a 120 day growing trial from January 31 to May 31. Daily gains and feed conversions were the same in the total mixed rations. Numerically, but not statistically different, the gain and efficiency of the cattle fed whole corn separate were slightly lower than cattle fed cracked corn. These data would indicate that economically it is doubtful if it would pay to crack corn no matter how it is fed.

Corn physical form Corn feeding method	Cracked Mixed	Cracked Separate	Whole Mixed	Whole Separate	P
No. of steers	29	29	28	29	
Daily gain, kg	1.24	1.23	1.25	1.17	.42
Feed DM/day, kg	8.71	8.74	8.72	8.75	.99
Gain/feed	.142	.141	.144	.134	.20

Key Words: whole corn, cracked corn, growing cattle

511   Effect of monensin plus tylosin or virginiamycin on feedlot performance of calf-fed Holstein steers fed to slaughter. G. J. Vogel*, S. B. Laudert, and C. A. Guthrie, *Elanco Animal Health, Indianapolis, IN*.

One-thousand four hundred sixty six (1466) Holstein steers averaging 137 kg BW were randomly allotted to 12 pens and fed monensin at 36.7 mg/kg of diet DM plus tylosin (90 mg/hd/d) or virginiamycin at 27.5 mg/kg of diet DM in the final diet during a 393 d trial conducted by Bos Technica Research Services. A 3 ration step-up program was used to adapt the calves to the final diet. The final ration, fed from day 11 to slaughter, was formulated to contain 1.47 Mcal NEg/kg, 12.5 % CP, 7.1% EE, 5.7% CF, 0.67% Ca and 0.31% P. Calves on the monensin plus tylosin treatment were started on monensin at 27.5 mg/kg of diet DM. Monensin levels were increased at each ration step such that the final ration contained 36.7 mg/kg of diet DM. Tylosin was included from d

1. Calves on the virginiamycin treatment were started at 27.5 mg/kg of diet DM and remained there for the duration of the study. Animals were fed twice daily. Cattle weights were obtained for each pen at the start of the trial, reimplant time, and at slaughter. All animals which died during the trial were necropsied. Data were analyzed as a randomized complete block design that was blocked over time. Pen was used as the experimental unit. DM intake was greater for steers fed monensin plus tylosin (7.76 vs. 7.56 kg/d; P=.03). Daily Gain, expressed on a "deads and rejects out" basis, was greater (1.22 vs. 1.15 kg; P<.01) while feed conversion was lower (6.35 vs. 6.56; P=.02) for steers fed monensin plus tylosin. The incidence of liver abscess was lower (22.2 vs. 52.6%; P<.01) for steers fed monensin plus tylosin. Total (3.0 vs. 5.4%; P=.03) and digestive (1.9 vs. 4.3%; P=.11) death loss was lower for steers fed monensin plus tylosin. These data demonstrate that animal performance was improved, while liver abscess incidence and death loss were reduced in steers fed monensin plus tylosin.

Key Words: Monensin, Tylosin, Virginiamycin

512   Effect of monensin level on feedlot performance of calf-fed Holstein steers fed to slaughter. G. J. Vogel*, J. C. Parrott, S. B. Laudert, and D. R. White, *Elanco Animal Health, Indianapolis, IN*.

One-thousand one hundred seventy two (1172) Holstein steers averaging 122 kg BW were randomly allotted to 18 pens and fed monensin at 24.4, 36.7, or 48.9 mg/kg of diet DM in the final diet during a 370 d trial conducted by Bos Technica Research Services. A 3 ration step-up program was used to adapt the calves to the final diets. The final ration, fed from day 17 to slaughter was formulated to contain 1.46 Mcal NEg/kg, 12.5 % CP, 5.2 % CF, 6.9% EE, 0.67% Ca and 0.30% P. All calves were started on monensin at 24.4 mg/kg of diet DM with monensin level being increased 6.1 mg/kg of diet DM at each ration step. Cattle in the highest monensin treatment had additional monensin increases made on d 22 and 27. Tylosin was fed throughout the trial to all cattle at 90 mg/d. All animals were fed twice daily. Cattle pen weights were obtained for each pen at the start of the trial, reimplant time, and at slaughter. All animals which died during the trial were necropsied. Data were analyzed as a randomized complete block design using pen as the experimental unit. Orthogonal contrasts were conducted to evaluate linear and quadratic trends among monensin levels. No differences were noted in DM intake among treatments (7.02, 6.97, 7.01 kg/d; P=.63). Daily gain, expressed on a "deads and rejects out" basis, increased linearly (1.29, 1.29, and 1.31 kg/d; P=.09) while feed efficiency improved linearly (5.43, 5.41, 5.35; P=.04) with increasing monensin dosage. No differences (4.09, 3.44, 2.62; P=.29) were observed in total death loss among treatments while digestive death loss decreased linearly (2.62, 1.62, and .25%; P<.01) with increasing monensin level. These data demonstrate that performance was improved and the incidence of digestive death loss was reduced with increasing monensin level without affecting DM intake.

Key Words: Monensin, Feedlot, Digestive

513   Effect of poultry blood meal on performance and carcass characteristics of feedlot heifers. B. H. Heiser, B. J. May*, D. R. Shelby, G. R. Engdahl, and C. B. Scott, *Angelo State University, San Angelo, TX*.

Fourty-four Brangus heifers were used to determine the effect of poultry blood meal as a protein source on the performance and carcass characteristics in a 140-d finishing trial conducted at the Angelo State University, Management, Instruction and Research Center in San Angelo, Texas. Heifers were blocked by weight and randomly assigned to one of two treatments with four replications of each treatment. Treatments consisted of a finishing ration with either (1) cottonseed meal as a control (CON), or (2) poultry blood meal (PBM) as the protein sources. All heifers were fed six successive diets increasing in concentrate and decreasing in roughage starting at 50.0% concentrate and 50.0% roughage for the first diet and finishing at 87.0% concentrate and 13.0% roughage for the sixth diet. All rations among treatments were formulated to be isonitrogenous and isocaloric. Heifer weights were taken every 28 d to adjust feed intake to minimize orts and maintain near ad libitum intake (3.0% BW). Upon completion of the trial, all heifers were slaughtered for evaluation of carcass data. Average daily gain over the entire trial was higher (P < .05) for the CON fed heifers than PBM. There were no differences in FE. Heifers fed CON had larger (P < .05) rib-eye

areas than PBM. Data from this study indicate that Brangus heifers fed finshing rations containing PBM as an escape protein source will not increase performance or carcasss characteristics over heifers fed nutritionally similar finishing rations with cottonseed meal as a protein source.

Key Words: Heifers, Performance, Protein

514   Effects of oral calcium propionate dose level on serum calcium levels of feedlot steers. S. K. Duckett, J. G. Andrae, G. T. Pritchard, S. L. Cuvala, and K. Watson, *University of Idaho.*

Four steers (500 kg) were used in a 4 x 4 Latin square to determine the serum calcium response to an oral drench of varying doses of calcium propionate. The dose levels used were: 0 g calcium in 750 mL of deionized water (control), 75 g of calcium in 750 mL calcium propionate gel (CA-75), 100 g of calcium in 1000 mL calcium propionate gel (CA-100), and 150 g of calcium in 1500 mL of calcium propionate gel (CA-150). Indwelling catheters were inserted into the jugular vein of each steer at the start of the period and removed after each 24 h collection. Steers were given a 6-d rest period before the start of the next period. Each steer received one of the dose levels in each of four periods. Blood samples were taken at 0 h before drenching and 1, 2, 3, 6, 12, and 24 h post drenching. Blood samples were allowed to clot and serum removed after centrifugation for determination of total, ionized, and normalized calcium levels. Data were analyzed using the General Linear Model of SAS with dose level and time as main effects. Serum total and normalized calcium values were higher (P < .05) for CA-75 and CA-100 than controls and baseline (0 h) levels at 1, 2, and 3 h post drenching. At 6, 12 and 24 h post drenching, serum total and normalized calcium levels for CA-75 and CA-100 g dose level were similar (P > .05) to control and baseline (0 h) levels. For CA-75 and CA-100, total and normalized calcium levels peaked at 1 h post drenching at 9% and 11% above control levels. For CA-150, serum total and normalized calcium values were higher (P < .05) than controls and baseline (0 h) levels at 1, 2, 3, and 6 h post drenching. At 12 and 24 h post drenching, serum total and normalized calcium levels were similar to controls and baseline (0 h) levels for CA-150. Serum total and normalized calcium levels peaked at 3 h post drenching for CA-150 at 36% and 29%, respectively, above the control level. Thus, the optimal dose level of calcium when given as an oral drench was 150 g with a maximal serum total calcium response of 36% at 3 h post dosing.

Key Words: Beef, Calcium, Blood

515   Effects of growth implants on the performance of stock heifers grazing irrigated rye pasture. Dale A. Blasi*[1] and Gerry L. Kuhl[1], [1]*Kansas State University, Manhattan.*

One 151-d field study was conducted to compare three anabolic implants for promoting weight gain in stocker heifers grazing center pivot-irrigated pastures of winter rye. Three hundred previously non-implanted British crossbred heifers averaging 191 kg were assigned to one of four treatments: 1) no implant-control (NC), 2) Ralgro® (RAL), 3)Revalor-G® (REV-G) and Synovex-H™ (SYN-H). Heifers were weighed at monthly intervals to evaluate the growth response curve of each implant type over time relative to NC. Only during the first 32-d period after implantation did heifers with REV-G gain significantly faster (P<.05) than NC. All implant treatments responded similarly (P>.05)during the next three monthly weigh periods. During the last period (d 124-d 151), SYN-H heifers gained faster (P<.05) than all other treatments. All implant types except RAL significantly improved gain (P<.05) compared to NC. Although there were no significant differences in overall liveweight gain between RAL and REV-G (P>.24), SYN-H-implanted heifers gained faster (P<.05) over the 151-d trial.

Heifer Daily Gain (kg) by
Monthly Weigh Periods on Rye Pasture

Treatment	No., Heifers	D1-32	D33-60	D61-92	D93-123	D124-151	D1-151
NC	75	$.45^a$	$.86^a$	$.65^a$	$.62^a$	$.88^a$	$.68^a$
RAL	75	$.46^{ab}$	$.91^{ab}$	$.72^{ab}$	$.66^{ab}$	$.89^a$	$.72^{ab}$
REV-G	73	$.56^{bc}$	$.91^{ab}$	$.71^{ab}$	$.65^{ab}$	$.90^a$	$.75^b$
SYN-H	73	$.62^c$	$.96^b$	$.77^b$	$.72^b$	1.03^b	$.81^c$

^{a,b,c}Values in columns not sharing a common superscript are different (P<.05).

Key Words: Heifers, Growth implants, Rye pasture

516   Effect of poultry by-product meal on performance of growing Angus bulls. M. E. Hall, B. J. May*, D. R. Shelby, G. R. Engdahl, and C. B. Scott, *Angelo State University, San Angelo, TX.*

Thirty-six weaned Angus bulls were used to compare the effects of poultry by-product (PBM) versus cottonseed meal on performance in a 112-d growth study conducted at the Angelo State University, Management, Instruction and Research Center in San Angelo, Texas. Bulls were blocked by weight and randomly assigned to one of two treatments with four replications of each treatment. Treatments consisted of a grower ration with either (1) cottonseed meal as a control (CON), or (2) poultry by-product meal (PBM) as the protein sources. Rations were formulated to be isonitrogenous (14.0% CP) and isocaloric (Neg 1.15 Mcal/kg). Bull weights were obtained every 28 d to adjust feed intake to minimize orts and maintain near ad libitum intake (3.0% BW). All feeds fed and refusals were weighed and recorded daily. Average daily gain and FE over the entire trial were similar for CON and PBM fed bulls. Data from this study indicate that growing bulls fed grower rations containing PBM as an escape protein source will not increase performance over bulls fed nutritionally similar grower rations with cottonseed meal as a protein source.

Key Words: Bulls, Performance, Protein

517   Evaluation of female reproductive traits in progeny of high and low scrotal circumference expected progeny difference Angus sires. D. J. Kemp*, W. O. Herring, and D. J. Patterson, *University of Missouri, Columbia, Missouri.*

Age at puberty (AP) is a major factor influencing the reproductive efficiency throughout the life of a beef female. This study was designed to evaluate correlated responses in reproductive traits with scrotal circumference EPD (SC EPD), in particular AP, in two divergent lines of Angus heifers. The lines were distinguished by the SC EPD of the sires used to develop each line. The average SC EPD of the sires used in the high SC EPD line (HSC) was +1.30 cm and the average for the low SC EPD line (LSC) was -0.87 cm. Birth weight, weaning weight, yearling weight, and milk EPDs of the sires were similar across both lines to aid in minimizing the impact of growth genetics. Traits measured on the heifers included: birth weight, weaning weight, yearling weight, semi-weekly weights from the onset of the study to puberty, and weight at puberty. Blood samples were collected semi-weekly as an indicator of puberty. Puberty was defined by a transient increase in serum progesterone concentration above 1 ng/ml that was followed by a normal estrus cycle. AP was analyzed with a model including a linear covariate for weight at puberty, fixed effects of contemporary group, age of dam, line, and a random effect of sire within line. Preliminary results for the first group indicated no significant difference between HSC and LSC for age at puberty. However, sire within line was significant (P<.05). While early results indicate no differences in age at puberty between LSC and HSC, two additional years of matings are yet to be measured in the study.

Key Words: EPD, Puberty, Reproduction

518   Estrus detection and pregnancy rates in postpartum beef cows after synchronization with GnRH and prostaglandin $F_{2\alpha}$. W. A. Greene and M. L. Borger*, *The Ohio State University, Wooster.*

Eighty-six beef cows were allotted to three similar groups based upon breed, age, postpartum interval, and postpartum cyclicity to compare estrus detection rates (EDR) and pregnancy rates (PR) among three synchronization regimens using GnRH and prostaglandin $F_{2\alpha}$ (PG). All cows received 100 µg GnRH i.m. on d 0 and 25 mg PG i.m. on d 7. All cows were observed for estrus 0700 and 1900 from d 7 to d 12. Cows allotted to the Select Synch (S) group were artificially inseminated (AI) approximately 13 h after detected estrus. Cows in the two Ovsync groups received an additional 100 µg GnRH i.m. 48 h after PG and were timed-AI either at the time of the second GnRH injection (T0 group) or 8 h after the second GnRH injection (T8 group). Following

the synchronization period, all cows continued to be observed for estrus until d 32 and bred until d 54. Cows were pregnancy diagnosed by ultrasonography on d 51 and d 86. The EDR from d 7 to d 12 was higher (P<.05) for S cows (79.3%) than either T0 (31.0%) or T8 (53.6%) cows. The PR to synchronization was higher (P<.05) for S cows (48.3%) than T0 cows (20.7%) but did not differ (P=.79) from T8 cows (42.9%). T8 cows tended to have higher d 7 to d 12 EDR (P=.11) and PR to synchronization (P=.09) than T0 cows. Overall PR at d 86 did not differ (P>.05) for S (82.8%), T0 (75.9%), and T8 (78.6%) cows. Although the Select Synch estrus detection rate was higher than either of the Ovsync methods, PR to synchronization was only significantly lower for Ovsync cows bred at the time of the second GnRH injection.

519 Outcome of breeding soundness evaluations performed on 2544 yearling beef bulls. S. P. Kennedy*[1], J. C. Spitzer[1], H. L. Higdon III[1], F. M. Hopkins[2], and W. C. Bridges, Jr.[1], [1]*Clemson University, Clemson, SC,* [2]*University of Tennessee, Knoxville, TN.*

Our objective was to perform a retrospective analysis of breeding soundness evaluations (BSE) as classified by the Society for Theriogenology (SFT) 1993 system and ascertain mean scrotal circumference(SC), motility(%M), and normal sperm(%NS) associated with bulls classified as satisfactory or unsatisfactory potential breeders. Data included BSE information obtained from four performance testing stations in South Carolina (SC1, SC2) and Tennessee (TN1, TN2) from 1986 through 1996 on 2544 Angus, Charolais, Gelbvieh, Polled Hereford, Santa Gertrudis and Simmental bulls. Analysis was simplified by classifying all bulls as either satisfactory or unsatisfactory potential breeders (unsatisfactory including all bulls originally classified as unsatisfactory or deferred). Analyses of variance were performed using GLM procedures of SAS. A model was constructed using satisfactory potential breeder as the dependent variable with main effects including (station, breed, time, age, year(time)) and interaction effects (age x breed, breed x time, breed x station, age x station, time x station, age x time.) Time was entered as a variable to account for bulls evaluated prior to1993 being originally evaluated under the Society for Theriogenology 1983 system. Mean SC, %M, and %NS for bulls classified as either satisfactory or unsatisfactory breeder were determined using univariate procedures of SAS. Of the 2544 bulls, 76% were classified as satisfactory potential breeders. Proportion of bulls classified satisfactory were influenced by breed(P = .001), year(time)(P = .005), age x station(P = .0002) and breed x station(P = .03). Further analysis indicated breed to be a significant variable at all stations with the exception of TN2(P < .01). Year(time) was significant at both TN stations(P < .0006) and breed x time was significant at TN2(P = .03). For satisfactory or unsatisfactory bulls, respectively, SC were 36.0cm±2.8cm and 33.2cm±3.9cm (P < .001), %M were 62.9%±17.8% and 31.5%±24.6% (P < .001), and %NS were 86.3%±7.1% and 66.4%±19.9%(P < .001). This analysis provides benchmarks for expected outcomes of BSE on yearling beef bulls.

Key Words: Breeding Soundness Evaluation, Beef Bulls

520 Effects of supplementation with undegraded intake protein pre- and postpartum on reproductive performance in primiparous heifers. T. A. Strauch, E. J. Scholljegerdes, D. J. Patterson, M. F. Smith, M. C. Lucy, W. R. Lamberson, and J. E. Williams, *University of Missouri-Columbia, Columbia, MO.*

Objectives of this study were to evaluate the effects of pre- and postpartum undegraded intake protein (UIP) supplementation on body condition score (BCS), BW, calf weight (CW), milk production (MP), serum concentrations of IGF-1, postpartum interval (PPI), and first service conception rates (FSCR) in primiparous beef heifers (n=38). Heifers were maintained on stockpiled fescue (11.7% CP, 38% ADF) and individually fed supplement daily beginning 60 d prepartum. Pre- and postpartum supplements provided 20.6% CP, 83.4% TDN (UIP); 16.3% CP, 84.2% TDN (CON); 23.9% CP, 83.8% TDN (UIP); and 19.1% CP, 83.0% TDN (CON), respectively. Bloodmeal (200 g/d) was the source of UIP. Statistical analysis using ANOVA and a split-plot design revealed no treatment effects (P > .2) on BCS, BW, CW, MP, or PPI throughout the study. There tended to be a treatment x time interaction on BCS (P < .09) with UIP heifers having higher BCS than CON at weeks 5, 7, and 9 postpartum. There was a treatment x time interaction on IGF-1 (P < .06) during the first 35 d postpartum. In UIP heifers, IGF-1 was increased at calving compared to CON heifers (117.5 UIP vs 92.4 CON ng/ml); however, these differences were not related to changes in BCS

or BW. Although concentrations of IGF-1 were increased at calving in heifers receiving UIP, there was no treatment effect on PPI (P > .7). During the first 30 d postpartum, IGF-1 differed (P < .01) among heifers with PPI described as short, < 50 d (128.9 ng/ml); medium, 51-65 d (115.2 ng/ml); and long, 66-130 d (52.9 ng/ml). When analyzed as a regression, a 1 ng/ml increase in IGF-1 (UIP and CON heifers) at calving (P < .05) and throughout the postpartum period (P < .01) decreased PPI by .13 d. Numerically, FSCR in UIP heifers was greater than that for CON (7 of 8 UIP vs 6 of 10 CON). Based on the results of this study, the inclusion of UIP in diets for primiparous heifers and its effects on PPI and FSCR warrants further evaluation.

Key Words: Heifers, UIP, IGF-1

521 Duration and synchrony of estrus in Angus and Beefmaster cattle given an intravaginal progesterone releasing insert plus estradiol benzoate or GnRH plus PG. W. A. Whitworth, D. R. Shelby*, C. B. Scott, B. J. May, and G. R. Engdahl, *Angelo State University, San Angelo, Texas.*

The objectives of this study were to evaluate the effects of two estrous synchronization regimens on the duration and synchrony of estrus and on the conception rate during the sychronized estrus. Treatments were (1) an intravaginal progesterone releasing insert (IVI) left in place for 7 d plus 1 mg of estradiol benzoate given i.m. at the time of insertion, (2) the Select Synch (SS) combination of GnRH and PG, and (3) control (C). Each treatment group consisted of 29 AN (7 virgin heifers, 22 lactating cows) and 11 BM (3 virgin heifers, 8 lactating cows) females maintained on dry west Texas rangeland with no flushing procedures, which is typical for local ranches. Estrus was detected and monitored by Heat Watch [TM]. The number of females in estrus within 6 d following treatment were 28, 29, and 10 for treatments IVI, SS, and C, respectively. There were no differences between the IVI or SS treatments, but both differed (P < .01) from the C treatment. The number of females cycling was reduced by the drought conditions of the rangeland and resulting reduction in availability of palatable, high quality forage. Treatment did not affect (P > .20) duration of estrus, number of mounts, or conception rate (IVI = 633 min, 33 mounts, 89 percent; SS = 654 min, 36 mounts, 79 percent; C = 723 min, 23 mounts, 80 percent). Heifers were in estrus longer and had more mounts (P < .01) than lactating cows (963 min, 49 mounts vs. 557 min, 25 mounts). The treatments were equally effective in synchronizing estrus and achieving pregnancy.

Key Words: Synchronization, Beef Cattle, GnRH

522 Impact of mastitis on the accuracy of the diphasic lactation curve model. E. H. Shim* and R. D. Shanks, *University of Illinois, Urbana.*

Lost milk production is a costly consequence of mastitis. To effectively gauge the loss in milk yield, lactation curves can be utilized to predict theoretical milk yields in the absence of mastitis. The diphasic logistic function is a proposed model for lactation curves in dairy cattle. Daily milk yields were collected from January of 1994 through January of 1996 at the University of Illinois Dairy Unit. The effect of mastitis diagnosis (no mastitis [144 records], mastitis within 150 days of freshening [49 records], or mastitis after 150 days of freshening [30 records]) and parity (first or second and later) on the diphasic logistic function was investigated. The function was fit on all records individually using NLREG[®]. The variation explained by the model significantly differed (P<.05) between animals with no mastitis (.670 ± .022) and animals with mastitis (.593 ± .023); and between records for animals with mastitis within 150 days of freshening (.566 ± .026) and animals with mastitis after 150 days of freshening (.644 ± .034). The variance explained by the model significantly differed (P<.05) between first parity (.561 ± .034) and lactations after first parity (.696 ± .016). The diphasic logistic function is most appropriate for first parity records. Mastitis within 150 days of freshening significantly reduced efficacy of the diphasic logistic function and lessened the accuracy of milk yield predictions.

Key Words: Mastitis, Lactation curve, Milk yields

523 The use of electrical conductivity as a measure to determine feed mixing uniformity in feedlot rations. D. R. ZoBell*[1], D. Karren[2], R. Atkins[3], D. Engstrom[3], and L. Goonewardene[3], [1]*Utah State University, Logan UT,* [2]*Raymond, AB,* [3]*Alberta Agriculture Food and Rural Development, Edmonton, AB.*

The objective of this trial was to determine if electrical conductivity can be used as a measure to determine feed mixing uniformity in three types of feedlot rations. Rations contained low (48.5 %), intermediate (77.1 %), and high (85.1 %) concentrate levels (DMB). Feedstuffs used were barley grain, barley silage, molasses and feedlot premix. Two feed mixers were used in the study which were paddle and auger types although they were not compared against each other. Ten samples were taken for each of the low, intermediate, and high concentrate rations and this was replicated five times over five days for each of the two mixers. A standardization test, which utilized sodium chloride and subsequent electrical conductivity, was developed to determine mixing uniformity of the rations and mixer types. Electrical conductivity calibration curves were developed for each of the feedstuffs used in the rations, for sodium chloride and for the feed mixtures and repeatability tests were also conducted. The data was analyzed to determine means, standard deviation and coefficients of variation (CV) for each ration and mixer type. This trial appears to demonstrate that electrical conductivity can be used to determine mixing uniformity in feedlot diets containing low, intermediate and high concentrate levels.

Key Words: Feed mixing, Electrical conductivity, Feedlot

524 Ruminal in situ degradation of alcohol-fermented feedstuff. J. S. Shin*[1], C. G. Yan[2], B. W. Kim[1], and B. J. Hong[1], [1]*Kangwon National University, Korea,* [2]*Yeon-Byeon Agriculture University, China.*

The objective of this experiment was to determine effects of yeast treatment on 72-h ruminal in situ dry matter (DM), crude protein (CP) and neutral detergent fiber (NDF) of two diets. The two diets consisted of alcohol-fermented feedstuff (AFF;100% corn added with 50% water, 10% molasses, and 5% yeast and fermented for 4 h at $32°C$) and control (non-fermented corn). Ten g DM samples of each diet were incubated in four 10x17 cm dacron bags in each of two ruminally cannulated Korean cattle, with the bags removed after 3, 6, 9, 12, 24, 48 and 72 h of incubation. Ruminal DM degradation was faster for AFF than control at all collection hours. Effective DM degradability (K=0.05) of AFF was higher (P < .05) than that of control by 3.89%. The NDF and CP disappearance rates were greater (P < .05) for AFF than control by 10.19 and 4.49%, respectively. Effective NDF degradability (K=0.05) of AFF was higher (P < .05) than that of control by 5.26%, but the CP degradability (K=0.05) of AFF did not differ with that of control. These data clearly indicate that fermentation with yeast can improve the digestibility of feedstuffs in the rumen.

Key Words: Alcohol-fermented, In situ

525 Resolution of Two Ultrasonic Units, Using a Multipurpose Tissue Mimicking Phantom as the Standard. F. N. Domatob*[1], J. E. Novakofski[1], S. L. Spahr[1], A. Mizrach[2], and E. Maltz[2], [1]*University of Illinois, Urbana,* [2]*ARO, Volcani Center, Bet Dagan, Israel.*

Echo genic point targets of known distances apart, and embedded in a multipurpose phantom of tissue mimicking material were scanned with two ultrasonic units to determine relative machine errors. Typical b-mode images of point targets were recorded at 50-mm depth with Pie medical, and 30-mm depth with Sonomed ultrasounds equipped with 3.5/5.0 - MHZ and 7.5 - MHZ transducers respectively. Feasibility of using digitized scans of subdermal fat from the two ultrasonic units for estimation of body condition score (BCS) was also investigated. Split-split-plot analysis of variances indicated differences in measurements of target points. The two ultrasound machines overestimated distances between target points, with no set pattern, and no differences due to transducer frequencies. It was visibly easier to measure the distances at higher transducer frequencies (5.0 and 7.5 - MHZ) due to increased attenuation. Regression of BCS from subdermal fat along lactation showed significant R^2 values of 0.36, 0.41, 0.33 for rib, loin, rump sites respectively, measured with Pie Medical, and 0.68, 0.69, 0.59 respectively with modified Sonomed ultrasound. The difficulty to diagnose differences in

ultrasonic machine resolutions could be attributed to the coded velocity and density of each ultrasonic unit that is not be tissue specific.

Key Words: Ultrasound, Resolution, Phantom

526 Evaluation of liver copper and zinc concentrations in southwestern calves. R. C. Waterman*, J. B. Taylor, J. E. Sawyer, L. A. Balstad, D. Bradden, J. R. Strickland, and M. K. Petersen, *New Mexico State University, Las Cruces, NM USA.*

Compromised immune response has been associated with marginal trace mineral status. To evaluate the claims that southwestern calves have a higher morbidity and mortality rate than calves from other parts of the country due to possible nutritional deficiency, liver biopsies were conducted along with lymphoblastogenesis analysis to evaluate the potential relationship between trace mineral deficiency and immune response. Liver biopsies were obtained from fifty calves off of seven different ranches, at El Sueno Del Corazon Ranch (ESDC, a prefeedlot conditioning operation: Abiquiu, NM) to determine liver copper (Cu) and zinc (Zn) concentrations. In addition, lymphoblastogenesis analysis was conducted 14 d after biopsy. Calves that were sampled had been in residence for 1 ' 12 d prior to biopsy. Upon receiving at ESDC, calves received Cattlemaster 4 and pasteurella vaccinations and were treated for any apparent sickness. Calves from four of the ranches received a slow release copper bolus. Liver biopsies were performed using a 14-gauge biopsy needle 15-cm long (Cook Urological Co. Spencer, Indiana). Samples were placed in 1.7-ml micro-centrifuge tubes with attached caps and frozen until prepared for analysis by atomic absorption spectroscopy. Liver Cu ranged from 36-1466 ppm and Zn ranged from 61-1349 ppm. Mineral status was adequate to high for all calves; however, there were some differences in Cu ppm among ranches (P<. 04). Liver sample wet and dry weights among calves were not different (P >. 2, P>. 1 respectively). No differences in liver Cu were detected among ranches within calves receiving the Cu bolus (P >. 2). Lymphocytes were isolated from jugular blood and proliferation responses to concanavalin A (CONA), phytohemagglutinin P (PHA), and pokeweed mitogen (PWM) were evaluated. All animals responded positively to lymphoblastogenesis assays (P >. 05) demonstrating that calves sampled were capable of mounting a cell-mediated immune response.

Key Words: Liver Biopsy, Trace Minerals, Immune response

527 The use of on-farm Quick Tests to estimate manure nitrogen. J. S. Van Kessel* and J. B. Reeves, III, *USDA-ARS, Beltsville, MD.*

Knowledge of the nutrient content of manure is fundamental in determining appropriate manure application rates. Nutrient analyses performed rapidly, on the farm could be very useful for determining manure nutrient contents. This experiment was designed to evaluate six Quick Tests for their accuracy in estimating manure N (total) or NH_4^+-N concentrations. Quick Tests included in the study were the hydrometer, electrical conductivity meter and pen, reflectometer, Agros N Meter (or Nova meter), and Quantofix-N-Volumeter. The hydrometer has been used to predict total N and P while the remaining Quick Tests have been used to predict NH_4^+-N. Manure samples (107) were collected from dairy farms in five eastern states. The samples were analyzed for total N and NH_4^+-N by traditional laboratory methods (Kjeldahl and distillation, respectively) and for total N or NH_4^+-N using each of the Quick Tests. Manure dry matter (DM) ranged from 1.4% to 38.6%; total N ranged from 0.09% to 0.94%; and NH_4^+-N ranged from 0.02% to 0.47%. The estimated concentration of N or NH_4^+-N determined by each Quick Test was regressed against laboratory-determined concentrations. In all cases, linear regressions were significant (P < 0.01). The strongest linear relationship for prediction of NH_4^+-N was with the Quantofix-N-Volumeter ($r^2 = 0.95$; slope = 0.98). The Agros N Meter and the reflectometer also predicted NH_4^+-N with relative accuracy ($r^2 = 0.81$ and 0.91; slope = 0.99 and 0.84; for Agros and reflectometer, respectively). The r^2 for the relationship between electrical conductivity and NH_4^+-N was 0.87 and 0.89 for the meter and pen, respectively. The hydrometer did not perform well as a predictor of total N ($r^2 = 0.48$; slope = 0.56). Because some of the Quick Tests were designed specifically for slurries, manure samples were also split into high (> 12%) and low DM ($\leq$ 12%) groups. In all cases, the regression of the predicted vs. laboratory N value was significant (P < 0.01) and the r^2 for the regression equation was higher for the low DM group than for the high DM

group. These data indicate that, several Quick Tests are viable options for measuring NH_4^+-N concentrations in dairy manure.

Key Words: manure, nitrogen, dairy

528   Mortality in dual-purpose calves from 0 to 12 months of age in Perija, Venezuela. O. Araujo-Febres* and S. Oliveros, *The University of Zulia. Animal Science Department*.

Calf records (n = 600) for both sexes between 1986 and 1990 were utilized with the objective of estimating mortality (TM) during the first 12 months of age in a dry tropical forest zone in the Perija region of Venezuela. The data was analyzed using distribution frequencies and the chi-square statistics, considering breed type and sex of the calf, year and season of birth, and number of parturitions (dam) as discrete independent variables. Results indicated that the total mortality rate during the period studied was 20.7%. The chi-square analysis determined the the TM varied with breed type (P<.001) being greater for predominantly Holstein (42.7%), intermediate for predominantly Brown Swiss (32.3%) and lower for predominantly Brahman (17.8%). The effect of sex on TM was significant (P<.001) with males being more susceptible that females (26.3% vs. 15.4% respectively). Year and season of birth was also significant (P<.001) as to TM with values which oscilated between 13.7 and 39.0% for year; while for season the major TM occurred during the April-June (27.5%) and the lower TM occurred during dry season December-March (15.0%). Parity had an (P<.001) effect on TM with first calf parturition being the major (29.2%) and lowest in cows with 4 or more parturitions (12.4%). Its was observed that highest TM occurred around the natal period (5.6%).

Key Words: Crossbred calves, mortality, tropics

529   Effects of milk replacer feeding level on Alpine kid performance. A. L. Goetsch*[1], R. Puchala[1], M. Lachica[1], M. Cameron[1], T. Sahlu[1], and L. J. Dawson[2], [1]*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK,* [2]*College of Veterinary Medicine, Oklahoma State University, Stillwater, OK*.

Seventy-nine Alpine kids (35 female and 44 male) were used to determine effects on ADG of milk replacer (MR) consumed ad libitum (AS/AV) or with restricted consumption of volume alone (AS/RV) or of volume and solids (RS/RV). Kids began the 8-wk experiment at 3 to 9 d after birth (3.5 ± .11 and 3.9 ± .08 kg initial BW for females and males, respectively). A commercial MR was fed twice daily. The AS/AV kids received ad libitum access to MR with 18% DM. The RS/RV kids received 18% DM MR, with ad libitum access in wk 1 and approximately 90, 80, and 70% of consumption by AS/AV kids in wk 2, 3, and 4 to 8, respectively. The AS/RV kids received ad libitum access to 18% DM MR in wk 1, thereafter receiving a similar quantity of solids as AS/AV kids but limited volume or water, with a MR DM concentration of 20, 22.5, and 25.7% in wk 2, 3, and 4 to 8, respectively. Milk replacer DMI was 231, 223, and 197 g/d in wk 1 to 4 (SE 7.1) and 276, 260, and 228 g/d (SE 8.2) in wk 5 to 8, and water intake was 1,050, 802, and 899 g/d (SE 30.7) in wk 1 to 4 and 1,258, 846, and 1,039 g/d (SE 32.8) in wk 5 to 8 for AS/AV, AS/RV, and RS/RV, respectively. Gain of BW was least (*P* < .07) among treatments for RS/RV in wk 1 to 4 (146, 131, and 118 g/d, SE 5.9) and 5 to 8 (137, 140, and 115 g/d, SE 7.2, for AS/AV, AS/RV, and RS/RV, respectively). However, sex influenced (*P* < .06) treatment effects on ADG in wk 1 to 8 (female: 129, 120, and 117 g/d and male: 155, 151, and 116 g/d for AS/AV, AS/RV, and RS/RV, respectively; SE 7.2). Treatment did not affect BW gain in the subsequent 4-wk period after weaning (*P* > .10). In conclusion, restricting intake of fluid or water alone in MR did not enhance ADG of Alpine kids, and lower growth potential of female vs male kids may lessen susceptibility to effects of limited MR DMI.

Key Words: Goat, Milk replacer

530   Postweaning growth performance in Spanish, Boer x Spanish, and Boer x Angora goat kids. M. R. Cameron*[1], J. Luo[1], T. Sahlu[1], S. Hart[1], and S. Coleman[2], [1]*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK,* [2]*USDA/ARS Grazinglands Research Lab, El Reno, OK*.

Postweaning performance, apparent total tract nutrient digestibility, and plasma metabolite profiles of growing Spanish (S), Boer x Angora

(BA) and Boer x Spanish (BS) castrates were investigated. The experiment was conducted over two 8-wk feeding periods: 78 S, 20 BA, and 30 BS were used in the first 8-wk period and 18 kids per genotype were used in the second 8-wk period. Kids were weaned at 8 wk of age and fed a commercial goat starter diet (25% CP, 2.71 Mcal/kg DE, 34.7% NDF, and 18% ADF) ad libitum. Feed intake was recorded daily and BW at 2-wk intervals. Digestibility was measured in wk 17 to 18 by weighing and sampling of offered feed, feed refusals, and feces for a period of 5 d. Boer x Angora and BS castrates had greater (*P* < .001) initial and final BW than S (7.3, 7.2, and 6.6 ± .2 kg; 24.4, 25.2, and 19.5 ± .25 kg, for BS, BA, and S, respectively). Final BW of BA was greater than BS (*P* < .03). Average daily gain (154, 161, and 117 ± 5.6 g/d), DMI (646, 683, and 522 ± 21.5 g/d), and gain:feed (263, 261, and 235 ± 8.0 g of BW gain/kg of feed consumed) were also greater (*P* < .05) for BS and BA vs S, respectively. Averaged daily gain, DMI, and feed:gain were similar (*P* > .05) between BA and BS. Body weight and DMI increased (*P* < .001) linearly and quadratically over time; the rate at which BW and DMI changed over time was greater (*P* < .001) for Boer crosses than S. Average daily gain increased linearly (*P* < .001) while feed efficiency decreased (*P* < .001) linearly and quadratically over the 16 wk feeding period. Genotype had no effect (*P* > .05) on digestibilities of dietary DM, OM, CP, or gross energy (687 ± 1.4%, 70.6 ± 1.3%, 69.9 ± 1.4%, and 69.3 ± 2.4%, respectively). Genotype also had no effect on plasma concentrations of total protein, glucose, or NEFA (*P* > .05). However, BA had greater (*P* < .05) concentrations of plasma urea N compared with S and BS (25.5, 19.6, and 21.3 ± 1.0 mg/dL, respectively). Under intensive management, the use of Boer bucks as terminal sires has the potential to produce crossbred kids which grow faster and achieve heavier BW as compared to fullblood Spanish goat kids.

Key Words: Goat, Boer, Growth

531   Influence of breed and nutrition on growth rate, scrotal circumference, and onset of puberty in bucks of meat-type goats. S. Wildeus*, *Virginia State University, Petersburg, VA*.

Spring-born bucks (n=30) of the Myotonic (MY), Nubian (NU), and Spanish (SP) breeds were used to determine changes in BW during a 57 d preweaning period (PRE), a 77 d postweaning period (POST) and a 98 d experimental period (EXP). Animals were managed either under a high (HI) or a low quality forage system (LO) during PRE and POST, then reallocated within breed and forage system for EXP and pen-fed a pelleted ration (16% CP) at either 3 or 4% of BW. Onset of puberty (ejaculate containing spermatozoa with a mass motility >10%) was determined from semen samples collected weekly by electroejaculation during EXP. Growth for PRE and POST was analyzed in a model with breed and forage system as main effect and birth type as covariate; for EXP plane of nutrition was added to the model. Preweaning ADG was not affected by forage system, but was lower (P<.05) in MY (88 g/d) than NU (150 g/d) and SP (130 g/d). Postweaning ADG was higher under HI than LO (62 vs 33 g/d; P<.01), and higher (P<.01) in SP (74 g/d) than in NU (43 g/d) and MY (34 g/d). During EXP, ADG was higher (P<.05) in NU (134 g/d) than in SP (99 g/d) and MY (87 g/d), and tended to be higher (P<.1) for bucks originating from LO than HI (120 vs 94 g/d). Growth of SC during EXP tended to be lower for SP (.056 cm/d) than NU and MY (.075 cm/d), and was higher (P<.01) in animals originating from LO than HI (.085 vs .054 cm/d). Plane of nutrition during EXP had no effect on ADG and SC growth. Age at puberty was earlier (P<.05) in SP (146 d) than in MY (172 d) and intermediate in NU (155 d), and BW at puberty was lower in MY (13.8 kg) than in NU (18.5 kg) and SP (17.9 kg), whereas SC was similar between breeds (18.6 cm). Forage system affected age of puberty (HI: 142 d; LO:172 d; P.<01) and SC at puberty (HI: 18.0 cm; LO: 19.5 cm; P<.05). These data indicate that a higher growth rate early postweaning enhanced the onset of puberty, and that breeds of different mature size varied in age and BW, but not SC, at puberty.

Key Words: Meat Goats, Puberty, Nutrition

532   Influence of weaning method on foal immune function. J. L. Turner*[1], J. E. Minton[1], M. J. Arns[1], and J. A. Pruitt[2], [1]*Kansas State University, Manhattan, KS,* [2]*Southwest Missouri State University, Springfield, MO*.

Previous reports suggest that weaning method influences cortisol secretion and foal immune function in the immediate post-weaning period.

This study evaluated the effect of two weaning methods on plasma cortisol and peripheral blood leukocyte (PBL) population of weaned foals. Twelve Quarter Horse mare-foal pairs were ranked by age (range = 4 to 6 mo) and randomly assigned to two weaning treatments: Abrupt (A; immediate isolation of foal from mare) or Gradual (G; fenceline contact for two days followed by total separation). Six foals per treatment were weaned on the same day (d 0). Foals were weighed on d -23, -16, -9, -2, 7, and 12 relative to weaning to measure changes in ADG. The activity levels of foals were measured with a pedometer at 12 h intervals. Plasma cortisol was measured through five days post-weaning. On d 0, 1, 3, and 5, PBL were differentially counted, and harvested lymphocytes were cultured in a lymphocyte transformation assay. Data were analyzed with the PROC GLM procedure of SAS as repeated measures over time. ADG declined (P<.01) after weaning, but did not differ between treatments. Activity level did not differ between treatments, but activity was elevated (P<.05) at 12, 72, and 108 h post-weaning. Plasma cortisol did not differ between A (45.1±3.7 ng/mL) and G (41.8±3.8 ng/mL) weaned foals. Total neutrophils (P<.05) and total white blood cells (P<.01) were higher for A on d 0, 1, and 3 when compared to G. There were no differences between treatments in lymphocyte proliferation in response to phytohemagglutinin or pokeweed mitogens. There was a day-by-treatment interaction for Concanavalin A stimulated lymphocyte proliferation with a greater (P<.01) response in A on d 1. We conclude that foals weaned by abrupt or gradual methods show a similar cortisol response to weaning. Foal immune function in the immediate post-weaning period does not appear to be greatly affected by weaning method.

Key Words: horse, weaning, immunity

533   Evaluation of vitamin E and selenium supplementation in late gestation on lamb survival and pre-weaning growth. A. Ali*[1], D. G. Morrical[1], M. P. Hoffman[1], and M. F. Al-Essa[1], [1]*Iowa State University, Ames, IA.*

Positive growth responses to supplemental vitamin E and selenium have been demonstrated in many sheep studies. The objective of this study was to evaluate vitamin E injection and selenium (Se) supplementation in late gestation on lamb survival and pre-weaning growth performance. Ewes were grouped in pens based on their fetal count and body weight. The feed provided to ewes in late gestation included hay, corn and protein according to NRC recommendations. Ewes in late gestation were assigned to the 2x2 factorial treatment design within fetal count. Treatments were no vitamin E or 900 IU injectable vitamin E per week and 10 or 90 PPM of Se in a mineral supplement fed free choice. Within each pen of ewes (8-10 hd), approximately one half of the ewes received injectable E beginning 4 wk before the first expected lambing and the other one half received no vitamin E. Vitamin E treatments ended at lambing time, however, ewes remained on their respective mineral sources during lactation. Lambs were provided access to creep (16% CP and 83% TDN and fortified with 35000 IU of vitamin E, 0.27 g Se and 50 g of chlortetracycline per 909 kg) from 10-d of age to weaning. Injectable vitamin E did not effect birth weights of lambs, however, 90 PPM Se improved birth weights of lambs (5.06 vs 4.88 kg, P < .10). Improved birth weight was from 90 PPM Se specifically in lambs born to 6-7 compared to 1-5 year old ewes (P < .01). Vitamin E specifically increased (P < .05) the performance of lambs from 1-2 and 6-7 year old ewes but that effect was not observed in lambs from 3-5 year old ewes. Multiple born lambs from ewes treated with vitamin E had increased survival (P < .05). Single born lambs survival was not effected by vitamin E or Se treatment. From this study it was concluded that supplementation of 90 PPM Se to ewes improved birth weights of lambs from 6-7 year old ewes and injectable vitamin E to ewes increased the survival of multiple born lambs and pre-weaning growth of lambs from 1-2 and 6-7 year old ewes.

Key Words: Lamb performance, Vitamin E, Selenium

534   Prickle factor in fleeces of performance-tested fine-wool rams. C. J. Lupton*, D. F. Waldron, and F. A. Pfeiffer, *Texas Agricultural Experiment Station, San Angelo, Texas.*

Prickle factor (PF, % of fibers > 30 μm) is an indicator of the relative comfort of wool fabrics worn next to the skin. PF, average fiber diameter (AFD), SD, and CV were measured (with an Optical Fibre Diameter Analyser) in three consecutive years on core samples of unskirted fleeces

from 524 fine-wool rams completing a central performance test to establish PF in fleeces produced under the unfavorable (from a wool fineness and uniformity perspective) test conditions and to determine relationships among PF, fiber fineness and variability measures. As part of the normal performance test routine, AFD, SD, and CV of side and britch samples were also measured for each fleece because AFD of side samples are used in the index of overall merit and AFD of side and britch samples constitute independent rejection criteria for ram certification. Core sample PF, AFD, SD, and CV averaged 5.5 %, 22.3 μm, 4.4 μm, and 20 % and ranged from .4 to 25.3 %, 17.3 to 26.8 μm, 3.1 to 6.4 μm, and 15.2 to 28.6 %, respectively. PF, SD, and CV did not differ by year (P > .05). It has been suggested that only wools having low PF (< 2 %) be used in apparel worn next to the skin. Eighteen percent of the fleeces were in this category. Stepwise multiple regression analysis for PF vs all measured variables plus AFD^2 and differences between side and britch AFD resulted in core AFD^2, core AFD, britch SD, core SD, side CV, and core CV entering the equation. No other variable met the .01 significance level for entry into the model. Partial r^2 values for the first three variables were .82, .10, and .03, respectively. This result was essentially unchanged when fleeces (349) having core, side, and britch AFD > 23.6, 24.9, and 27.8 μm, respectively (i.e., from coarse, uncertifiable rams) were excluded from the analysis. Most of the variability in PF can be accounted for by core data alone, i.e., PF = 199.57 + .46*AFD^2 - 19.33*AFD + 6.01*SD - 1.01*CV, r^2 = .94.

Key Words: Wool fleeces, Prickle factor, Performance-tested rams

535   Results of skirting and classing fleeces on the value of wool from fine-wool range ewes. F. A. Pfeiffer* and C. J. Lupton, *Texas Agricultural Experiment Station, San Angelo.*

Fleeces from 1633 (± 337) mixed-age, fine-wool range ewes were skirted (inferior portions separated from bulk of fleece) and classed (fleece portions grouped according to measurable characteristics) at shearing time in April or May of each year from 1992 to 1997 to establish average proportions and values (prices paid) of each classing line and overall value of the annual clip. The wool clips (6765 ± 1340 kg) were prepared in accordance with the American Sheep Industry Association's Code of Practice. Average prices obtained for these classed wools were compared with the extremes of price ranges published in the USDA, AMS Market News for comparable original bag (OB; wool packaged without skirting) Texas wool (64's grade, 54% yield, ≥ 7.6 cm) during the first week of May in each year of the study. The average proportion ± SD (%) and average price ± SD (/greasy kg) of the major classing lines were: main 12-mo line (A), 56.1 ± 4.7, 3.02 ± .57; 12-mo yearling wool (AL), 8.9 ± 6.3, 3.15 ± .61; tender or short wool (A2), 5.7 ± 1.6, 2.13 ± .35; bellies (BLS), 7.2 ± 1.0, 1.34 ± .24; pieces (PCS), 9.9 ± 2.7, 1.54 ± .30; and locks (LKS), 11.2 ± 1.3, .99 ± .33, respectively. Because A and AL were more valuable than the other classing lines, clip value would be maximized by minimizing the amounts of A2, BLS, PCS, and LKS. Average price received for skirted and classed clips ($2.49 ± .50/kg) was not different than either the mean low ($2.35 ± .59/kg; P = .46) or the mean high ($2.64 ± .61/kg; P = .37) of the ranges for OB wool published in the Market News. Marketing these skirted and classed wools failed to produce more income than would have been generated by selling comparable weights of wool packaged in OB form.

Key Words: Wool, Skirting, Classing

536   Production and evaluation of peptidoglycan (PG) derived from e. coli BL-21 as an immunopotentiator in early weaned pigs. H. Lam, R. R. Hacker*, and C. Okere, *Dept. of Animal & Poultry Science, University of Guelph, Guelph, Ontario Canada N1G 2W1.*

Piglet diarrhea occurs continuously or sporadically in all swine herds in Ontario. Also emerging evidence indicates widespread resistance to antibiotics commonly used to combat neonatal diarrhea. Peptidoglycan (muramyl dipeptide) derived from bacterial cell wall is a well known immunopotentiator. This study was designed to evaluate the feasibility of producing PG from an alternative inexpensive source *E.coli BL-21* and also to determine the immunological consequences of supplementing neonatal pigs with PG derived from this source. PG was derived from *E.coli K12 strains BL-21* by modifications of methods described by Sprott et al. 1994. Approximately 400 mg crude PG was recovered from 4 litres of cultured *E.coli BL-21* cells. This represented a yield of 0.1 g/litre of culture. Piglets (n=193) from 20 litters were randomly

allotted to five treatment groups consisting of PG 1 (4% PG, 2 mg/ml); PG 2 (4% PG, 20 mg/ml) manufactured by Ajinomoto Co., Inc. Tokyo, Japan; PG 3 (70% PG, 0.15 mg/ml); PG 4 (70% PG, 1.5 mg/ml) PG derived from *E.coli BL-21* and saline. PG or saline (1 ml/piglet) was administered orally for 7 consecutive days from d 3 to 9 of lactation. All piglets were weaned on lactation d 10. Piglets were weighed or bled at birth, days 3, 10, 15 and 21 postpartum. Concentrations of IgG and IgA in piglet serum were determined by SRID (Mancini et al. 1965). Also piglets were observed and scored for clinical signs of postweaning diarrhea. Day 10 weaning weights were larger (3.00, 3.01, 3.11, 3.05 vs 2.92 kg) for PG 1, PG 2, PG 3, and PG 4 treated piglets compared to controls. However, when birth weight was included as a covariate weaning weights were similar for each group (P=0.48). Body weights on day 21 were also similar for each group (4.68, 4.74, 4.77, 4.67 vs 4.42 kg, P=0.25). Compared to controls, all four treatments resulted in non-significant increases in postweaning serum IgG and IgA concentraitons (1032.1, 1009.5, 1094.5, 1031.4 vs 1004.9 mg/100 ml, P=0.18) and (806.7, 878.8, 869.6, 805.6 vs 745.8 mg/100 ml) for days 10 and 21 respectively. These results demonstrated the feasibility of producing large quantities of PG from an alternative, inexpensive and aerobic source *E.coli Bl-21*. Also, the sustained postweaning high levels of serum IgG in treated piglets suggest that PG derived from *E.coli BL-21* have invitro-immunopotentiating activity.

Key Words: Peptidoglycan, Immunopotentiator, Neonatal pigs

537   Estrus profile in female swine according to the weaning-to-estrus interval and parity. T. Lucia, M. N. Correa, J. C. Deschamps, G. Gaciba, and L. Caron, [1]*Centro de Biotecnologia - UFPEL.*

Short weaning-to-estrus interval (WEI) is associated with long estrus duration (ED). This study characterized the estrus profile (duration and frequency of estrus according to the period of estrus detection) across categories of WEI and parity. We analyzed 98 F1 sows: 28 primiparous (P1); and 70 having parity two or higher (P2+). The WEI was categorized as: Short, when equal to at most 97 h (55.1% of the sows); and Long when longer than 97 h (44.9% of the sows). Estrus detection was conducted four times daily (8:30 a.m., 3:30 p.m., 6:30 p.m. and 10:30 p.m.). The beginning and the end of the estrus were determined by a positive and a negative response to back pressure in the presence of a boar, respectively. Frequency distributions measured the proportion of females detected in estrus at each period. Effects of parity on WEI, and effects of period of detection, parity and WEI on ED were analyzed by ANOVA through the GLM procedure of SAS?. The association between WEI and ED was estimated by a linear regression model. Mean parity was equal to 2.5, whereas mean intervals were equal to 80.4 h for short WEI and to 118.6 h for long WEI. While 40% of the females were detected in estrus at 8:30 a.m., 10% of the females were detected in estrus at 6:30 p.m., and 25% of the females were detected in estrus at each of the other periods (3:30 p.m. or 10:30 p.m.). Parity did not influence the WEI (P > .05). The period of estrus detection did not influence the ED (P > .05). The ED did not differ (P > .05) between P1 and P2+ sows (53.8 and 59.1 h, respectively). The ED was shorter (P < .0001) for long WEI (61.9 h) than for short WEI (51.0 h). According to the linear regression model (R2 = .05), the ED would be estimated by the following equation: ED = 73.3 -.12(WEI) (P = .02). Thus, despite the higher proportion of females detected in estrus at 8:30 a.m., the period of estrus detection had no influence over the ED. In this study, the negative association between WEI and ED was not influenced by parity.

Key Words: Estrus profile, weaning-to-estrus interval, parity

538   Effect of subcutaneous or intramuscular administration of PG600® on estrus and ovulatory responses in prepubertal gilts. R. V. Knox*, K. Tudor, and J. Robb, .

This experiment investigated the impact of subcutaneous (sc) versus intramuscular (im) administration of PG600 on estrus and ovulation in prepubertal gilts. The experiment was conducted in 5 replicates from Jul 1997 to Feb 1998. Crossbred gilts were randomly assigned by age, weight and litter to receive PG600 sc in the flank (n = 56) or im in the neck (n = 50). Control animals (no treatment, n = 26) were included in 3 replicates. Females were 165.6±0.3 d of age and weighed 99.5±1.2 kg when allotted to treatment. After administering PG600, all females were regrouped and moved to new pens in an open front barn. Within each replicate, each treatment was allocated equally across pens. All

animals were detected for estrus once daily for 15 min using fence-line contact with a boar. Estrus detection continued for 12 d and then reproductive tracts were collected. Ovaries were examined for the presence of CL, cystic follicles (>14 mm) and cystic CL. There were no differences in the mean age or weight of gilts at initiation of the experiment across treatments (P>.10). A greater proportion (P<.005) of gilts was induced into estrus with scPG (82%) compared to imPG (56%), and a greater proportion of gilts (P<.001) was induced into estrus with imPG compared to controls (19%). Age at puberty (170.2±0.3 d) and days to estrus (4.8±0.1 d) from initiation of boar exposure and PG600 injection were not influenced by treatment. Greater proportions (P<.001) of gilts ovulated with scPG (84%) and imPG (78%) compared to controls (19%), but scPG and imPG did not differ from each other (P>.10). The number of CL (19.4±1.6) were not influenced by treatment, and there was no effect of treatment on proportions of gilts with cystic CL (P>.1) or cystic follicles. The results of this study indicate that administration of PG600 to prepubertal gilts by a subcutaneous route could provide advantages for induction of estrus and fertility.

Key Words: Gilts, PG600, Estrus

539   Method of Boar Exposure on Puberty Attainment in Gilts. J. L. Patterson*[1], H. J. Willis[2], G. R. Foxcroft[1], and R. N. Kirkwood[2], [1]*University of Alberta, Edmonton, Alberta/Canada,* [2]*Agriculture Food and Rural Development, Edmonton, Alberta/Canada.*

Eighty-nine prepubertal large white gilts were used to confirm the most effective method of boar exposure for the attainment of puberty in a modern, commercial genotype. At approximately 160 d of age, groups of gilts were stratified by age and weight, and randomly allocated to one of three treatments representing different strategies for puberty stimulation: 1) gilts to boar stimulation pen (GB; n=25), 2) boar to gilts' pen (BG; n=25), 3) boar in front of gilts stalls (BS; n=21). Treatments BG and GB allowed direct contact with boars while BS only permitted fenceline contact. All gilts were fed a grower diet ad libitum. Twice daily, puberty attainment was determined by recording when gilts first exhibited a standing reflex in response to the back pressure test during fenceline contact with a boar. Gilts were then exposed to a mature vasectomized boar for a minimum of ten min. At pubertal estrus, body weight, backfat thickness, age and length of standing heat were recorded. For the purpose of analysis gilts were excluded if, 1) they were known to be already cyclic based on plasma progesterone assay, or 2) they exhibited a standing reflex within 3 d of the start of treatment. Of the gilts used in the analysis, any gilt which had not exhibited a standing reflex when twice-a-day estrus detection ceased at 215 d, was assigned a pubertal age of 215 d. Treatment affected (P≤0.05) mean (±SEM) age at puberty (SB, 191.8 ± 3.3 d; GB, 181.1 ± 3.1 d; BG, 182.5 ± 3.1 d). Also, GB were lighter (P≤0.05) at puberty (123.9 ± 4.3 kg) than BS (139.4 ± 4.4 kg) with BG intermediate (128.8 ± 4.2 kg). There were no differences between treatments for backfat thickness or duration of estrus at puberty. Results confirm that the direct exposure of gilts to a boar is more effective than fenceline contact for pubertal stimulation.

Key Words: gilt, boar, puberty

540   Relationships of Serum Leptin Concentrations to Growth, Carcass and Reproductive Traits of Gilts. C. Okere*, C. Tyler, and R. R. Hacker, *Dept. of Animal & Poultry Science, University of Guelph, Guelph, Ontario Canada N1G 2W1.*

The recent identification of the *ob* gene and its protein hormone product Leptin has provided new insight in the mechanisms of nutritional signaling to the reproductive system. The objective of this study was to determine whether serum leptin concentrations were predictive of growth, carcass traits and early onset of reproductive functions in gilts. Prepubertal gilts (n=20) were selected at day 120 of age and divided equally between two groups. Gilts were weighed and bled at one weekly interval until 100 kg bodyweight (group 1) or puberty (group 2). Weekly serum leptin concentrations were determined by RIA using leptin assay kit (Linco Research Inc., Cat. #XL-85K). Gilts were bred after heat detection and sacrificed at approximately d 18 of gestation to collect reproductive and carcass data. Traits measured included age and weight at puberty, uterine weight and length, embryo number and survival rate, estimated lean yield, fat depth, lean depth, carcass index, and dressing percentage. Also, serum leptin concentrations at puberty and slaughter were recorded. Mean values for growth, carcass and reproductive traits

did not differ between groups (P>0.05). Means for age at puberty, uterine weight and length, embryo number and survival rate were 154.0 ± 10.0 d, 501.6 ± 133.2 g, 181.5 ± 37.5 cm, 8.5 ± 5.7 and 53.8 ± 32.0% respectively. Also, mean values of 89.8 ± 11.4 kg, 74.4 ± 23.3%, 60.3 ± 1.3%, 17.6 ± 2.4 mm and 91.8 ± 21.0 were recorded for hot carcass weight, dressing percentage, estimated lean yield, fat depth and carcass index. Serum leptin concentrations at puberty and d 18 of gestation were 2.35 ± 0.8 ng/ml and 2.12 ± 0.3 ng/ml respectively. The concentration of leptin in a single sample taken at breeding was correlated with

age at puberty (r=0.36, P<0.05). While causal relationships cannot be determined from the present study, the data are consistent with the hypothesis that serum leptin may be the metabolic signal for early onset of puberty. The correlation between serum leptin levels at slaughter and embryo number and survival rate, carcass weight, lean yield and lean depth were low or negative and may reflect a role of leptin in growth and reproduction which diminishes with advancing gestation.

Key Words: Leptin, Reproduction, Gilts

RUMINANT NUTRITION

541   Review of new information on the use of wet and dry millng feed byproducts in feedlot diets. R. A. Stock*[1], J. M. Lewis[1], T. J. Klopfenstein[2], and C. T. Milton[2], [1]*Cargill Corn Milling, Blair, NE 68008-0300,* [2]*University of Nebraska, Lincoln, NE 68583-0908.*

The wet and dry milling of grains to produce human foods, beverages, or fuel ethanol is continuing to increase along with an increased production of associated feed byproducts. Within the last 10 years, the feeding of corn gluten feed (CGF; wet milling) or distillers grains (DG; dry milling) in a wet or semi-moist form has received wide acceptance in feedlots. CGF and DG contain 10 to 20% more NEG when fed in the wet form than when fed in the dried form. The nutrient profiles of CGF and DG are often confused by cattle feeders and nutritionists. In addition, the nutrient profiles of these feed byproducts may vary widely from plant to plant because each plant may produce different types of human foods or beverages (wet milling) or use different grain types in the fermentation process (dry milling). Thus, it is important to understand the differences between and within the wet and dry milling industries in order to fully understand the nutritional value of these feed byproducts. In the wet milling process, corn is soaked (steeped), ground, and then separated into several fractions. Human and industrial products are primarily derived from the starch and oil fractions of the grain. The primary feed byproducts are corn gluten meal (CGM) and CGF. CGM contains 66% CP (DM basis) and the protein is high in undegradable intake protein (60% UIP). CGF is comprised primarily of bran and steep. CGF is lower in both CP (14 to 24%, DM basis) and UIP (20 to 25%) than CGM, but it is high in NEG (1.4 to 1.8 Mcal/kg). The NEG content of wet CGF appears to be similar when fed in a range of 20 to 50% of the diet DM. As the proportion of steep increases and bran decreases in CGF, the CP and NEG content of CGF increases. In the dry milling process, grain is ground, fermented, and distilled to produce alcohol. The feed byproducts that are produced include DG and condensed distillers solubles (CDS). On a DM basis, DG and CDS are generally higher in protein (25 to 32%) and higher in NEG (1.5 to 2.3 Mcal/kg) than CGF because corn oil is not removed during processing. Wet CGF and DG also reduce the incidence of subacute acidosis. Because CGF and DG have a high nutritional content and are often economically priced, they are excellent sources of energy and protein for feedlot cattle.

Key Words: Corn gluten feed, Distillers grains, Grain

542   Comparison of corn and wet corn gluten feed in roughage- or concentrate-based diets for growing beef heifers. J. S. Drouillard*, N. G. Whitham, D. A. Blasi, E. C. Titgemeyer, C. M. Coetzer, and R. D. Hunter, *Kansas State University, Manhattan, Kansas.*

Two hundred and sixteen crossbred beef heifers (238 kg) were used in a 99-d experiment to evaluate growth performance when fed roughage- or concentrate-based diets containing corn or wet corn gluten feed. Roughage-based diets contained approximately 60% ground alfalfa hay and were supplemented with either dry-rolled corn and molasses (RUFCORN) or wet corn gluten feed (RUFCGF). High-concentrate, limit-fed diets contained approximately 15% ground alfalfa hay with corn, molasses, and soybean meal (LFCORN) or with CGF (LFCGF). Additionally, limit-fed diets were top-dressed with 20 g/d of Smartamine®-ML per heifer (LFCORN-AA and LFCGF-AA). Roughage- and concentrate-based diets were fed once daily at 2.75% and 2.0% of body weight, respectively. Heifers were allotted to pens of six head, with six pens per treatment. All cattle were fed a common diet for 14 d prior to initiating the experiment. Experimental diets were fed for 84 d, after which cattle were fed a common series of step-up diets for an additional 15 d

to minimize treatment differences in gastrointestinal tract fill. Average daily gains during the 99-d trial were 1.14, 1.17, 1.15, 1.17, 1.03, and 1.00 ± .04 kg/d and gain efficiencies were .133, .130, .185, .189, .166, and .160 ± .004 kg gain/kg DM for RUFCORN, RUFCGF, LFCORN, LFCORN-AA, LFCGF, and LFCGF-AA, respectively. ADG and gain efficiencies were not different (P>.50) for RUFCORN and RUFCGF, but heifers fed LFCORN gained faster (P<.05) and were more efficient (P<.05) those fed LFCGF. Limit-fed cattle were more efficient (P<.05) than their roughage-fed counterparts. Addition of ruminally protected amino acids did not improve ADG (P>.50) or gain efficiency (P>.30) of heifers fed high-concentrate diets. CGF can effectively replace CORN in growing beef cattle diets, though its value is greater in roughage-based diets than in limit-fed, high-concentrate diets.

Key Words: Limit Feeding, Growing Cattle, Amino Acids

543   Effects of virginiamycin or monensin plus tylosin on ruminal nitrogen metabolism in steers fed corn based finishing diets with or without wet corn gluten feed. S. E. Ives*[1], E. C. Titgemeyer[1], T. G. Nagaraja[1], D. J. Bindel[1], and A. del Barrio[2], [1]*Kansas State University, Manhattan, KS,* [2]*University of the Philippines Los Banos, Laguna, Philippines.*

Six ruminally cannulated Holstein steers (345 kg) were used in a 6 x 6 Latin square to evaluate a 2 x 3 factorial arrangement of dietary and antibiotic treatments on ruminal N metabolism. CORN+SBM diet contained (% of DM) dry rolled corn (72), soybean meal (12), alfalfa hay (10), and molasses (4), and CORN+CGF diet contained dry rolled corn (63), wet corn gluten feed (30), and alfalfa hay (5). Antibiotic treatments included control (C), virginiamycin (175 mg/d, V), and monensin/tylosin (250 and 100 mg/d, respectively, MT). Steers were fed at a daily rate of 2.4% of empty BW at 12 h intervals. Each period was 18 d of adaptation and 3 d of ruminal fluid collections. Samples were collected at 0, 2, 4, 6, 8, and 10 h after the morning feeding on d 1 and 2 of collections. On d 3 of collections, rumens were dosed with 350 g of solubilized casein 2 h after the morning feeding to evaluate ruminal protease and deaminase activities. Ruminal fluid samples were collected 1, 2, 3, 4, and 6 h after the casein dose. Antibiotics created few differences in ruminal α-amino N and peptide N on d 1 and 2. After casein dosing, peptide N was unaffected by antibiotics, but α-amino N was increased (P < .05) for V compared to MT and C (9.89 vs 6.03 and 6.98 mM). Relative to MT and C, V reduced ruminal isovalerate (2.85 vs 3.63 and 3.62 mM) and increased ruminal propionate (43.8 vs 27.7 and 33.4 mM) on d 3. CORN+CGF led to higher (P < .05) ruminal α-amino N (2.11 vs 1.36 mM) and peptide N concentrations (3.09 vs 1.82 mM) compared to CORN+SBM on d 1 and 2. After casein dosing, ruminal peptide N concentrations were similar, but α-amino N was lower (P < .05) for CORN+CGF than CORN+SBM (6.3 vs 9.0 mM). Overall, virginiamycin appeared to depress deaminase activity, and the protein in CORN+CGF appeared to be more ruminally degradable than that in CORN+SBM.

Key Words: Cattle, Antibiotic, Ruminal nitrogen metabolism

544   Efficiency of limit-fed fibrous by-product diets compared to limit-fed corn or free-choice hay for developing beef heifers. A. D. O'Neil, D. L. Lalman, D. R. Gill, R. P. Wettemann, and C. A. Lents, *Oklahoma State University Stillwater.*

Thirty six Angus and Angus x Hereford heifers (314 kg initial BW) were used in a randomized complete block design to compare efficiency of limit-fed fibrous byproduct diets to a limit-fed corn diet or free choice hay for developing yearling beef heifers. Dietary treatments consisted

of: 1) free choice prairie hay (5% CP, DM basis)plus .9 kg soybean meal based supplement (CONT); 2) a whole shelled corn based diet fed at 1.22% of BW with .47% BW hay (CORN); 3) a wheat middlings / soybean hull-based diet fed at 1.42% BW with .47% BW hay (WMSH); 4) a barley malt sprout-based diet fed at 1.43% BW with .47% BW hay (BMS). All diets were formulated for .454 kg weight gain per day using 1989 and 1996 National Research Council feed energy values. Preplanned orthogonal contrasts were used to compare differences among treatments. Daily gain was greater (P<.05) for heifers fed concentrate diets (.63 kg) compared to CONT heifers (.51 kg). Daily gain among concentrate-fed groups was similar (.63, .63 and .62 kg/d for CORN, WMSH and BMS respectively). Body condition score did not differ among treatments. By design, feed DM intake differed (P<.05) among all groups at 9.19, 4.98. 5.59 and 6.24 kg for CONT, CORN, WMSH and BMS, respectively. Gain:feed for the CONT fed diet was lower compared to limit-fed diets (.055 vs .112, P<.01) and gain:feed for CORN (.126) was greater than WMSH (.112, P=.03) and BMS (.099, P<.01). Efficiency of WMSH and BMS was similar (P = .06). Limit-fed diet tabular net energy values were compared to values calculated from animal performance and DMI. Net energy for gain for CORN, WMSH and BMS was 24.7, 26.8 and 27.8% greater than tabular values and did not differ among treatments. We conclude that the improvement in efficiency of limit-fed fibrous by-product concentrate diets is similar to the improvement seen in energy value of corn-based limit-fed diets.

Key Words: Beef, Limit-fed, By-product

545   Poultry manure as a protein and mineral supplement in high concentrate diets limit-fed to gestating and lactating beef cows. J. E. Rossi*, S. C. Loerch, and M. L. Borger, .

Two experiments were conducted to evaluate poultry manure as a crude protein and mineral supplement in high concentrate limit-fed diets fed to gestating and lactating beef cows. In Exp. 1, 67 gestating beef cows (640 ± 2.86 kg) were allotted by weight to six groups with two groups per treatment. Trial duration was 126 d and began when cows averaged 134 d in gestation. Limit-fed cows were fed (on a DM basis) 5.3 kg/cow/d whole shelled corn, 1.4 kg/cow/d hay, and either 1.1 kg/cow/d of a 38% CP supplement (**SUPP**) or 1.1 kg/cow/d poultry manure (32% CP; **PM**). Cows in a third treatment were offered orchardgrass hay (11.6% CP) ad libitum (**Hay**) and consumed 14.4 kg/cow/d. Weight change was similar (P > .38) among treatments (+45.4, +57.6, and +58.5 kg for SUPP, PM, and Hay; respectively). Body condition score change was similar (P > .25; +.40, +.57 and +.47 for SUPP, PM and Hay; respectively). Feed costs per day were $1.11, $.82, and $1.46 for SUPP, PM, and Hay; respectively. In Exp. 2, 84 beef cows (620.2 ± 4.04 kg) were allotted by weight to four groups with two groups per treatment. Trial duration was 84 d. The trial began when cows averaged 243 d in gestation and ended when cows averaged 42 d post-parturition. Cows were fed 5.5 kg/cow/d whole shelled corn, 1.2 kg/cow/d hay, and either 1.0 kg/cow/d of a 38% CP supplement (SUPP) or 1.0 kg/cow/d poultry manure (37% CP; PM). Weight loss from trial initiation to 3 days post-parturition was greater (P < .10) for PM (-49.5 kg) compared with SUPP (-33.0 kg) cows. Likewise, weight loss from 3 days post-parturition to trial termination was greater (P < .05) for PM (-29.9 kg) compared with SUPP (-23.1 kg) cows. Body condition score change was similar (P > .20; -.44 and -.77 for SUPP and PM; respectively). Feed costs per day were $1.11 and $.82 for SUPP and PM; respectively. Poultry manure was equally effective as the soybean meal based supplement in providing supplemental crude protein and minerals to cows consuming high-concentrate diets. In addition, poultry manure reduced daily feed costs $.35 compared with the supplement.

Key Words: Restricted feeding, Cows, Poultry manure

546   Nutritive evaluation of diets containing food industry byproducts for sheep. A. S. Bertin*, H. W. Harpster, V. H. Baumer, and R. L. Swope, *The Pennsylvania State University, University Park.*

A metabolism trial was conducted to determine the nutritive value of a food industry byproduct blend fed at two levels and in either unprocessed or extruded form (213° F; Insta-Pro® model 2000R extruder). Byproduct blend was a recycled food industry waste consisting of 20% cereal waste, 20% candy waste, 20% chip waste, and 40% wheat middlings. Pre-extrusion values for byproduct were DM 94%; CP 11.7%;

Lipid 17.2%; NDF 23.3%; and ADF 10.8%. Byproduct (unprocessed and extruded) was substituted for the control diet (C) at two inclusion levels. Twenty Dorset wethers (38.3 kg) were randomly allotted to five isonitrogenous (urea) treatments (DM basis): 75% alfalfa hay and 25% cracked corn (C); 66% unprocessed byproduct; 33% unprocessed byproduct; 66% extruded byproduct; and 33% extruded byproduct. Preplanned orthogonal contrasts were: 1. C vs. byproduct; 2. unprocessed vs. extruded; and 3. 33% vs. 66% byproduct. Following a 17 d adaptation period, ad-libitum DMI was recorded for 9 d. During the subsequent 7 d total collection period, wethers were fed at 90% of their ad-libitum intake level. Least square means for the five respective diets (and significant*, p < .05, contrasts) were: ad-libitum DMI (g/h/d), 837^b, 997^{ab}, 1190^a, 1055^{ab}, 1021^{ab} (1*); and ad-libitum digestible DMI (DDMI, g/h/d), 582^b, 719^{ab}, 933^a, 787^{ab}, 754^{ab} (1*). Respective digestion coefficients (%) were: DM, 67.7^b 72.0^{ab}, 77.8^a, 74.6^{ab}, 73.1^{ab} (1*); CP, 74.6^{ab}, 69.4^b, 80.1^a, 73.0^b, 75.6^{ab} (3*); lipid, 64.7^a, 93.0^b 90.4^b, 93.4^b, 88.0^b (1*); ADF, 47.4^a, 32.3^b, 58.8^a, 45.9^{ab}, 49.7^b (3*) and NDF, 53.1^a, 50.9^a, 64.8^b,57.4^{ab}, 55.2^{ab}. These data suggest that byproduct can substitute for corn in ruminant diets. Ad-libitum DMI and DDMI were 27% and 37% higher in byproduct vs the control diet. However, little benefit was noted for extrusion processing. Further the 66% vs 33% byproduct inclusion level did not result in increased DDMI and was related to depressed fiber digestibility.

Key Words: Byproduct, Digestibility, Extrusion

547   Feed intake of growing lambs fed diets containing oat hulls and soy hulls to provide indigestible neutral detergent fiber. M. L. Thonney* and D. E. Hogue, *Cornell University, Ithaca, NY.*

Sixty Suffolk-sired lambs out of Finn x Dorset ewes were used to evaluate the effect of high levels of dietary fiber on feed intake of lambs growing for 42 days. Three pens of 2 ewe lambs (initial weight 24 kg) and 2 pens of 2 ram lambs (initial weight 28 kg) were assigned to each of 6 diets. Oat hulls (OH) and soy hulls (SH) provided fiber to make up diets containing 14, 19, or 24% estimated indigestible neutral detergent fiber (INDF). The hypothesis derived from previous results was that, above 14% INDF, additional fiber from SH would increase intake and additional fiber from OH would decrease intake. The 24% INDF OH+SH diet contained the same proportion of OH as the 19% INDF oat hull diet but with SH replacing corn to increase the fiber content. Thus, lambs fed the 24% INDF OH+SH diet were expected to have higher intakes than lambs fed the 19% INDF OH diet. The 24% INDF SH+OH diet contained the same proportion of SH as the 19% INDF SH diet but with OH replacing corn to increase the fiber content. Thus, lambs fed the 24% INDF SH+OH diet were expected to have lower intakes than lambs fed the 19% INDF SH diet. The 2 (fiber source) x 3 (fiber level) factorial arrangement of treatments used pen as the experimental unit and included gender as a block effect. There was a fiber source x level interaction (P<.04) for dry matter intake. Lambs fed OH diets consumed 4.0, 3.5, and 4.6% of body weight whereas lambs fed SH diets consumed 3.6, 4.2, and 4.3% of body weight for 14, 19, and 24% INDF, respectively (SE = .20). Average daily gain for ewe lambs was 313 and for ram lambs was 367 g/day (SE = 13.6, P<.07). Neither source nor level of fiber significantly affected growth rate or feed efficiency. Surprisingly, the 4 ram lambs fed the 24% INDF SH+OH diet averaged 453 g of gain/day. This unexplained sex difference in rate of gain within diet contributed to a lack of statistical differences between fiber sources for growth rate. These results support the hypothesis that fiber from OH depresses feed intake compared to fiber from SH when INDF is greater than 14% of the diet.

Key Words: Sheep, Intake, Fiber

548   Ruminal degradable protein requirements of microbes in steers consuming concentrate-based diets. C. J. Fu*, E. E. D. Felton, and M. S. Kerley, *University of Missouri-Columbia.*

Four cannulated cross bred steers (260 ± 20kg) were used in a 4 x 4 Latin square design to determine the effects of rumen-degradable protein (RDP) on microbial efficiency (MOEFF), nitrogen flow, and digestibility in the rumen. Treatments consisted of four levels of dietary RDP (6.5, 10.5, 14.5, and 18.5% on a DM basis). The basal diet consisted of cracked corn, soybean meal, and cottonseed hulls. Dietary rumen-fermented carbohydrate (RAC) was 66, 63, 58, and 57% on a dry matter basis. Soybean meal and urea was added as an RDP and ammonia

source, respectively. Dry matter intake was 4.8 kg/d (1.8% of BW). RDP levels had no effect (P > .2) on total nitrogen flow, ruminal pH, particulate passage rate (PPR), liquid passage rate (LPR), bacteria nitrogen flow, MOEFF, and ruminal true organic matter digestibility. As RDP level increased, ruminal dry matter digestibility (P < .01), organic matter digestibility (P < .01), ruminal true nitrogen digestibility (P < .03), total tract dry matter digestibility (P < .01), total tract nitrogen digestibility (P < .01), ammonia (P < .01), and peptide (P < .01) concentration increased linearly. From this study, we concluded that MOEFF was maximized and that the RDP requirement of ruminal bacteria was met at 6.5% on a DM basis. These results were in agreement with previous continuous culture study results (5.5-8.7% RDP at a 3.0%/h dilution rate). In this experiment, degradation rates of RDP and RAC were similar, a requirement when expressing a static RDP requirement. The only effect of increasing RDP was an increased DM digestibility in the rumen. Based upon MOEFF values, the predicted RDP requirement was approximately 7.0% on a DM basis, in agreement with experimental results.

Key Words: RDP, Microbes, Requirement

549   Effect of ruminal versus postruminal administration of degradable protein on utilization of low-quality forage by beef steers. C. A. Bandyk*, R. C. Cochran, T. A. Wickersham, E. C. Titgemeyer, and C. G. Farmer, *Kansas State University, Manhattan, KS.*

An experiment was designed to determine the effects of ruminal and postruminal infusions of degradable protein (casein) on intake and digestion of low-quality hay by beef steers. Twelve ruminally-fistulated British steers (BW = 563 kg) were assigned to one of 3 treatments: control (C; hay only), or hay plus ruminal (R) or postruminal (P) infusion of 400 g/d of casein. There were 5 periods: 1) 10-d adaptation to hay; 2) 7-d measurement of hay intake; 3) 10-d adaptation to treatments (intake measurements continued); 4) 7-d measurement of hay intake and digestibility; 5) 3-d ruminal sampling. Steers had ad libitum access to tallgrass-prairie hay (3.4% CP, 76.6% NDF). Casein was administered 1X/d before feeding, either directly into the rumen or via anchored infusion lines into the abomasum. Hay intake was increased by supplementation (p=.01). Ruminal infusion elicited a greater (p=.05) increase in hay intake than postruminal. Intake tended (p=.11) to be lower in period 4 than 2 for C animals, but was greater (p≤.04) in period 4 than 2 for both R and P. The increase in intake between period 2 and 4 was greater for R than P steers (p=.03). Supplementation improved diet OMD (p=.04), but not NDFD (p=.18). There were no differences in either OMD (p=.42) or NDFD (p=.35) between the R and P treatments. Plasma urea nitrogen samples collected 0 and 3 h after feeding on the last day of the trial were lower (p=.05) for C than R and P, but no difference (p=.48) was evident between R and P. Ruminal ammonia N levels were also increased by supplementation (p<.01), with a much larger increase seen in R steers (p<.01). Total VFA concentrations were not affected by treatment (p=.21), but R steers exhibited lower proportions of acetate, and relatively larger proportions of isobutyrate, valerate and isovalerate than P (p<.01). In conclusion, ruminal and postruminal infusion of degradable protein improved forage utilization, but ruminal infusion elicited a greater increase in hay intake than postruminal.

Key Words: Intake, Protein supplementation, Low-quality forage

550   Lamb performance and serum urea nitrogen and amino acid concentrations as influenced by concentrate- or pasture-finishing. K. E. Turner*[1], K. E. McClure[2], J. G. Foster[1], and D. P. Belesky[1], [1]*USDA-ARS, Beaver, WV,* [2]*The Ohio State University, Wooster.*

Thirty-six wether lambs (avg initial BW 28 kg) were blocked by weight and assigned to finishing diets to evaluate performance, dietary total non-structural carbohydrates (TNC), and serum concentrations of urea nitrogen (SUN) and urea-cycle amino acids (UCAA) related to nitrogen (N)-use. Lambs were offered an all-concentrate diet in dry lot (DL), grazed on alfalfa (ALF), or grazed on perennial ryegrass (RG) to an end BW of 51 kg for DL and 52 kg for ALF and RG. ADG was greatest (P < .01) when lambs were offered DL (395 g d^{-1}) compared to ALF (277 g d^{-1}) or RG (213 g d^{-1}). The DL, ALF, and RG had total N:TNC ratios of .04, .24, and .40, respectively. Ending SUN concentrations were higher (P < .01) in ALF (33.7 mg dl^{-1}) and RG (30.3 mg dl^{-1}) lambs

compared to DL lambs (15 mg dl^{-1}). Serum creatinine (CR) concentration was greatest (P < .01) for DL (.89 mg dl^{-1}) compared to ALF (.68 mg dl^{-1}) and RG (.70 mg dl^{-1}). Concentrations (μmol dl^{-1}) of UCAA, Arg and citrulline (Cit), were higher (P < .01) in serum from ALF (Arg, 2.1; Cit, 2.8) and RG (Arg, 1.9; Cit, 2.9) lambs than in serum from DL lambs (Arg, 1.5; Cit, 1.3). The opposite was true for the basic amino acids His and hydroxylysine (P < .01). Serum Lys was higher (P < .05) in ALF (1.6 μmol dl^{-1}) than in RG (1.2 μmol dl^{-1}) or DL (1.1 μmol dl^{-1}); the same was true for the three branched-chain amino acids, Val, Ile, and Leu. The Cys concentration was lowest (P < .05) in serum from RG-pastured lambs (.16 μmol dl^{-1}) compared to ALF and DL which were similar (mean .20 μmol dl^{-1}). Serum concentrations of the other sulfur-containing amino acids, Met and taurine, were similar (P > .10) among treatments (mean 2.6 and .9 μmol dl^{-1}, respectively). Higher dietary total N:TNC ratios, higher concentrations of SUN and UCAA, and lower serum CR concentrations were indicative of lower N-use efficiency in lambs finished on pasture as compared to lambs finished on concentrate.

Key Words: nitrogen-use, pasture-finishing, lambs

551   Characterization of variation in composition and in situ protein degradation of porcine meat and bone meal. F. Orias*, N. R. Merchen, and L. L. Berger, *University of Illinois, Urbana, Illinois, USA.*

Porcine meat and bone meal (pMBM) samples were obtained from 14 different rendering plants and analyzed for DM, OM, CP, amino acids, hydroxyproline, collagen, fat, ash, Ca, and P in preliminary evaluation of its use as a protein supplement for ruminants. Mean and SD for DM were 95.9 % and 1.7, respectively. Means (% DM) for OM, CP, fat and ash were 74.7, 59.6, 11.9, and 25.3, respectively; corresponding SD were 3.5, 3.8, 1.8, and 3.5. Collagen was estimated by determining hydroxyproline (% DM) and multiplying by 8. Collagen (% DM) ranged from 13.6 to 30.4 %, which represented a range from 22 to 51% of the average CP among pMBM sources. Mean value for collagen was 23.6 % and the SD was 3.91. In order to determine rate and extent of ruminal N disappearance, triplicate samples of each pMBM (2 g/ each) were weighed into polyester bags (8 X 14 cm.; pore size 20 to 70 μ), placed in the rumen of 2 steers, and removed after 0, 3, 6, 9, 12, 18, 24, 36, and 48 h. of incubation. A non-linear model (Orskov and McDonald, 1979. J. Agric. Sci. 92:499) was used to calculate the total potentially digestible fraction (T), fractional rate of degradation (kd), extent of degradation (ED), and escape crude protein (ECP). Fraction T ranged from 56.8 to 79.6 % of total CP with a mean value of 66.8 and a SD of 6.7. Fractional rate of degradation (%/h), ED (% of total CP), and ECP (% DM) ranged from 3.4 to 13.1, 45.6 to 58.6, and 25.5 to 34.5, respectively with corresponding mean values of 7.8, 50.9, and 29.5; and SD of 2.9 , 3.4, and 2.4. These data demonstrates substantial variation in composition and ruminal digestion kinetics among different pMBM sources, which can affect the nutritive value of a given pMBM source for ruminants.

Key Words: Meat and bone meal, Composition, Digestion kinetics

552   Effect of substitution of chickpeas by soybean meal on total tract digestibility of finishing diets for sheep. R. Barajas, J. F. Obregon*, A. Estrada, and J. A. Felix, *Universidad Autonoma de Sinaloa (Mexico).*

This study was conducted to determine the effect of substituting ground chickpeas for soybean meal on the characteristics of total tract digestion in sheep fed finishing diets. Four male sheep (5/8 Pelibuey-3/8 Dorset blood; 30.4 kg BW) were used in a crossover design consisting of two treatments: 1) Diet 1, 20:80 roughage:concentrate (23.6% CP) containing 30% soybean meal (SBM); and 2) Diet 2, (17% CP) similar to number 1 but containing 30% chickpeas (CHP) substituted for all the SBM. The substitution of CHP for SBM increased (P=0.03) total tract digestibility of dry matter (79.36 vs 81.26%), increased (P=0.04) total tract organic matter digestibility 2.1% (80.64 vs 82.36%), and decreased (P=0.03) total tract crude protein digestibility (81.33 vs 76.68%). The inclusion of CHP increased (P=0.04) the DE content of the diet 2.4% (3.39 vs 3.47 Mcal/kg). Using the substitution method, the calculated true digestibility of CHP crude protein was 93.7% and its content of DE was calculated to be 3.91 Mcal/kg. It is concluded that chickpeas can be used as a substitute for soybean meal in diets for finishing sheep.

Key Words: Chickpeas, Digestibility, Sheep

553 Estimate of feed rumen degradable proteins by using the CNCPS carbohydrates and proteins fractions. F. Masoero[1], M. Moschini[1], F. Rossi[1], and G. Piva*[1], [1]*Istituto di Scienze degli Alimenti e della Nutrizione (ISAN) - Facolta di Agraria, UCSC - Piacenza.*

The diet formulation programs for high producing dairy cows are continuously implemented with new parameters for a better balance of the diet being fed to animals. The rumen degradation rates of feeds are important parameters to be considered in diet formulation, along with synergic effects of feeds into the diet. The object of this work was to calculate predicting equations for the potentially degradable component of the protein fraction (b) based on the CNCPS analytical parameters. Alfalfa hay (n = 26), grass hay (n = 16), corn silage (n = 8) and concentrate (n = 25) samples were analyzed for CNCPS protein fractions (% of carbohydrate component = A_{CHO}, $B1_{CHO}$, $B2_{CHO}$, C_{CHO}; % of the protein component = A_{CP}, $B1_{CP}$, $B2_{CP}$, $B3_{CP}$, C_{CP}). Samples (particles size: 5mm forages - 2mm concentrate) were incubated (0, 4, 8, 24, 48 and 96 hours) with the nylon-bags technique (12 x 8 cm, 46 μm pore size) in three fistulated cows (513 $\pm$ 13 kg live weight) feeding on alfalfa hay (67% on a DM basis), corn silage (22% on a DM basis) and a 20% crude protein content concentrate (11% on a DM basis). Duplicate were observed for each incubation time. Bags were introduced in the rumen before the morning meal. Immediately after removal, bags were washed in tap water until eluate was clear, and placed in a forced-air oven at $65°C$ until constant weight was reached. Weight of bags with the dried residue was determined for estimating dry matter disappearance. Nitrogen was determined on incubated residues by Kjeldahl method and corrected for dry matter disappearance in each incubation time to estimate ruminal protein degradation. The degradation kinetic parameter b was calculated according to Orskov et al. and regressed on CNCPS parameters according to the stepwise procedure of SAS. The potentially degradable component of the protein fraction can be estimated with adequate accuracy in grass and alfalfa hay and concentrate by using the CNCPS protein and carbohydrates fractions. No equation was obtained for corn silage. Predicting equations and relative r2 were the following: Grass hay (r2 = .95) b = 186.47-1.44A_{CHO}-2.15$B2_{CHO}$+0.66A_{CP}-5.47$B1_{CP}$+0.25$B3_{CP}$; Alfalfa hay (r2 = .98) b= 11472.18-113.33A_{CHO}-114.55$B1_{CHO}$-113.52$B2_{CHO}$-112.6C_{CHO}-2.53 A_{CP}-2.38$B1_{CP}$+0.99$B3_{CP}$-3.90C_{CP}; Concentrates (r2 = .78) b = 3.79+.91$B2_{CP}$

Key Words: rumen, protein degradation, CNCPS

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554 Metabolizable protein estimates of treated soybean meal products. R. A. Mass*, D. J. Jordon, T. L. Scott, and T. J. Klopfenstein, [1]*University of Nebraska-Lincoln.*

Three treated soybean meal products and commodity soybean meal were evaluated for ruminants. Metabolizable protein (% of CP; MP) of each product was calculated from estimates of undegraded intake protein by the in vitro ammonia release procedure (% of CP; UIP) and true nitrogen digestibility in lambs (% of CP; TND). Two lamb digestion trials consisting of three, 21-d periods each were conducted. For each trial, two bags (45 kg total) of each of the following products were sampled from commercially available lots: nonenzymatically browned soybean meal (SoyPass®), expeller soybean meal (SoyPlus®), a heated soybean meal:soyhull mixture (AminoPlus®), and solvent-extracted soybean meal (SBM). All lambs were fed individually (equal percentage of body weight, DM basis) a base diet which was formulated to be low in UIP but adequate in degradable intake protein: 72.6% cottonseed hulls, 15% dehydrated alfalfa pellets, 5% dry-rolled corn, 5% molasses, 1.5% urea, and .9% vitamins and minerals. Control lambs received only the base diet and treatment lambs received base diet plus an additional 3.75% of base diet DM added as units of N. Treatment contributed 27% of total N intake. The following CP (% of DM), UIP, TND (SE), and MP values were determined for each product in Trial I: SoyPass- 52.7, 80.2, 89.0 (3.1), 69.2; SoyPlus- 48.9, 57.9, 81.4 (3.1), 39.3; AminoPlus-54.6, 71.4, 81.0 (3.4), 52.4; and SBM- 48.5, 31.2, 91.4 (3.8), 22.6. The same estimates were made for each product (different samples) in Trial II, except that two AminoPlus samples were analyzed because the preliminary UIP estimate of the first sample was low: SoyPass- 52.1, 71.6, 82.4 (3.3), 54.0; SoyPlus- 43.7, 47.0, 69.5 (3.3), 16.5; AminoPlus #1-51.4, 55.8, 84.6 (3.1), 40.4; AminoPlus #2- 53.9, 67.1, 79.6 (3.4), 46.7; and SBM- 48.4, 29.6, 91.6 (3.4), 21.2. Differences in TND exist both within and among products and those differences may be due to temperature conditions of each process. Regular monitoring of the UIP content of treated soybean meal products is merited.

Key Words: Protein, Ruminants, Soybean meal

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555 Effects of supplementation of limit-fed growing diets with either soybean meal or non-enzymatically browned soybean meal on steer performance. C. M. Coetzer*, J. S. Drouillard, C. A. Loest, D. J. Bindel, H. J. LaBrune, J. J. Higgins, R. D. Hunter, and T. Nutsch, *Kansas State University, Manhattan, Kansas.*

Seventy-two individually fed Angus x Hereford steers (292 kg) were used to evaluate the effects of supplementing limit-fed, growing diets with either soybean meal (SBM; 28% UIP) or non-enzymatically browned soybean meal (NEBSBM; 82% UIP) on steer performance. Steers were stratified by weight and randomly allotted, within strata, to one of nine treatments. Eight steers were allotted to a control diet composed of 49% high-moisture corn, 42% cotton seed hulls, 5% cane molasses, 2.25% urea and 1.75% vitamins and minerals on a DM basis. The remaining steers were allotted to each of four protein levels within each SBM source. Levels of SBM were 100 (6.5% CP), 80 (4.9% CP), 60 (3.2% CP) and 40% (1.6% CP) of supplemental N as SBM, with the balance of supplemental N provided as urea. Levels of NEBSBM were 60 (3.9% CP), 45 (2.9% CP), 30 (1.9% CP) and 15% (1% CP) of supplemental N as NEBSBM, with the balance of supplemental N as urea. All diets were formulated to contain 13.0% crude protein on a DM basis. Steers were fed once daily at 2.25% of BW for 80 d. Data were analyzed by regression using the level of supplemental protein from each source as a continuous variable, nested within supplement source (SBM or NEBSBM). Gain and efficiency did not differ between sources (ADG_{SBM}=0.878 + 0.047(%CP from SBM); ADG_{NEBSBM}=0.878 + 0.044(%CP from NEBSBM); gain to feed$_{SBM}$=0.140 + 0.006(% CP from SBM); gain to feed$_{NEBSBM}$=0.140 + 0.005(% CP from NEBSBM)). The growth response to SBM supplementation suggests that degradable intake protein may have been limiting in the basal diet.

Key Words: Non-enzymatically Browned Soybean Meal, Beef Cattle, Growing

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556 Urinary allantoin excretion of finishing steers. R. A. Mass*[1], D. J. Jordon[1], C. T. Milton[1], T. J. Klopfenstein[1], and R. A. Stock[2], [1]*University of Nebraska, Lincoln, NE,* [2]*Cargill Corn Milling, Blair, NE.*

A two-part trial utilized five ruminally cannulated steers (350 kg) to investigate urinary allantoin excretion (ALLAN) as a bacterial CP marker for finishing steers. In both parts cattle were fed every 2 h by timed feeders and allowed ad libitum access to feed. In Part I the objective was to measure ALLAN as cattle were adapted to a dry-rolled corn finishing diet in five steps: 45, 35, 25, 15, and 7.5% alfalfa for 4, 4, 7, 7, and 7 d, respectively. Total urine was collected throughout grain adaptation but only the last 4 d of each step were analyzed for ALLAN. Daily DMI for each step was 7.9, 8.2, 8.7, 7.6, and 8.1 kg/d, respectively. Excretion of ALLAN per unit DMI for each step averaged 55.7, 51.6, 58.6, 62.0, and 89.6 mmol/day, respectively. In Part II the objective was to determine the effect of the corn wet milling by-products steep liquor (SL) and distillers solubles (DS) on ALLAN. Steers were utilized in a 5 × 5 Latin square design with 21-d periods. Total urine was collected on days 18-21 of each period. Treatments consisted of five finishing diets: the control diet was 92.5% dry-rolled corn plus supplement and 7.5% corn cobs; in experimental diets SL or DS replaced dry-rolled corn at either 7.5 or 15% of diet DM . All five diets were balanced at 15.3% CP. Daily DMI was not different (P > .1) for any treatment with control steers consuming 8.0 kg/d. Ruminal pH was measured every 3 h from 1100 to 2300 on days 12-13 of each period. There was a numerical decline in average daily ruminal pH for the average of the four by-product treatments compared to control (5.63 vs 5.75; P =.32). Excretion of ALLAN per unit DMI was higher (P = .05) for control (105.5 mmol/d) than for the average of the four by-product diets (89.5 mmol/d). This decline may be due to lower ruminal pH of the by-product diets and less rumen-available energy in the by-products themselves; however, more observations are needed that precisely relate ruminal pH to ALLAN of finishing steers.

Key Words: Allantoin, Microbial protein, Cattle

557 Effects of protein source and level on weight gain and plasma urea N (PUN) levels of growing steers. G. B. Huntington, M. H. Poore, J. W. Spears, and B. A. Hopkins, *North Carolina State University, Raleigh, North Carolina.*

The objective was to correlate PUN levels to weight gain in response to different dietary protein regimens for steers. Angus steers (average initial weight, 302 kg) were assigned to five levels of dietary N (control plus supplemental N to provide from 100 to 400 g more crude protein daily) within two sources of supplemental N (soybean meal [SBM] or a mixture of two parts corn gluten meal: one part blood meal[CGM:BM]). There were 6 or 7 steers in each level X source. They were housed in groups of 12, and fed individually for 84d. SBM or CGM:BM was combined with corn grain, vitamins, minerals and an ionophore to make a total of .89 kg supplement daily. Corn silage (35% DM, 6.52% CP) was fed at a restricted rate to minimize orts. Jugular blood samples were collected at the end of the experiment. Break-point analysis of gain predicted that maximal ADG of steers fed SBM (1.0 kg) was reached with 173 g/d supplemental protein or 524 g/d total crude protein. Maximal ADG of steers fed CGM:BM (.91 kg) was reached with 133 g/d supplemental protein or 479 g/d total crude protein. DMI was lower (P<.05) for control (5.61 kg/d) than for steers fed SBM or CGM:BM (6.32 kg/d), and higher (P<.07) for SBM (6.42 kg/d) than CGM:BM (6.22 kg/d). PUN was 1.60 mg/dl for steers fed control. PUN increased linearly (P<.05) from 2.44 to 9.02 mg/dl for steers fed SBM, but increased quadratically (P<.08) from 2.74 to a maximum of 6.33 mg/dl for steers fed 300 g/d supplemental protein from CGM:BM. Increasing calculated ruminal escape protein from 36% (SBM) to 65% (CGM:BM) supported similar weight gain of growing steers, but decreased endogenous production of urea. Neither protein source improved ADG at CP levels that provided more than 9% CP in the diet.

Key Words: Protein, Urea, Growth

558 Amino Acid: Energy Relationship for Receiving Calves. J. W. Lehmkuhler*, E. E. D. Felton, P. Brooks, and M. S. Kerley, *University of Missouri-Columbia.*

Seventy-seven crossbred steers with an initial weight of 238 kg (±13) were utilized in a completely randomized receiving study. Diets were formulated with the 1996 Beef NRC model to supply one of three amino acid:energy levels. A combination of bloodmeal and fishmeal was top-dressed for the adequate (A) and high (H) treatments at levels which synchronized the predicted amino acid and energy allowable daily gain or provided an amino acid allowable gain 25% above the energy allowable gain. Diets consisted of chopped hay, dry corn, whole soybeans and a corn based supplement. Hay was replaced with 10% dry corn weekly to achieve 20% hay in the diet during the last week. The low (L) treatment contained 20% whole soybeans with an amino acid allowable gain less than the energy allowable gain. Calves were weighed weekly and bunk samples were taken twice weekly. Diets averaged 19.4%, 16.5%, 17.2%, 16.5%, 15.9%, 16.8%, 19.0%, 18.2%, and 20.4% crude protein for L, A, and H, respectively by week. There were no differences (P>.05) for weekly DMI, BW, or ADG (Table 1). Utilizing bloodmeal-fishmeal combinations to balance amino acid:energy allowable gain for receiving diets was not beneficial when compared with a high crude protein diet for DMI, BW or ADG during the first 21 days on feed. However, synchronizing amino acid and energy allowable gain may elicit a positive response later in the feeding period.

Item	Treatment		
	L	A	H
Week 1			
DMI, kg	5.3	5.6	5.5
BW, kg	248.9	247.5	247.8
ADG, kg	1.7	1.3	1.4
Week 2			
DMI, kg	6.5	6.7	6.5
BW, kg	273.9	274.8	273.1
ADG, kg	3.4	4.0	3.6
Week 3			
DMI, kg	6.7	6.6	6.2
BW, kg	280.6	284.7	284.3
ADG, kg	0.8	1.2	1.4

Key Words: amino acid, receiving, whole soybeans

559 Cilate protozoal populations in the rumen of cattle fed high concentrate, barley-based diets. A. N. Hristov*, M. Ivan, L. M. Rode, and T. A. McAllister, *Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB.*

Fermentation characteristics and the concentration and genera distribution of ciliate protozoa in the rumen were measured in 10 ruminally cannulated steers fed barley-based backgrounding and finishing diets. The steers (451±11.1 kg) were gradually adapted to a diet comprising (as-is): 55% rolled barley grain, 40% barley silage and 5% soybean meal (diet 1). After 30 d on diet 1, they were adapted to a diet of 85% rolled barley, 10% barley silage and 5% soybean meal (diet 2). Samples of ruminal contents were collected at 5-d intervals over the 30 d immediately following adaptation to each diet. Ruminal pH and ammonia concentration were lower ($P < 0.001$) with diet 2 than with diet 1. Soluble protein concentration was higher ($P < 0.001$) and concentrations of reducing sugars and total free amino acids tended to be higher ($P < 0.1$ and $P = 0.102$, respectively) with diet 2 than with diet 1. Total protozoal counts were 42% lower ($P < 0.01$) with diet 2, and varied significantly with animal and sampling day. On diets 1 and 2, respectively, *Entodinium* spp. made up 79.9 and 81.1% of the ciliate protozoal populations. Increasing concentrate in the diet from 60 to 90% decreased ($P < 0.05$) the number of protozoa in all genera (except *Epidinium*, numerically lower). With diet 1, relative proportions of *Dasytricha, Ophryoscolex, Ostracodinium, Diplodinium* and *Metadinium* spp. in the total ciliate population were 4.5, 0.4, 0.5, 0.7, and 0.3%, respectively. When diet 2 was fed, these genera were not detected. Over the course of the experiment only two ruminal samples (one on diet 1, day 5 and one on diet 2, day 15) were free of protozoa, but the effect was transient. As at d 30 on diet 2, protozoa were present in all 10 samples; eight of the 10 contained $>10^3$ per cm^3. These data demonstrate that large, diverse protozoal populations can persist in the rumen of cattle fed diets high in barley grain. Thus, the role of ciliate protozoa in ruminal metabolism of nutrients under these dietary conditions warrants reevaluation.

Key Words: Rumen ciliates, Finishing cattle, Barley

560 Effect of dietary concentrate level on polysaccharide-degrading enzyme activities and bacterial distribution in the solid and liquor fractions of in vitro ruminal digesta. Q. Meng*[1], X. Xiao[1], Z. Xia[1], L. Lu[1], and W. Gao[1], [1]*College of Animal Science & Technology, China Agricultural University.*

A dual-flow continuous culture system with 12 fermenters was used to study the effect of dietary concentrate level on the activity of polysaccharide-degrading enzymes and the distribution of bacterial populations in the solid and liquor fractions of in vitro ruminal digesta. Solid and liquid dilution rates were .04 and .08 of fermenter volume per hour, respectively. Six diets with concentrate levels of 0, 20, 40, 60, 80, and 100% were formulated with rice straw, ground corn, alfalfa and cotton-seed meal as primary ingredients. In vitro ruminal digesta was sampled when a steady-state of incubation was achieved after 7-day's adaptation. Liquor fractional bacteria were collected by passing through 8 layers of cheesecloth. Solid-associated bacteria were obtained by filtration prior to homogenizing squeezed solids in a pre-cooled (4°C) anaerobic salts solution. Xylanase, carboxymethylcellulase (CMCase) and amylase activities were measured. Viable bacteria including cellulolytic, amylolytic and whole populations associated with digesta solids and liquor fractions were anaerobicly counted. As the concentrate level increased, there was an increase in the activity of xylanase (quadratic, P<.03), CMCase (quadratic, P <.01) and amylase (linear, P<.013) in digesta solids, whereas no significant (P>.10) change in the activity occurred in liquor fractions. At all concentrate levels, polysaccharide-degrading enzymes were more active in the solid fraction than those in the liquor fraction. Assessment of the numbers of viable bacteria indicated that the cellulolytic, amylolytic and whole bacterial populations from both digesta solids and liquor fractions increased (P<.01) with increasing dietary concentrate levels. The numbers of cellulolytic, amylolytic, and whole bacteria collected from digesta solids averaged 37.4% (ranged from 6.9 to 62.3%), 26.1% (ranged from 11.6 to 46.3%) and 18.4% (ranged from 6.1 to 38.4%), respectively. The number of bacteria distributed in the digesta solids varied with the dietary concentrate levels. There were linear correlations between xylanase activities and cellulolytic bacterial counts (R^2=.79, P<.0177), CMCase activities and cellulolytic bacterial counts (R^2=.77, P<.0218), and amylase activities

and amylolytic bacterial counts (R^2=.55, P<.0934) in digesta solids, respectively.

Key Words: concentrate level, polysaccharide-degrading enzyme, ruminal bacteria

561   Effect of sodium chlorate on *Escherichia coli* O157:H7 and *Salmonella* Typhimurium DT104 in rumen contents. R. C. Anderson*, D. J. Nisbet, S. A. Buckley, R. B. Harvey, and L. H. Stanker, .

Escherichia coli O157:H7 (EC) and *Salmonella* Typhimurium DT104 (ST) are important food borne pathogens affecting the beef industry and strategies are sought to rid these from slaughter cattle. As members of the family *Enterobacteriaceae*, both pathogens possess respiratory nitrate reductase. Since most ruminal anaerobes lack nitrate reductase, and since most known respiratory nitrate reductases also reduce chlorate to cytotoxic chlorite, we hypothesized that chlorate may selectively inhibit EC and ST. To test this, ruminal fluid, collected from a cannulated cow maintained on pasture (predominantly rye grass), was mixed 1:1 with phosphate buffer (pH 6.8) containing cellobiose, glucose, soluble starch, and xylose (1% wt/vol each). The buffered ruminal fluid was incubated anaerobically (39^oC) in duplicate with or without 5 mM sodium chlorate and either 5.9 ± 0.06 $\log_{10}$ colony forming units/ml (cfu/ml) of a novobiocin (NO) and nalidixic acid (NA) resistant EC or 5.4 ± 0.08 $\log_{10}$ cfu/ml of ST. Colony counts for EC were determined via direct plating on MacConkey agar containing 25 μg NO/ml and 20 μg NA/ml and for ST via plating on Brilliant Green agar containing NO and chloramphenicol (25 μg/ml each). Concentrations of EC declined slightly to 5.1 ± 0.01 $\log_{10}$ cfu/ml following 24 hr culture in ruminal fluid without added chlorate but declined rapidly to below our level of detection ($\leq$1 $\log_{10}$ cfu/ml) by 6 hr when incubated with added chlorate. Concentrations of ST declined to 1.7 ± 1.04 vs 4.1 ± 0.07 $\log_{10}$ cfu/ml when incubated 24 hr with or without added chlorate, respectively. Sodium nitrate (2.5 mM), when added to ruminal fluid containing chlorate, caused ST concentrations to decline to $\leq$1 $\log_{10}$ cfu/ml following 24 hr incubation, presumably by inducing expression of nitrate reductase. As expected, chlorate addition had little effect on the most probable number of culturable anaerobes (ranging from 9.9 ± 0.72 to 10.7 ± 0.01 $\log_{10}$ cells/ml).

Key Words: *Escherichia coli* O157:H7, *Salmonella* Typhimurium DT104

562   Isolation and characterization of a succinate-degrading bacterium from the rumen. T. L. Weddington*, D. M. Hopkins, H. J. Strobel, and K. A. Dawson, *University of Kentucky, Lexington, KY.*

Succinate-containing enrichment media were used to selectively enrich and isolate gram-negative, rod-shaped, anaerobic bacteria from the rumen of a heifer fed a fescue hay-based diet. Most probable number enumeration procedures indicated that succinate degrading organisms were present at concentrations of at least 100 million organisms/mL. A representative isolate (TL7) stoichiometrically decarboxylated one mole of succinate to one mole of propionate. Succinate was the only substrate that sustained growth of this isolate. Evaluation of the gene sequence encoding for the 16S ribosomal RNA subunit suggests that this isolate represents a previously undescribed species of ruminal bacteria. Yeast extract was a required constituent in a semi-defined minimal medium and a mixture of 2-methylbutyrate, iso-butyrate and iso-valerate enhanced but were not a requirement for growth. Studies indicate that TL7 was resistant to monensin at concentrations of 2.5 mg/mL. The ability of TL7 to decarboxylate radiolabeled succinate was compared with that of *Selenomonas ruminantium* strain HD4 and the succinate-degrading organism, *Schwartzia succinovarns* strain 10052. The affinity (Km) for succinate was similar in TL7, HD4 and 10502 (mean of 4.18 + 2.31 mM). However, the theoretical maximum decarboxylation rate was greater for TL7 and 10502 as compared to HD4 (114.07 and 221.23 vs. 6.17 μmoles/mg protein/h, respectively). After 72 h, the rate of end product formation from filter paper cellulose in cultures of *Fibrobacter succinogenes* strain S85 was 4-fold greater when strain TL7 was included (9.40 vs. 35.75 mM). Propionate was the major end-product in cultures containing both S85 and TL7 while acetate and succinate were the predominant end-products measured in cultures containing S85 alone. The data from these studies suggest that this newly recognized

group of succinate-decarboxylating organisms may play an important role in propionate formation in the rumen.

Key Words: Propionate, Ruminal bacteria, Succinate

563   Effects of defined xylanase and cellulase enzyme preparations on digestive processes of ruminal microbial cultures. J. M. Tricárico and K. A. Dawson, *University of Kentucky, Lexington KY.*

The use of supplemental exogenous enzyme preparations in ruminants has yielded variable results. We performed a series of studies to examine the effects of defined xylanase and cellulase enzyme preparations on digestion of fescue hay by ruminal microorganisms. *In vitro* batch cultures were established with rumen fluid from a heifer fed a 50% fescue hay: 50% concentrate diet. Cultures were supplemented with enzyme and incubated at 39°C for 12 h under anaerobic conditions. Addition of xylanase at 135 IU/mL rumen fluid enhanced total volatile fatty acid (VFA) production (44.3 vs. 57.2 mM; P<.05) and estimated hexose utilization rate (1.95 vs. 2.52 mmoles/h; P<.05). This level of xylanase addition enhanced acetate (27.2 vs. 34.4 mM; P<.05), propionate (7.5 vs. 9.9 mM; P<.05) and butyrate (5.3 vs. 7.2 mM; P<.05) productions. Lower levels of xylanase addition (1.35 and 13.5 IU/mL rumen fluid) had no effects on VFA production or hexose utilization rates. On average, addition of cellulase (2, 3, 4 and 5 CMC U/mL rumen fluid) enhanced total VFA (36%) and estimated hexose utilization rates (40%). The lowest level of cellulase addition resulted in higher acetate (19.2 vs. 24.8 mM; P<.05), propionate (5.2 vs. 7.0; P<.05) and butyrate (2.6 vs. 4.1; P<.05) concentrations without affecting the acetate:propionate ratio (A:P ratio). As the level of cellulase supplementation increased (3, 4 and 5 CMC U/mL rumen fluid) the A:P ratio decreased (3.7 vs. 2.7, 2.2 and 1.8; P<.05, respectively). The combined addition of xylanase (135 IU/mL) and cellulase (5 CMC U/mL) resulted in higher total VFA production (40.9 vs. 61.5 mM; P<0.05) and estimated hexose utilization rates (1.88 vs. 3.08 mmoles/h; P<.05). Although acetate production increased when both enzymes were added (26.5 vs. 28.0 mM; P<0.05), the A:P ratio decreased markedly (3.4 vs. 1.5; P<.05). These observations indicate that defined exogenous enzyme preparations differ in their abilities to affect fermentation of fescue hay by ruminal microbial cultures.

Key Words: Ruminants, Digestion, Enzyme supplements

564   *In vitro* effects of steroidal saponins from *Yucca schidigera* extract on rumen microbial protein synthesis and ruminal fermentation. Y. Wang*[1], L. J. Yanke[1], Z. Xu[1], P. R. Cheeke[2], and T. A. McAllister[1], [1]*Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB,* [2]*Desert King International, Chula Vista, CA.*

A crude butanol extract prepared from *Yucca schidigera* powder was added to *in vitro* incubations of ground barley grain in ruminal fluid to determine the effects of steroidal saponins (SAP) on rumen microbial protein synthesis and ruminal fermentation. Prior to incubation, ruminal fluid was centrifuged ($1,000 \times g$) to remove protozoa and small feed particles. Extract was included to provide 0 (control), 15, 75 or 225 μg/mL SAP (as smilagenin equivalents). Incorporation of ^{15}N (from $(^{15}NH_4)_2SO_4$) into microbial protein was increased ($P < 0.05$) by 15 μg/mL SAP, but was decreased ($P < 0.05$) by 225 μg/mL SAP. Gas production, VFA production and microbial protein synthesis were quadratically ($P < 0.05$) related to SAP concentration. Gas and VFA production peaked at 75 μg/mL SAP, and were elevated ($P < 0.05$), relative to the controls, at this concentration of SAP. Acetate:propionate ratios in the incubation fluid were linearly reduced ($P < 0.01$) by SAP from 8 to 24 h of incubation. Throughout the incubation (2 to 24 h), SAP at 75 and 225 μg/mL increased ($P < 0.05$) reducing sugar concentrations, but SAP at 15 μg/mL did not affect them. Over 2, 4 and 8 h of incubation, β-glucanase activity (measured as release of reducing sugars) was linearly increased ($P < 0.05$) by SAP, but it was reduced ($P < 0.05$) at 12 and 24 h by SAP at 225 μg/mL. A quadratic relationship between the concentration of SAP and their effects on microbial synthesis and fermentation of barley *in vitro* was clearly demonstrated. This relationship, and the alterations to fermentation that were observed in the present study are similar to recorded ionophore-mediated effects on fermentation of barley-based feedlot diets. Thus, SAP from *Yucca schidigera* could be effective for increasing propionate production and

rumen microbial protein synthesis in ruminants fed high barley diets, but optimum application rates remain to be defined.

565 Demonstration of endosymbiotic methanogens and hydrogenosomes in ruminal protozoa from sheep.
R. J. Wedam*, M. L. Nelson, and V. R. Franceschi, .

Fluorescence microscopy (using autofluorescence of F_{420}, a reduction enzyme from the methane pathway) and transmission microscopy were used to study endosymbionts and hydrogenosomes in entodiniomorph protozoa from the rumen of a sheep fed an alfalfa diet. Fluorescence microscopy was used to demonstrate the presence of endosymbiotic methanogenic bacteria. Surface area was measured and methanogenic endosymbionts counted in randomly selected protozoa starved for 0, 6.5, and 18h. Data were analyzed as a completely randomized design. Transmission electron microscopy was used to visualize hydrogenosomes, endosymbionts and their physical relationship. Protozoal surface area ($190.3 \pm 33.10 \ \mu m^2$) and number of methanogenic endosymbionts/protozoal area, μm^2 ($.2 \pm .04$) did not differ ($P \geq .10$) across duration of culture starvation. Results show these methanogens were symbionts and not ingested bacteria being degraded in digestive vacuoles. With these imagery techniques, it was noted that the methanogens tended to congregate into one area of the protozoal endoplasm, which was presumably most metabolically active. Additionally, the close physical proximity between hydrogenosomes and endosymbionts, but not direct physical contact, was shown.

566 Inoculation with *Lactobacillus buchneri* increases the acetate and propionate content of barley silage resulting in improved aerobic stability.
N. K. Ranjit[1], L. Kung, Jr.*[1], J. M. Robinson[1], and K. K. Kreikemeier[2], [1]*University of Delaware, Newark,* [2]*Biotal, Eden Prairie, Minnesota.*

Lactobacillus buchneri (LB) at 3 different levels as silage inoculant was compared with one biological and one chemical additive. Barley (36.7% DM) was ensiled in triplicate 20-L laboratory silos after the following treatments: 1) Untreated; 2) LB, 1×10^5 cfu/g of fresh forage; 3) LB, 5×10^5 cfu/g; 4) LB, 1×10^6 cfu/g; 5) Biotal Plus (*Lactobacillus plantarum*, *Pediococcus pentosaceus* and *Propionibacterium freudenreichii*), 1×10^5 cfu/g; and 6) TMR-Mate[TM] (a buffered propionic acid based product), 2 g/kg. After 120 d of ensiling, acetate contents were 2.48, 4.06, 4.86, 4.98, 3.14, and 2.00% (DMB); lactate 3.53, 2.51, 2.11, 2.43, 3.43 and 3.88%; and propionate 0.28, 0.91, 1.29, 1.44, 0.54 and 0.38% for treatments 1 through 6, respectively. Compared to the untreated silage, all silages treated with LB had higher ($P < 0.05$) acetate and lower ($P < 0.05$) lactate contents. Only the silages treated with LB at $\geq 5 \times 10^5$ cfu/g had higher ($P < 0.05$) propionate compared to the untreated silage. Yeast counts of silages were low (< 1000 cfu/g). Aerobic stability of silage or TMR was determined as the number of hours before a $2°C$ rise in the temperature when exposed to air (ambient temperature $23°C$). None of the silages exhibited signs of spoilage even after 7 d of aerobic exposure. Therefore, TMR were formulated using the experimental silage (30%, DMB), alfalfa haylage (30%) and dairy concentrate (40%). The alfalfa haylage contained 148500 cfu yeasts/g. The TMR were stable for 95, 104, 107, 120, 97 and 105 h for treatments 1 through 6, respectively. The improvements ($P < 0.05$) in the aerobic stability in TMR 2, 3 and 6 were similar, whereas the improvement in aerobic stability in TMR 4 was the greatest ($P < 0.05$). Inoculation with LB at $\geq 5 \times 10^5$ cfu/g was very effective in improving the aerobic stability of barley silage based TMR.

567 Use of the reducible dyes resazurin, 2',6'-dichloroindophenol and methylene green to estimate rumen microbial numbers.
R. E. Dodson*[1], S. A. Ericsson[1], K. L. Sternes[1], T. W. Downing[2], and P. H. Purdy[1], [1]*Sul Ross State University, Alpine, Texas,* [2]*Oregon State University, Corvallis, Oregon.*

The objective of this study was to determine if reduction of the dyes resazurin (blue) to pink or colorless, 2',6'-dichloroindophenol (DCIP) (blue to colorless) and methylene green (green to colorless) could be

used to assess the number of rumen microbes. Rumen samples were collected with a stomach tube and rumen fluid strainer from Holstein dairy cows (n=79) and the number of bacteria and protozoa were determined using 400x phase contrast microscopy. Rumen samples were identified as having below the average number of microbes ($< 10^{10}$ bacteria and $< 10^5$ protozoa/ml), or containing at least the average number of rumen microbes ($\geq 10^{10}$ bacteria and $\geq 10^5$ protozoa/ml). A 50 μl drop of resazurin (0.338 mM), DCIP (1.034 mM), or methylene green (0.045 μM) was added to separate 1 ml aliquots from each sample and observed to determine the amount of time required for a visual change in the color of the dye. Predictive value theory statistics were used to analyze the data. Specificity is the ability of a test within a set time, to detect a change in dye color in a rumen sample known to contain at least the average number of microbes. The specificities of the resazurin to pink (100% at 10 min) or colorless (100% at 10 min), DCIP (99% at 4.5 min), and methylene green (100% at 10 min) illustrate that these tests can accurately identify samples known to contain at least the average number of microbes. The negative predictive value (NPV) is the probability that an unknown rumen sample will have at least the average number of microbes if the dye changed color within a set time limit. All the dye tests had a NPV of 100% at varying times, resazurin to pink (0.5-1 min) or colorless (1.5 min), DCIP (0.25-0.5 min) and methylene green (0.5-1 min) showing that these dyes can be used to determine if unknown samples contain at least the average number of rumen microbes. Sensitivity and positive predictive value (PPV) is the ability of a test to detect an absence of change in dye color in a rumen sample containing less than the average number of microbes in known and unknown samples, respectively. All of the dye test sensitivities and PPV's were 0%. These results suggest that the dye tests are accurate for predicting if rumen samples contain at least the average number of microbes.

568 Assessment of trace mineral status of ruminants.
R. L. Kincaid*[1], [1]*Washington State University, Department of Animal Sciences.*

Assessment of trace mineral status of ruminants requires that the objective be clear; i.e., to determine the prevalence of a deficiency within a population, the mean of a population, or to detect differences due to treatments. The number of needed samples depends upon herd size, expected prevalence, and estimated standard deviation. Diet analysis provides very useful supporting data if all dietary components are sampled and intakes known. The bioavailability of minerals is affected by forage species and processing, relative ratio of forage to concentrate, and interactions with other minerals. Concentrations of Cu and Se in whole blood change slowly with shifts in intake because of the 120-day lifespan of erythrocytes. Concentrations of Se plateau in serum within a couple weeks of an increase in Se intake whereas Se levels in whole blood and activities of glutathione peroxidase increase for months. Concentrations of Zn and Cu in plasma remain within normal ranges even though intakes of Zn and Cu can vary several-fold. Diets severely deficient in Zn will cause plasma Zn to drop within days. Plasma Cu values are not reduced substantially until liver reserves of Cu are depleted to $< 40 \ \mu g$ Cu/g of liver DM. Infection, stress, pregnancy, and hemolysis influence plasma concentrations of Zn, Cu and Se; concentrations of Cu are lower in serum than plasma. Concentrations of Mn in plasma are low and poorly correlated with Mn intakes. Serum Co is a poor measure of B_{12} status and either measurement of liver B_{12} or metabolite accumulation is needed for assessment. The trace mineral status of animals is better described by analyses of liver than blood. Improvements in sensitivity of blood measures to assess trace mineral status await determination of the most critical metallo-activity. At present, metallo-enzyme activities are seldom more useful than concentrations of minerals in plasma and often are impractical because of loss of activity in shipment to the laboratory. Perhaps the ultimate assessment is response of animals to supplementation.

569 Performance and lipid and cholesterol metabolism in finishing steers fed varying concentrations of copper.
T. E. Engle* and J. W. Spears, *North Carolina State University, Raleigh, NC.*

Forty-eight Angus and Hereford-Angus crossbred steers (average initial BW 329 kg $\pm$ 4.1) were utilized to determine the effects of copper (Cu)

on performance and lipid and cholesterol metabolism. Steers were stratified by weight within breed and randomly assigned to treatments. Treatments consisted of 0 (control, no supplemental Cu), 10, and 40 mg of supplemental Cu (as tribasic Cu chloride)/kg diet DM. The growing diet was a corn silage-soybean meal based diet that analyzed 10 mg of Cu/kg diet DM. The growing diet was fed for 42 d. Animals were then switched to a high concentrate finishing diet that analyzed 5.0 mg of Cu/kg diet DM. Steers remained on the same dietary treatment during both the growing and finishing phases. Steers were housed in pens equipped with individual electronic Calan gate feeders. Equal numbers of steers per treatment were slaughtered after receiving the finishing diets for either 112 or 124 d. Average daily gain over the finishing period was higher (P < .06) and final body weights were higher (P < .09) in the steers receiving supplemental Cu. Liver Cu concentrations were higher (P < .05) in steers receiving supplemental Cu at the end of the experiment. Steers supplemented with 40 mg of Cu/kg diet DM had higher (P < .05) liver Cu concentrations than those supplemented with 10 mg of Cu/kg diet DM. Serum total cholesterol concentrations were reduced (P < .05) by 84 d and at subsequent sampling dates in steers supplemented with Cu. Serum nonesterified fatty acid concentrations tended to be higher (P < .11) on d 70 and plasma reduced glutathione was reduced (P < .09) on d 84 in animals receiving supplemental Cu. Backfat depth was lower (P < .10) in steers receiving supplemental Cu, but marbling scores were similar across treatments. These results indicate that Cu addition to a finishing diet containing 5 mg of Cu/kg diet DM alters lipid and cholesterol metabolism in steers.

Key Words: Cattle, Copper, Cholesterol

570   Effect of dietary copper level and high sulfate water on copper metabolism and growth in cattle. C. L. Wright*, J. W. Spears, T. E. Engle, and T. A. Armstrong, *North Carolina State University, Raleigh, NC.*

This experiment was designed to determine the effects of supplemental Cu and high SO_4 water on Cu metabolism and growth of cattle. The experiment was divided into an 84-d depletion phase and 70-d repletion phase. In the depletion phase, twenty-nine Angus and Angus x Hereford heifers were blocked by weight and randomly assigned to one of two treatment groups. One treatment received ad libitum access to water containing 1500 mg SO_4/L added as $MgSO_4$, the remaining treatment received control water. In the depletion phase, all heifers were individually fed a corn silage-soybean meal based diet that contained 6 mg Cu/kg and 1 mg Mo/kg DM. Rumen soluble Cu decreased (P < .01) in calves receiving high SO_4 water. High SO_4 water reduced (P < .01) liver Cu on d 42 and d 84. In the repletion phase, heifers continued to receive their appropriate water treatment and were assigned to one of three dietary treatments. Dietary treatments included: 1) basal diet (Con), 2) basal diet + 10 mg Cu/kg as $CuSO_4$ (10Cu), 3) basal diet + 100 mg Cu/kg as $CuSO_4$ (100Cu). The basal diet from d 0 through d 36 was a corn silage-soybean meal based diet that contained 6 mg Cu/kg DM. On d 37 the basal diet was changed to a corn-cottonseed hull based diet which contained 5 mg Cu/kg DM. Cattle given high SO_4 water continued to have reduced (P < .01) liver Cu during the repletion phase. Liver Cu was increased (P < .01) in the 100Cu treatment relative to the 10Cu and Con treatments, and tended to be greater (P < .07) in the 10Cu treatment relative to the Con treatment. Rumen soluble Cu was increased (P < .01) in the 100Cu treatment relative to 10Cu and Con treatments. Copper supplementation decreased (P < .03) ADFI. Feed intake from d 37 to d 70 was depressed (P < .04) in the 100Cu treatment relative to 10Cu. Neither Cu supplementation nor high SO_4 water affected plasma ceruloplasmin, biliary Cu, feed efficiency or ADG. High SO_4 water decreases liver Cu and rumen soluble Cu. High levels of supplemental inorganic Cu depress intake and increase hepatic Cu stores in the presence of high SO_4 water.

571   Trace Mineral Solubility in a free-choice mineral supplement treated with petrolatum. L. W. Greene*[1], D. V. Dhuyvetter[2], and N. K. Chirase[1], [1] *Texas A & M University System, Amarillo,* [2] *Farmland Industries, Kansas City, MO.*

A laboratory procedure was conducted to determine the trace mineral solubility in a free-choice mineral supplement (ProPhos 10 E-EXTRA, Farmland Industries, Kansas City, MO) treated with or without petrolatum (PET). Petrolatum has recently been used to prevent moisture penetration into free-choice mineral supplements to enhance the weathering ability. Petrolatum was heated to its' melting point and 3% blended into

the mineral supplement for 3 min with a paddle mixer speed of 58 rpm. Zero, 1, 2, 4, 8 and 10 g of treated and untreated mineral supplement was placed into 125 ml erlenmeyer flask. Ruminal fluid from 4 ruminally cannulated cows fed either a high roughage diet (n=2; 50% cottonseed hulls; CSH; 40% steam-rolled corn, SRC; 10% protein-mineral-vitamin supplement; PMV) or a high concentrate diet (n=2; 10% CSH, 80% SRC and 10% PMV) was collected, composited by diet type and 100 ml added to each erlenmeyer flask. Flasks were incubated in a 39° C water bath for 30 min. Each treatment combination was replicated 3 times. After incubation, flask contents were filtered. Supernatant was diluted and analyzed for Zn, Cu, Mn and Fe via inductively coupled plasma argon spectrophotometry. Source of ruminal fluid or addition of PET did not affect the solubility of Zn, Mn or Fe in any of the incubations (P > .10). As level of mineral supplement increased, the amount of soluble Zn and Mn in the incubation vessel increased (P < .0001). Copper solubility was 46% less (P < .0082) when PET was included in the supplement compared to the non-treated control. As level of mineral supplement increased the amount of soluble Cu increased (P < .0001). These data indicate that including PET into this mineral supplement did not affect the solubility of Zn, Mn and Fe, but, reduced Cu solubility by 46%. These differences could be related to characteristics of specific mineral salts added to the supplement. In this study, sulfate was used to provide added Cu and oxide was the predominant source of added Zn, Mn and Fe.

Key Words: Mineral, Solubility, Supplement

572   Effect of decreasing dietary phosphorus on nutrient balance in beef feedlots. G. E. Erickson*, C. T. Milton, and T. J. Klopfenstein, *University of Nebraska, Lincoln, NE.*

The effect of decreasing dietary P on mass balance in the feedlot was evaluated in two experiments with calves from November to May (183 d) and two experiments with yearlings from May to October (137 d). The conventional diet (CON) consisted of dry-rolled corn and 7.5% alfalfa averaging .40% P for all four experiments. A lower phosphorus diet (LOWP) was formulated to not exceed the NRC-predicted requirements, averaging .22% P for yearling and .30 to .22% P for calf experiments. LOWP was changed every 14 d for calves and 28 d for yearlings to minimize overfeeding. P balance was evaluated by measuring P intake, manure removed, soil on the pen surface, and runoff. P retention in the animal was similar (P > .20) for both diets due to similar (P > .15) ADG, resulting in .88 and 1.11 kg steer^{-1} retained for yearlings and calves, respectively. Efficiency of dietary P use was increased by feeding LOWP because 26.7 and 24.7% of dietary P was retained in steers fed LOWP, whereas only 14.9 and 16.3% was retained in steers fed CON for yearlings and calves, respectively. P excretion was decreased (P < .01) by feeding LOWP. However, P removed in manure was not different (P > .15) between treatments. P in runoff ranged from 1 to 4.7% of P excreted. More soil P from the pen surface was removed from LOWP (P < .10) which explains the similarity of P in manure between treatments. Correcting manure for soil P results in 1.08 and 2.62 kg of p/steer with yearlings and 3.03 and 4.68 kg of p/steer with calves for LOWP and CON, respectively. Mass balance did not account for all the P excreted, suggesting that 47% of the P from yearlings and 12% from calves is either being lost or was not accounted for in soil, manure or runoff. No differences were observed between treatments for amount of P lost in three of the four experiments suggesting that the influence is on absolute amount of P. These results suggest that decreasing dietary P will improve efficiency of P use and decrease P excretion into the environment without adverse effects on ADG.

Key Words: Phosphorus, Nutrient management, Requirement

573   In Situ Rumen Degradability of Processed Kitchen Wastes. J. J. Lechner*, B. A. Altizio, and M. L. Westendorf, .

Productive ruminants require a source of dietary rumen escape or undegradable intake protein (UIP), which are often quite expensive. We performed a study to determine if a less expensive product, dry, processed food waste, could serve as an UIP source. We compared in situ degradability of soybean meal (SBM), pelleted food waste plus wheat middlings (FWW) and pelleted food waste plus corn (FWC). Both food waste (FW) samples were acquired from Nutrafeed Corp. (Clermont, FL), and contained approximately 35% food waste and 65% wheat middlings or corn. Samples (10g) were placed in dacron bags (Ankom Tech.)

having a pore size of 50 ± 15 microns, heat-sealed and pre-washed. Bags were placed in the rumen of a cannulated Holstein heifer and incubated for 0, 4, 8, 12, 16, 24 and 48 h, with 4 replicates per treatment and time. Residues were analyzed for DM, CP and ADF disappearance with results reported as percent disappearance (mean $\pm$ SEM). Data were analyzed by a two-way ANOVA, with time and treatment as main effects. DM, CP and ADF disappearance for all main effect comparisons were significantly different at $p < 0.05$. DM disappearance at 12 and 24 h for SBM were $76.3 \pm .3$ and $85.9 \pm 9.0\%$, for FWW 52.4 ± 2.8 and $61.5 \pm 1.6\%$, and for FWC 63.9 ± 3.9 and $74.6 \pm .9\%$. ADF disappearance for SBM at 12 and 24 h were 54.1 ± 4.8 and $79.9 \pm 14.5\%$, for FWW 27.4 ± 1.1 and $33.7 \pm .6\%$, and for FWC 37.8 ± 1.9 and $40.4 \pm .8\%$. CP disappearance at 12 and 24 h for SBM were 78.4 ± 1.0 and $81.6 \pm 8.4\%$, for FWW 62.1 ± 5.3 and $72.8 \pm 5.2\%$, and for FWC 47.5 ± 8.4 and $62.1 \pm 3.7\%$. Percent DM and ADF disappearance were greatest for SBM. Between the FW treatments, percent DM disappearance was greater for FWC than FWW, possibly due to the higher fiber content of wheat middlings. This can also be explained by FWW having a lower percent ADF disappearance than FWC. These differences in ADF disappearance between the two FW diets may be due to the different sources of fiber present. Percent CP disappearance was greatest for SBM, meaning that the two FW diets contained a greater percentage of UIP than did the SBM. Between the two FW diets, FWW had less UIP than FWC. These data suggest that the protein within food waste has both rumen degradable and undegradable components and may provide an economical source of UIP in the ruminant diet.

Key Words: Undegradable Intake Protein, Food Waste, Rumen Degradability

574   Evaluation of corn steep liquor as a rumen degradable protein source for starch and cellulose digestion by rumen microorganisms in vitro. C. C. Ribeiro-Filho* and A. Trenkle, *Iowa State University, Ames.*

Corn steep liquor, a byproduct from the corn wet milling industry, was evaluated as a source of nitrogen for rumen microorganisms. The experiment consisted of measuring in vitro rate of NH_3-N accumulation and the rate of in vitro dry matter digestibility by batch cultures of rumen microorganisms using cellulose or starch as substrate. In the digestibility trial the fermentation periods were 12, 24, 36, or 48 h with cellulose, and 8, 12, 20, or 32 h with starch. In the NH3-N accumulation trials the fermentation periods were 4, 8, 12, or 24 h for both substrates. The experimental units (n=12) consisted of incubating 100 mg of purified cellulose or purified insoluble starch as substrate, 20 ml of buffer-nutrient solution, 1 ml of strained rumen fluid, and a nitrogen source (0 mg N in the control or 4 mg N in the other treatments). The nitrogen sources used were steep liquor, urea, soybean meal (SBM), casein, casein plus starch, or ammonium sulfate plus sucrose with cellulose as substrate, and steep liquor, urea, or SBM with starch. The use of steep liquor as nitrogen source increased (P<.01) starch digestibility when compared with the control, urea, or SBM at 8, 12, and 20 h fermentation. However, the use of steep liquor decreased (P<.01) cellulose digestion when compared with urea, SBM, casein, and ammonium sulfate plus sucrose. The use of steep liquor decreased (P<.01) NH_3-N accumulation when compared with urea and ammonium sulfate plus sucrose with both starch and cellulose. Accumulation of NH_3-N with steep liquor was similar to SBM, except at 4 h fermentation when the steep liquor was higher (P<.01). The addition of corn steep liquor resulted in better starch digestion and an inhibition of cellulose digestion when compared with other nitrogen sources. Corn steep liquor had a slow rate of NH_3-N accumulation when compared with sources of nonprotein nitrogen.

Key Words: Byproducts, Cattle, Steep liquor

575   Evaluation of a modified condensed molasses solubles (CMS) as a nitrogen source for rumen microbes in vitro. C. C. Ribeiro-Filho* and A. Trenkle, *Iowa State University, Ames.*

The objective of this study was to evaluate a modified condensed molasses solubles (CMS), a high protein byproduct from the production of lysine, as a nitrogen source for rumen microorganisms by measuring the rate of in vitro dry matter digestibility and NH_3-N accumulation. The study consisted of a series of in vitro trials using two different substrates, starch or cellulose, in four different fermentation periods. They

were 12, 24, 36, or 48 h with cellulose and 8, 12, 20, or 32 h with starch to evaluate digestion, and were 4, 8, 12, or 24 h for NH_3-N accumulation with both substrates. Each experimental unit (n=12) was the incubation of 100 mg of substrate, 20 ml of buffer-nutrient solution, 1 ml of strained rumen fluid, and 0 mg (control) or 4 mg of nitrogen (treatments). The nitrogen sources used were modified CMS (different bacteria used to produce lysine), urea, soybean meal (SBM), unmodified CMS, ammonium sulfate, urea plus ashed CMS, or casein with the cellulose substrate, and urea, unmodified CMS, or SBM with the starch substrate. The utilization of modified CMS as nitrogen source increased (P<.01) cellulose digestion at 12, 24, and 36 h fermentation when compared with the SBM, and (P<.0002) at 12 and 24 h when compared with control, ammonium sulfate, urea, and urea+ashed CMS. The addition of modified CMS increased (P<.0005) starch digestion at 8, 12, and 20 h when compared with control, urea, and SBM. The utilization of modified CMS as nitrogen source increased (P<.005) the accumulation of NH_3-N when compared with control, soybean meal, and casein at all fermentation periods. When compared with urea, CMS increased (P<.0002) NH_3-N accumulation at 4 and 8 h fermentation with cellulose and at 4 h with starch. The results of this study indicate that utilization of modified (CMS) as a nitrogen source for rumen microorganisms resulted in greater and faster cellulose and starch digestion, and a more rapid NH_3-N accumulation.

Key Words: Byproducts, Cattle, CMS

576   Comparative nutritional value of steam-flaked white corn and moisture-heat damaged cottonseed in diets for beef cattle. R. Barajas, A. Felix, and A. Estrada*, *Universidad Autonoma de Sinaloa (Mexico).*

To determine the comparative nutritional value of steam-flaked corn and moisture-heat damaged cottonseed on growth performance of beef cattle, sixty four brahman (262 kg) bull-calves were used in a 55-d feedlot trial. In agreement with a randomized block design, four groups of 16 calves (four calves per pen), were designated to be fed with one of the four diets: 1) Diet 1 (12% CP, 1.72 Mcal/kg NEm) containing 18% of straw and 82% concentrate, with 52% ground white corn(GWC); 2) Diet 2, similar to diet 1, but substituting steam-flaked white corn (SFWC; density=380 g/L) for GWC; 3) Diet 3, similar to diet 2, but 20% whole cottonseed (WCS) was substituted for SFWC ; and 4) Diet 4, similar to diet 3, but moisture-heat damaged cottonseed was substituted for the WCS . Steam flake processing of white corn increased (P=0.03) average daily gain 15.3% (1.560 vs 1.799 kg/d), improved (P=0.02) feed efficiency 17% (DM intake/ADG; 7.244 vs 6.011), and increased (P<0.01) NEm of the diet (1.996 vs 2.287 Mcal/kg). The calculated NEm-content of SFWC was 2.8 Mcal/kg. The substitution of WCS for SFWC had no effect (P>0.10) on ADG (1.799 vs 1.642 kg/d), or feed efficiency (6.011 vs 6.332). The substitution of moisture-heat damaged cottonseed for WCS did not affect (P>0.10) ADG (1.642 vs 1.719 kg/d) or feed efficiency (6.332 vs 5.935), and had no effect on diet NEm content (2.21 vs 2.31 Mcal/kg). The calculated NEm of WCS was 2.4 Mcal/kg. It is concluded that steam-flake processing of white corn increase its NE content more than 20%, and that moisture-heat damaged cottonseed can be used as a substitute for whole cottonseed in diets of growing beef cattle.

Key Words: Corn, Cottonseed, Cattle

577   Effect of moisture-damaged cottonseed on total tract digestion characteristics of finishing diets for sheep. R. Barajas*, J. F. Obregon, A. Estrada, and S. Arechiga, *Universidad Autonoma de Sinaloa (Mexico).*

In the northwest of Mexico it is usual that the rainy season starts together with the cotton harvest. Consequently, some of the cotton harvested is rained on, and the cottonseed suffers some damage due to microbial activity. This is detected by increased temperature and softening of the cottonseed. There is a lack of information about the effects of this moisture-heat damaged cottonseed on digestion characteristics in ruminants. This study was conducted to determine the effect of the substitution of moisture-heat damaged cottonseed for whole cottonseed on total tract digestibility of diets for sheep. Eight sheep (22 kg; male; Pelibuey 5/8- Dorset 3/8 blood) were used in a crossover design. The diets that made up the treatments were: 1) a diet with 12% roughage:88% concentrate (19%CP), containing 20% of whole cotton seed (WCS) included as part of the concentrate; and 2) a diet similar

to treatment 1; but with moisture- heat damaged cottonseed (MHDCS) substituted for the WCS. The substitution of MHDCS for WCS had no effect (P>0.28) on total tract digestibility of dry matter (70.17 vs 68.41%), organic matter (72.25 vs 70.51%) or nitrogen (70.00 vs 68.87%, for WCS and MHDCS, respectively). The digestible energy content of diets was similar (P=0.30) with values of 2.98 and 2.89 Mcal/kg of diet DM for WCS and MHDCS, respectively. From this data, and using the substitution method, the DE content of MHDCS was 3.9 Mcal/kg. It is concluded that moisture-damaged cottonseed can be used up to 20% of finishing diets for sheep, without adverse effect on digestibility and energy value of the diets.

Key Words: Cottonseed, Digestion, Sheep

578   Ruminal Fermentation and Microbial Protein Synthesis of Korean Cattle Fed Alcohol-Fermented Feed-stuff. B. W. Kim*[1], C. G. Yan[2], J. S. Shin[1], and B. J. Hong[1], [1]*Kangwon National University, Korea,* [2]*Yeon-Byeon Agriculture University, China.*

Generally, alcohol has been known to increase the efficiency of diet utilization when it is fed to animals. However, no information is presently available about the effect of feedstuffs fermented with yeast on ruminal fermentation and microbial protein sysnthesis. The objective of this study is to investigate the effects of the alcohol-fermented feedstuff (AFF) on ruminal pH, ammonia N, volatile fatty acids (VFA) and amino acids (AA) productions of growing Korean cattle. The diet consisted of 80% corn and 20% oat was added with 50% water, 10% molasses, and 5% yeast and fermented for 4 h at 32°C. Twenty six Korean cattle averaging 230kg were randomly assigned into two dietary treatments (AFF; AFF + rice straw and Control; non-fermented corn and oat + rice straw). Ruminal pH ranged from 5.9 to 6.6 for both control and AFF, and pH was always lower (P < .05) in AFF after feeding. Ammonia N in the rumen was highest at 2 h after feeding in both control (19.14mg/100ml) and AFF (17.05mg/100ml) and decreased with time. The higher total VFA concentration was resulted in AFF. The total AA productions of microbes were higher (P < .05) in AFF (339.2mg/g) than in control (269.1mg/g). These results indicate that alcohol enhances microbial protein yield primarily through greater fermentation efficiency.

Key Words: Alcohol-fermented, Korean cattle, Amino acids

579   The effects of feeding whole cottonseed on reproductive parameters in crossbred Nubian bucks. Q. Mc-Crary*, S. Solaiman, H. Goyal, and E. Coleman, *Tuskegee University.*

This study was conducted to determine the effect of feeding moderate level (15%) and high level (30%) of whole cottonseed (WCS) containing 1083 ppm and 2166 ppm gossypol, respectively, on gossypol level in plasma and reproductive parameters in growing crossbred Nubian bucks. Twelve bucks were stratified by weight and were randomly assigned to three experimental treatments. Treatment 1) contained 50% bermudagrass (BG) hay + 50% concentrate mix containing 0% WCS (control), treatment 2) contained 50% BG + 50% concentrate mix containing 30% WCS and treatment 3) contained 50% BG + 50% concentrate mix containing 60% WCS. Feed was offered ad libitum. All animals were fed control diet for four weeks (pre-treatment period) to establish the baseline data and were switched to respective treatment there after. Body weight data, scrotal circumference, semen and blood samples were collected every four weeks. Plasma samples were collected to monitor gossypol in blood via jugular venipuncture. Serum samples were collected every hour for 6 hours to monitor testosterone level in blood through catheterization of jugular vein. Semen parameters and sperm abnormalities were evaluated for each collection. Body weights were increased (p<0.05) from August through January with no difference (p>0.10) observed among treatments. Scrotal circumferences were similar for animals receiving 0% and 15% WCS diets and were reduced (p<0.05) for animals receiving 30% WCS diet. Semen volume, semen concentration and gross motility did not differ (p>0.10) among diets, however sperm progressive motility was reduced (p<0.05) for animals receiving 30% WCS diet. Percent normal sperm, head abnormality and tail abnormality tended to be higher (p<0.10) for animals receiving 30% WCS diet. Plasma gossypol was increased (p<0.05) for animals fed 15% and 30% WCS. Serum testosterone levels were not affected (p>0.10) by feeding WCS. Feeding WCS at levels higher than 15% can adversely affect semen quality in male goats.

Key Words: Whole Cottonseed, Reproductive Parameters, Goats

580   In vitro evaluation of sunflower heads with varying levels of nonstructural carbohydrate and degradable intake protein. J. W. Lehmkuhler, D. A. Schmidt, M. D. Howard*, and M. S. Kerley, *University of Missouri, Columbia, MO.*

Sunflower heads (seeds removed) were evaluated as a feed source for ruminants using a continuous culture system. The objective was to evaluate the digestibility profile and microbial N synthesis capacity of sunflower heads in response to varying levels of degradable intake protein (DIP) and nonstructural carbohydrate (NSC). Urea and soybean meal supplied DIP and corn was the source of NSC. The continuous culture system was a single effluent type. A dilution of .03/h was used. Using regression equations that predict maximum bacterial efficiency for three functional classes of bacteria, diets were formulated to provide degradable intake protein and fermentable carbohydrate needed to support maximum bacterial growth. The experiment consisted of 6 treatments: 0, 30 and 60% added NSC, with each level of NSC formulated for either 1 or 1.5 x the DIP requirement (0/1, 0/1.5 30/1, 30/1.5, 60/1, 60/1.5). True DMD and OMD were increased linearly (P = .0001) with addition of NSC: an interaction (P = .03) of NSC x DIP existed for true OMD. True DMD ranged from 72% (0/1) to 79.8% (60/1.5). True OMD ranged from 71% (0/1) to 80.2% (60/1.5). Digestibility of NDF was linearly and quadratically (P = .0001) affected by NSC and linearly (P = .005) affected by DIP: an interaction of NSC x DIP existed (P = .05). Digestibility of NDF ranged from 37.4%(60/1.5) to 63.7%(0/1.5). Bacterial efficiency (g bacterial N/kg of truly digested organic matter) was linearly (P = .0004) affected by increasing DIP: an interaction (P = .01) of NSC x DIP existed. Efficiency ranged from 5.91 (60/1) to 9.38 (60/1.5). Actual g of bacterial DM synthesized was linearly affected by increasing NSC (P = .02) and DIP (P = .01): an interaction of NSC x DIP existed (P = .02). Bacterial DM synthesized ranged from 3.26 (30/1) to 4.8 (60/1.5). Based on digestibility values, sunflower heads appear to be a useful feed for ruminants; however, it would require supplemental NSC and DIP in order to maximize microbial N synthesis.

Key Words: Sunflower Heads, Nonstructural Carbohydrate, Degradable Intake Protein

581   The effects of high levels of molassed sugar beet pulp or barley inclusion and floor type on performance and liver copper accumulation in early weaned lambs. T. F. Crosby*, P. J. Quinn, J. J. Callan, B. Flynn, and P. J. Malone, *University College Dublin, Dublin, Ireland.*

One hundred and twenty three early weaned (weaned at 35 days old), Texel sired lambs from mainly Suffolk cross ewes were intensively reared on two concentrate types (barley based and molassed beet pulp (MSBP) based), and housed on one of two floor types (straw bedding and expanded metal flooring), in a 2 x 2 factorial experiment in order to evaluate lamb performance and copper accumulation in the liver. The background copper content was higher in the MSBP based concentrate (12.52 vs 8.2 mg/kg DM). The lambs were drafted for slaughter once they reached 36 kg live weight. Lambs reared on the straw bedding had a lower liver copper level than the lambs reared on the expanded metal flooring (301.5 vs 482.3 mg/kg DM; S.E.M. 43.6; P<0.005). Lambs on the MSBP based diet accumulated more copper than on the barley based diet (482.6 vs 301.2 mg/kg DM; S.E.M. 43.59; P<0.005). While liver copper values on the straw bedded treatments were lower, the lambs on these treatments also had a lower growth rate to slaughter (304 vs 346 g/hd/day; S.E.M. 5.6; P<0.05) and took longer to reach slaughter weight (107.8 vs 100.4 days; S.E.M. 1.6; P<0.05). Growth rate was higher in male relative to female lambs from the start of the trial to slaughter (344 vs 306 g/hd/day; S.E.M. 6.0; P<0.0001). There were no significant (P>0.05) differences in growth rate due to dietary treatments. Lambs reared on the pulp based diet had better conformed carcasses (P<0.05), were fatter (P<0.05) and had a higher kill out proportion (0.490 vs 0.475; S.E.M. 0.0026; P<0.0001) than lambs reared on the barley based concentrate. Female lambs had better conformed carcasses (P<0.05), but were fatter (P<0.0001) and had a higher kill out proportion (0.488 vs 0.476; S.E.M. 0.0028; P<0.005) than male lambs. The data indicate significant differences in performance due to concentrate type and that floor type in addition to dietary treatment can affect liver copper values in intensively fed lambs.

Key Words: Lambs, Concentrate, Copper

582 Effects of grain sorghum planting density and processing method on in vitro ruminal pH and dry matter digestibility. P. J. Defoor*[1], M. L. Galyean[2], and N. A. Cole[3], [1]*West Texas A&M University, Canyon, TX,* [2]*Texas Tech University, Lubbock, TX,* [3]*USDA-ARS, Bushland, TX.*

Five grain sorghum hybrids grown in 38- and 76-cm rows (HD and ND, respectively) were steam-flaked (SF), high-moisture (HM) harvested followed by rolling and ensiling, or dry-rolled (DR). These grains were evaluated in the laboratory to determine the effects of grain sorghum planting density and subsequent processing method on IVDMD and pH in a reduced-strength buffer (25% McDougall's Buffer Solution and 75% distilled H_2O) in vitro system. Ruminal fluid was collected from four ruminally cannulated steers, freeze dried, stored frozen, and reconstituted to its original volume with distilled water upon use. Dry matter disappearance and in vitro culture pH were evaluated after 6-, 12-, 18-, and 24-h incubation periods. Treatments were arranged as a 3 x 2 factorial, (three processing methods and two planting densities) blocked by hybrid, and data were analyzed by analysis of variance. Relative to ND, HD planting resulted in lower (P < .10) in vitro ruminal culture pH at 6 h (5.79 vs 5.84), and lower (P < .10) IVDMD at all incubation times except 12 h (37.1, 42.3, 46.4, and 49.1% for HD and 38.5, 42.6, 47.9, and 50.4% for ND at 6, 12, 18, and 24 h, respectively). These differences in IVDMD may have resulted from the lower (P < .001) N content of the HD sorghum relative to the ND (9.7 vs 10.8% CP). Disappearance of DM at 6, 12, 18, and 24 h was least (P < .001) for DR (29.7, 32.6, 37.6, and 41.3%, respectively), and greatest for SF (47.4, 52.7, 56.8, and 57.4%, respectively), followed by HM sorghum (36.2, 42.1, 47.0, and 50.6%, respectively). In vitro ruminal culture pH was least (P < .001) at 6, 12, 18, and 24 h for SF (5.6, 5.0, 4.8, and 4.6, respectively) and greatest (P < .001) for DR (6.1, 5.8, 5.8, and 5.6, respectively), followed by HM sorghum (5.8, 5.5, 5.3, and 5.1, respectively). These data indicate that relative to planting density, processing has a much greater effect on in vitro ruminal DM disappearance and pH.

Key Words: Ruminants, Grain Sorghum, In Vitro Disappearance

583 Evaluation of digestive characteristics of dry and temper rolled hulless and covered barley fed to beef cattle. J. V. Anderson*[1], C. W. Hunt[1], J. G. Andrae[1], G. T. Pritchard[1], and K. A. Johnson[2], [1]*University of Idaho, Moscow,* [2]*Washington State University, Pullman.*

A 4 x 4 Latin square experiment utilizing four ruminally cannulated beef cows (BW = 616 kg) was conducted to examine digestibility characteristics of hulless barley. The experiment had a 2 x 2 factorial arrangement of treatments to test the main effects and interactions of barley type (covered and hulless) and processing method (dry rolled and temper rolled). The covered barley contained 63.5% starch compared with 67.3% starch in the hulless barley. The tempering process involved applying water to the barley to a final moisture content of 19% for at least 12 h prior to rolling. The roller spacing was adjusted for each of the four barley treatments such that each kernel was fractured at least once. Cows were fed diets consisting of 60% barley and 40% forage (DM basis) which was a 60:40 mixture of alfalfa silage and chopped grass hay. Ruminal pH was lower (P < .10) from 8 h through 16 h after feeding for cows fed dry rolled compared with temper rolled barley. A processing x barley type interaction (P < .10) was observed for in situ DM disappearance (**ISDMD**) of grain at each incubation time (2 through 48 h). The nature of the interaction was that tempering reduced ISDMD of covered barley but improved ISDMD of hulless barley. This same interaction (P < .10) was observed for total tract DM digestibility. Twenty-four and 48 h ISDMD of barley and total tract DM digestibility were greater (P < .10) for hulless than covered barley treatments. In situ DM disappearance of forage was greater for hulless barley diets at 8 h (P < .05) and was numerically greater at 16 h (P = .11) and 24 h (P = .21) of incubation. Cows fed tempered covered barley had the lowest (P < .001) DMI compared with other treatments. These data indicate that ruminal degradation and total tract digestion was greater for hulless than covered barley. Improved digestion of hulless barley, however is highly dependent on type and degree of processing.

Key Words: Barley, Digestion, Hulls

584 Effects of grain processing and hay quality on performance of Holstein cattle in mid-lactation. F. Ysunza*[1], R. Gómez[2], and A. Navarro[3], [1]*CIAD, A. C.,* [2]*PATROCIPES, A. C.,* [3]*UNISON, Hermosillo, Sonora, México.*

Twenty-four Holstein cows (159±25 days in milk) were used to evaluate the effects on performance of forage quality and corn steam flaking. Alfalfa hay of high quality (35% NDF and 20% CP) or medium quality (44% NDF and 18% CP) and ground or steam-flaked corn were used in a factorial arrangement in four diets (free-choice chopped alfalfa hay plus 12 kg/d of a 50% corn concentrate formulated to 21% CP). Cattle were individually fed using electronic gates (American Calan®) and received the ration in four services daily for 30 d of adaptation and 40 d of evaluation. All cows were milked at 0400 h and 1600 h daily. Milk yield was not affected neither by forage quality nor by grain processing method (mean = 30.9 kg, SEM = 0.73). Feed efficiency improved by 7.8% (P = 0.08) for cows fed steam flaked corn, due to a lower hay intake (P = .02, 14.1 kg vs 12.4 kg for steam-flaked vs ground corn, respectively). Sustained milk production with lower intakes may be achieved by increasing energy availability from starch in the form of steam-flaked corn for dairy cattle in mid-lactation.

Key Words: Steam-flaked grain, Hay quality, Dairy cattle

585 Effects of grain processing or protein level on feeding value of grain sorghum in limit-fed growing diets for cattle. R. D. Hunter*, E. C. Titgemeyer, J. S. Drouillard, and T. A. Nutsch, .

Two trials were conducted to evaluate growth performance of cattle fed restricted quantities of high-concentrate growing rations. In Trial 1, 552 crossbred steers (290 kg) were allotted to 24 pens (23 head/pen) based on initial BW, breed type, and previous nutritional regimen. Diets containing 85% concentrate were formulated to provide 16.2% CP, .71% Ca, .39% P, 33 mg/kg monensin, and 11 mg/kg tylosin, and fed once daily at 2% of BW. Feed intakes were programmed on d 1 and increased weekly, assuming a gain of .9 kg/d. Treatments were 70% steam-flaked grain sorghum (SFGS), 70% dry-rolled corn (DRC), 70% dry-rolled grain sorghum (DRGS), 35% SFGS+35% DRGS, 35% SFGS+35% DRC and 35% DRGS+35% DRC. Diets were fed for 95 d followed by 5 d on a common diet. At the end of the growing trial steers were placed on finishing diets for 142 d and then slaughtered. There were no significant associative effects for grain combinations. Gain and efficiency were similar for SFGS and DRC, but DRGS resulted in lower gains and poorer efficiencies (P<.03). Carcass traits were not affected by treatments applied during the growing phase. Cattle fed DRGS tended to gain faster during the finishing period, partially compensating for poorer performance in the growing phase. In Trial 2, DRGS was used as the primary ingredient in limit-fed growing diets (88% concentrate) fed to 72 heifers for 100 d. Heifers were stratified by weight and allotted, within strata, to 12 pens (6 head each). Treatments consisted of four levels of nonenzymatically-browned soybean meal (Soypass®; 0, 6.7, 13.3, and 20% of DM). Diets were formulated to provide .73% Ca, .45% P, 33 mg/kg monensin, and 11 mg/kg tylosin, and 12.5, 14.9, 17.4 or 19.6% dietary CP. Increasing Soypass® tended (P<.15) to improve gain and efficiency, which may be attributable to higher energy content of Soypass® relative to DRGS. Cattle benefit from extensive processing of grain sorghum when it is included in limit-fed growing diets.

Key Words: Associative Effects, Finishing, Compensation

586 Feeding concentrate computerised individual versus total mixed ration (TMR) - Studies in ruminal fermentation and chewing activity of dairy cows. C. Scheidemann*, C. Dietrich, H. Steingass, and W. Drochner, *Inst. Anim. Nutr., Hohenheim Univ., Germany.*

Four ruminally cannulated Holstein cows were used in a double 2 x 2 Latin square design over a period of 13 d each to study the effects of feeding concentrate computerised individually over 24 h (A), in 2 meals/d (B) and in a TMR (C) on ruminal fermentation and chewing activity. In each group cows received daily a total of 17 kg DM with a concentrate share of 49% of total DM. The basal ration consisted of 38% corn silage, 29% grass silage, 27% hay, 3% soybean meal and 3% of a mineral mixture (% of DM). The concentrate contained 42% corn, 24% soybean meal, 21% wheat, 9% sunflower seeds, 0,5% soyoil and 3,5% of a mineral mixture. Basal ration and concentrate were identical for each feeding

group. Feeding times were at 08.30 and 17.00h. Chewing activities were measured from d 5 to 10. Rumen fluid was collected the following 3 d 5 times daily every 2 h beginning 1 h before the morning feeding. Samples were analysed for pH, bicarbonate, ammonia and volatile fatty acid (VFA) concentrations. Data were analysed by using GLM procedure and repeated measures ANOVA. While total chewing time was not influenced by the treatments, rumination time for cows in A was shorter (P≤0.05) than for cows in C and in tendency shorter in comparison to cows in B. Also the rumination periods in A were shorter (P≤0.05) than in the other two groups. Computerised concentrate feeding resulted in a lower (P≤0.05) pH value in rumen fluid in comparison to B and C. No differences in pH were obtained between B and C. The total VFA concentration was lower (P≤0.05) in B than in cows of the other two groups without a change in VFA pattern. On the other hand, ruminal bicarbonate concentration was lowest in B indicating a higher dilution due to drinking and/or a higher rumen outflow. These results suggest, that in rations with the same proportion of concentrate rumination is stimulated by feeding TMR. The shorter rumination time in A is probably due to interruptions of physiological rumination periods by frequent concentrate intake.

Key Words: Feeding Frequency, Rumen, Dairy Cow

587   Effect of acetate and roughage on ruminal VFA levels and performance of steers. T. W. White* and D. C. Blouin, *Louisiana State University Agricultural Center*.

Two experiments were conducted to study the effects of dietary acetate (A) on ruminal VFA levels and performance of beef steers. All-concentrate (C) diets (11.1% CP, 8.3% NDF, and 3.0% ash, DM basis) based on corn were diluted with rice hulls (RH), rice straw (RS), and (or) sodium acetate, and fed for 112 d in both experiments. The five diets fed in Exp.1 were: C, C + 1.65% A, 20% RH, 20% RH + 1.32% A, and 20% RS. The six diets fed in Exp. 2 were: C, C + .55% A, 20% RH, 20% RH + .44% A, 20% RS, and 20% RS +.44% A. Hereford steers, 40 in Exp.1 (BW=270 kg), and 48 in Exp. 2 (BW=297 kg), were randomly assigned to diets in pens of two. In Exp. 1, concentrate intake, ADG, carcass weight, and fat thickness over the 12th rib increased (P <. 05) from an average for C and RH diets of 6.0 kg, .89 kg, 226 kg, and 7 mm, respectively, to 7.3 kg, 1.2 kg, 240 kg, and 10 mm when A was added to these diets. Intake and performance was similar when diets contained A or RS. Acetate added to C and RH diets increased (P < .05) ruminal pH and decreased (P <. 05) butyrate and valerate. In Exp. 2, A increased (P < .05) concentrate intake, ADG, and carcass weight when added to the RH diet but had no effect when added to the RS diet. Acetate had little effect on ruminal fluid characteristics at the level fed in Exp 2. Levels of A in excess of .55% appear necessary to improve DMI and ADG of finishing steers.

Key Words: Roughage, VFA, Beef Steers

588   Effect of feeding high-oil corn, and control corn with added fat on ruminal and total tract digestion of finishing steers. C. Belknap* and A. Trenkle, *Iowa State University*.

The objectives of this experiment were to determine the differences in the site and extent of digestion of finishing steer diets containing high-oil corn, isogenetic control corn, or isogenetic control corn supplemented with animal/vegetable fat. Two 3 x 3 Latin Squares were utilized in an 84 d digestion trial using three ruminally fistulated mature beef steers with cannulas located in the proximal duodenum. Each square consisted of three, 14 d periods, with the first 8 d of each period being for diet acclimation, followed by the last 6 d for sampling. Diets consisted of 70% whole corn grain, 12.3% corn silage and 2.0% N, with the treatment differences being high-oil corn (HOC) grain, control corn (CC) grain, or control corn grain supplemented with animal/vegetable fat (CC+F). The CC+F diet was formulated to provide the same ether extract content as the HOC diet. Diets were fed every 12 h at 90% ad libitum. Total tract (TT) and ruminal (R) digestibilities were calculated for each treatment using chromic oxide as a marker. Rumen pH and NH3-N were measured over time. TT DM and OM digestibilities were greater (P<.04; 73.3 and 74.7% vs. 64.3 and 65.7% respectively), as was apparent N digestion (P<.03; 71.3% vs. 63.7% respectively) for CC than HOC. TT DM and OM digestion tended to be greater (P=.06; 72.1 and 73.5% vs. 64.3 and 65.7% respectively) for CC+F than HOC, but was not different (P>.10) for N digestion. There were no differences (P>.10) in DM, OM, or N TT digestion between CC and CC+F. No differences

were observed (P>.10) in R DM or OM digestion among treatments. Rumen pH and NH3-N were also not different (P>.10) among treatments. These data suggest that feeding whole high-oil corn grain at a level above 70% of diet DM in steer finishing diets decreases TT DM, OM, and N digestion when compared to isonitrogenous diets containing an equal amount of control corn grain.

Key Words: Cattle, High-oil corn, Digestion

589   Influence of ruminal pH and NDF source on in situ fiber disappearence. M. Basalan*[1], E. Polat[2], and F. N. Owens[3], [1]*Oklahoma State University, Stillwater, OK,* [2]*Agriculture Ministry, Turkey,* [3]*Optimum Quality Grains, Des Moines, IA*.

In vitro disappearance of NDF decreases as pH declines. Yet, to maintain ruminal function, forage fiber generally is included in grain-rich feedlot diets where ruminal pH is low, often below 5.5. Reductions in fiber digestibility have been attributed to reduced activity or retarded attachment of cellulolytic microbes or interference by other nutrients and toxins in the rumen environment. Although most studies with NDF disappearance have examined cellulose, hemicellulose has been largely ignored. The objectives of this study were to measure the impact of ruminal pH on in situ disappearance of hemicellulose (NDF minus ADF) and of ADF. To obtain different and relatively constant ruminal pH values, three ruminally cannulated heifers (387.5 kg) in a 3 by 3 Latin square experiment were fed a 90% concentrate diet (based on ground corn grain) at three levels of feed intake (1% and 1.5% of body weight daily or free choice) at three times each day. Three different fiber sources (alfalfa hay, prairie hay and wheat straw) were placed in dacron bags and extracted with neutral detergent devoid of EDTA to obtain NDF. These were incubated in situ for 0, 6, 12, 24, or 96 h, recovered, and again extracted with neutral detergent and with acid detergent. After 96 h of incubation, NDF disappearance ranged from 14 to 33%, being greater (P < .05) with wheat straw than with alfalfa hay. Rate of disappearance of hemicellulose and ADF as a fraction of that disappearing at 96 h were quadratically related to pH with minimums of 5.9 and 5.4 respectively. Stepwise regression indicated that below a pH of 5.2 to 5.6, depending on the source of fiber, pH had no impact on disappearance of hemicellulose or ADF and that above this pH, disappearance increased quadratically with pH. Results indicate that rate and extent of fermentation differ with fiber source and that low ruminal pH inhibits disappearance of both hemicellulose and ADF in a curvilinear fashion rather than abruptly at a pH of 6.0.

Key Words: NDF, Hemicellulose, fermentation

590   Evaluation of a dietary component for limiting intake by starting cattle. L. F. Caswell*, *Coronet Industries, Inc., Plant City, FL*.

Overconsumption by starting cattle and the related potential for subacute acidosis the remainder of the feeding period prompted four trials (T1, T2, T3, T4) to evaluate a thermochemical combination of tertiary calcium phosphate and calcium pyrophosphate as an intake limiting component (ILC). Crossbred calves (259 kg BW initially; n = 34, 151, 184 and 148) were fed: 1) silica (CTRL), or 2) ILC, at 92, 106, 91 or 90 g/d in T1 through T4, respectively. Complete starting diets were fed *ad libitum* for 28 d in T1 and T2. In T1, CTRL and ILC were fed continuously to three pens each. In T2, CTRL was fed continuously to three pens; three remaining pens were fed ILC on d 1, 3-7 and 15-28, but fed CTRL on d 2 and 8-14. Intake of the ILC diet in T1 was 91% (P<.05) of that for CTRL. However, continuous feeding of ILC did not reduce variation; SEM for CTRL and ILC intake curves were .90 and .89. Venous glucose (1000 h, d 28) was higher (P<.10) for ILC. Eating behavior suggested less time eating, and avoidance of agonistic feeding situations, by calves fed ILC. In T2, intake by calves fed ILC intermittently was 93% (P<.05) of that for CTRL fed continuously. Variation in intake was reduced with the ILC feeding scheme; SEM for the CTRL and ILC intake curves were 1.79 and 1.03. Arterial glucose (1000 h, d 28) was higher (P<.10) for ILC; no differences were found for venous glucose, PCV or pH. ILC numerically improved feed:gain in both T1 and T2. T3 and T4 were conducted to determine whether the higher blood glucose for ILC in T1 and T2 was due to a difference in hydration related to feed intake. In T3, three pens per treatment were limit fed concentrate (containing CTRL or ILC) at 0630 h and hay at 1830 h for 28 d in an attempt to assure similar hydration between treatments. Venous glucose (0830 h, d 24) was higher (P<.05) in calves fed ILC. T4

had three pens per treatment limit fed concentrate (containing CTRL or ILC) at 0700 h and hay at 1600 h for 21 d. Arterial and venous glucose (1100 h, d 21) were higher (P<.05) for ILC; no differences were found for PCV or pH. These data indicate that variation in intake can be reduced by intermittent feeding of the ILC.

Key Words: Beef Cattle, Starting Diets, Limit Feeding

591   Practical aspects of urea and ammonia metabolism in ruminants. G. B. Huntington and S. L. Archibeque, *North Carolina State University, Raleigh, North Carolina.*

Nitrogen was recognized over 200 years ago as an element essential for normal function of farm animals. During the first half of the last century, the roles of proteins and urea in nitrogen metabolism were discovered. By the middle of the 20th century, the substrates, products, and enzymes of the urea cycle were elucidated. Work since then quantifies dietary crude protein requirements for specific production goals, protein synthesis and breakdown, ruminal ammonia production, endogenous urea synthesis, and urea recycling. In ruminants fed conventional diets, Nitrogen absorbed as ammonia can be several times the amount of nitrogen absorbed in the form of amino acids or peptides. Nitrogen recycled to the digestive tract as urea in saliva or urea transported from blood ranges from 10 to 40% of nitrogen consumed in feed. Under production conditions, from zero to 20% of nitrogen consumed by ruminants is retained as tissue nitrogen or excreted as milk protein. This review will discuss the quantitative aspects of urea and ammonia metabolism in ruminants, then relate the metabolic or economic costs of that metabolism to practical feeding situations. The review will conclude with a discussion of conflicts and considerations among three main priorities in ruminant nitrogen metabolism: 1) maximizing microbial function in the rumen; 2) optimizing amino acid supply to the host ruminant; and 3) minimizing negative environmental effects of cycling nitrogen through ruminant production systems.

Key Words: Ruminant, Urea, Ammonia

592   Evaluation of alfalfa leaf meal in steer receiving diets. C. M. Zehnder* and A. DiCostanzo, *University of Minnesota, St. Paul, MN.*

A trial was conducted to study the effect of including alfalfa leaf meal (ALM) in receiving diets of steers on feedlot performance, morbidity, and mortality during the receiving period. One hundred forty medium-frame Angus and Angus cross steer calves (initial shrunk BW, 228 kg) were stratified by weight to one of 14 pens (15 steers or 8 steers/pen). Pens were randomly assigned to one of two dietary treatments for a 37-day receiving trial. Treatments were soybean meal (SBM) or alfalfa leaf meal (ALM) providing 100% of supplemental protein. Receiving diets were formulated to contain 1.19 Mcal NEg/kg DM, 14% CP, .6% Ca and .3% P. Interim BW data were based on full weights; entire trial data were based on shrunk weights. Steers fed ALM diets consumed more (P < 0.05) DM than those fed SBM (5.25 and 5.93 kg/d for SBM and ALM treatments, respectively) for the entire trial. Steers fed SBM had faster (P > 0.05) ADG (3.3 and 2.64 kg/d for SBM and ALM treatments, respectively) for the first 14 d of trial, and similar (P > 0.05) ADG (1.17 and 1.07 kg/d for SBM and ALM treatments, respectively) for the entire trial. Steers fed SBM required less (P < 0.05) DM/kg gain (3.34 and 4.68 for SBM and ALM treatments, respectively) for the first 14 d and for the entire trial (4.52 and 5.53 for SBM and ALM treatments, respectively) than steers fed ALM. Morbidity rate was 7.1 and 12.9% for SBM and ALM, respectively; however this difference was not significant (P > 0.05). Data from this and a previous study indicate that ALM fed at 24% of the diet DM enhanced DMI in receiving calves without a concurrent gain response, which resulted in lower efficiency.

Key Words: Alfalfa, Steers, Diets

593   Evaluation of alfalfa leaf meal in steer finishing diets. C. M. Zehnder*[1], A. DiCostanzo[1], and L. B. Smith[2], [1]*University of Minnesota, St Paul, MN,* [2]*Northwest Experiment Station, Crookston, MN.*

Two finishing trials were conducted in each of two consecutive years with 96 (year 1) or 112 (year 2) medium-frame Angus, and Angus cross steer calves (initial shrunk BW, 252 kg) to determine the effects of alfalfa leaf meal on feedlot performance and carcass characteristics. Steers

were stratified by weight and origin into 8 pens, 12 steers/pen (year 1) or 14 steers/pen (year 2). Pens were randomly assigned to one of four dietary treatments for a 175-d (year 1) or 179-d (year 2) finishing trial. Treatments were control (supplemental protein from soybean meal) or alfalfa leaf meal (ALM) providing 33%, 66%, or 100% of supplemental protein; the balance of protein source was soybean meal. Diets were formulated to contain 1.34 Mcal NEg/kg DM, 12.5% CP, .6% Ca and .3% P. Steers fed 100% ALM had faster (P < 0.05) ADG (1.71, 1.75, 1.73, 1.83 kg/d for control, 33%, 66% and 100% ALM, respectively) and higher (P < 0.05) DMI (10.23, 10.21, 10.58, 11.18 kg/d for control, 33%, 66%, and 100% ALM, respectively). Feed efficiencies were similar (P < 0.05) across all treatments. Steers fed 100% ALM had heavier (P<0.05) adjusted finished weights (HCW/.62) than those in the other treatment groups (568, 565, 561, 579 kg for control, 33%, 66%, and 100% ALM, respectively). There were no significant (P > 0.05) dietary treatment effects on HCW, REA, marbling, kidney, pelvic, heart, fat depot percentage, yield grade or quality grade. Incidence of liver abscesses in steers fed 100% ALM was numerically lower than in those fed the other treatments (P < .10; 21, 23.3, 27.3, 9.8% for control, 33%, 66% and 100% ALM, respectively). Thus, ALM is a suitable replacement for soybean meal as a protein source in finishing diets. Feeding ALM as the sole protein source may have added benefits including decreased incidence of liver abscesses.

Key Words: Alfalfa, Steers, Diets

594   Expeller crambe meal as a protein source for growing calves. D. L. Riley*, M. L. Bauer, V. L. Anderson, G. P. Lardy, and J. S. Caton, *North Dakota State University, Fargo.*

Thirty-four crossbred steers and heifers (264.2 ± 29.5 kg BW) fed in Calan gates were used to evaluate expeller crambe meal (ECM) as a protein source in comparison to soybean meal (SBM). Calves were blocked by sex, stratified by weight, and allotted randomly to one of six supplemental treatments containing graded amounts of ECM (0%, 25%, 50%, 75%, and 100%), replacing SBM and beet pulp; and a urea control. Diets were formulated to contain 11.5% CP. Supplements were formulated to provide 60% of total dietary CP. SBM and ECM make up .33% and .41% of total dietary CP, respectively. Diets consisted of 37.3% sorghum silage, 37.3% corncobs, 7.4% alfalfa hay, and 18% supplement on a DM basis. Calves were fed at 1.95% of BW on a DM basis with 14-day weigh intervals. Weekly samples of feed ingredients were taken. Weekly orts were collected, weighed and sub-sampled. Initial weights and final weights were the average of three consecutive days, with the trail being 85 days. There were no statistical differences (P > .21) in performance with orthoganol contrast used (urea vs. protein, linear and quadratic ECM effects, SBM vs. ECM). Metabolizable protein may not have been limiting gains or replication may have been too small.

| | | | Treatments | | | | |
| | | | | SBM:ECM | | | |
Item	Urea	100:0	75:25	50:50	25:75	0:100	RMSE[a]
n	5	5	6	6	6	6	
Final Weight,kg	298	314	290	302	283	299	43.4
ADG, kg	.34	.54	.37	.47	.27	.48	.221
ADG/Urea[b], kg	—	.23	.07	.16	-.03	.17	.220
Gain:Feed, g/kg	56.9	93.3	67.1	84.4	49.7	85.8	1.09
Gain:Protein[c], g/kg	—	778.6	215.1	599.1	-173.4	632.9	25.9

[a]Root mean square error [b]ADG above urea [c]Gain above urea divided by supplemental true protein

Key Words: Calves, Crambe meal, Protein

595   Effect of a Revalor[TM] implant on the growth response to an animal by-product protein mixture in high energy feedlot diets. P. J. Guiroy*[1], D. H. Beermann[1], D. G. Fox[1], and D. J. Ketchen[1], [1]*Cornell University.*

A mixture of four animal by-product protein sources (pork meal, fishmeal, blood meal and hydrolyzed feather meal) was formulated based on the NRC 1996 to contain an ideal amino acid (AA) pattern. The 1996 NRC model level 2 was used to develop three high energy diets that met ruminal N requirements, and met or exceeded MP requirement, with addition of 0, 3, or 6% of this UIP mix in the ration DM (diets contained 13.4, 14.3, and 15.6% CP, respectively). Ninety-six crossbred beef steers with an average weight of 350 kg, half implanted (I) with Revalor[TM] and half not (noI), were blocked by weight in pens of 8 and fed ad libitum

one of the diets. Daily feed intake was recorded and live weight was measured every 28 days. Plasma urea nitrogen (PUN) concentrations were determined on days 56 and 112. Initial weight of the cattle was used as a covariant for statistical analysis. The cattle were commercially slaughtered after 134 days on feed, weighing an average of 576 and 540 kg for I and noI (P<.01), respectively. Eighty-four percent exhibited a small degree of marbling (Choice Quality Grade) or higher. Carcass composition of 48 steers was determined by Hankins and Howe rib dissection. Across treatments ADG and feed efficiency were 1.7 and 1.4 kg/d, and 6.6 and 7.3 DM/kg gain for I and noI (P<.01), respectively. Neither were affected by UIP level (P = .63 and P = .16). PUN was lower for I vs. noI (P<.001), 10.3 and 12.4 mg/dL, and was increased (P<.001) with UIP addition. The implants decreased PUN at 56d, but not at 112d. Rib eye area and longissimus dorsi weight in the primal rib was higher for I vs. noI (P = .076 and P = .03), 80 vs. 77 cm2, and 2.39 vs. 2.17 kg, but they were not affected by UIP level. Carcass composition at slaughter was not affected by treatments, because I and noI were fed to the same body fat composition endpoint. However, implanted animals deposited 126 and 39 g/d more moisture and protein, respectively. The NRC 1996 model level 2 accurately predicted rumen microbial N and animal AA requirements.

Key Words: Feedlot, Undegradable intake protein, Implant

596   Potential Improvement of the Efficiency of Dietary Nitrogen Utilization in Holstein Steers Through the Use of Animal By-products. W. F. Knaus*[1], D. H. Beermann, P. J. Guiroy, M. L. Boehm, and D. G. Fox, *Cornell University*.

The objective of this study was to examine the effects of feeding increasing amounts of an 'amino acid-balanced' combination of animal by-product protein sources on rate and efficiency of N retention in growing cattle. The 1996 NRC model was used to formulate a corn-based (86:14 concentrate-hay) control diet to allow, based on the supply of ME and MP, for an ADG of 1.4 kg in 250 kg steers with an estrogenic implant and fed an ionophore. The model was then used to formulate an undegradable intake protein (UIP)mix containing pork meal, blood meal, fish meal and hydrolyzed feather meal that would provide an optimal amino acids spectrum. Four steers were assigned in a 4 x 4 Latin square design to treatments consisting of three levels of UIP administration (0, 2.6%, and 5.2% of the total DM) as well as a "urea-diet" containing no soybean meal and no UIP mix. All four diets were formulated to fulfill the N requirements of the rumen and to provide ME and MP in amounts allowing roughly the same ADG. Diets contained approximately 13.9, 14.6, 15.3, 13.4% CP on a DM basis, respectively. N intake was 145 g/d for the "urea diet" and increased from 155 to 162 g/d as % UIP increased from 0 to 5.2%. N digestibility was not affected, but urinary N excretion was significantly greater when the 5.2% UIP diet was fed. Only the 5.2% UIP diet resulted in a significant reduction of N retention and efficiency of N usage. Biological values were 46, 46 and 45% for the 2.6% UIP, "urea diet" and the control diet, respectively. The use of 5.2% UIP in the diet reduced (P<.05) the biological value to 38 %, indicated also by a significant elevation of the plasma urea N. Results demonstrate that use of the 1996 NRC model to formulate diets and feeding small amounts of a mixture of UIP sources, formulated to improve amino acid balance and increase total mass of absorbed N, elevate N retention and optimize biological value of absorbed N in growing cattle.

Key Words: Cattle, Undegradable Intake Protein, N Balance

597   Accounting for the effects of a ruminal nitrogen deficiency within the structure of the Cornell Net Carbohydrate and Protein System. L. O. Tedeschi*[1], D. G. Fox[1], and J. B. Russell[1,2], [1]*Cornell University, Ithaca, NY,* [2]*Agricultural Research Service, USDA, Ithaca, NY.*

The Cornell Net Carbohydrate and Protein System (CNCPS) prediction of cell wall digestion and microbial mass production on degraded NDF depends on ruminal bacterial N requirements being met by dietary N. We developed a submodel to account for the effects of a ruminal N deficiency on bacterial growth on the cell wall fraction. In cases in which the rumen N balance are negative, 1) the rumen available peptide and ammonia is divided by microbial N content to determine the N allowable microbial growth, 2) this value is subtracted from the energy allowable microbial growth to obtain the reduction in microbial mass, 3) this mass reduction is allocated between fiber (FC) and non-fiber (NFC) bacteria

by their original proportions in the energy allowable microbial growth, and 4) the reduction in fermented NDF is computed as the FC bacterial mass reduction divided by its growth rate, which is added to the NDF escaping the rumen. With these adjustments, both metabolizable protein (MP) from bacteria and metabolizable energy from NDF are reduced when rumen N is deficient. Treatments from Lomas et al. (J.Anim.Sci. 55:909), in which a growth response was observed when NPN was added to corn silage at different levels, were used to compare the measured ADG (kg/d) with CNCPS predicted MP allowable ADG. The CP (% of DM) of these treatments ranged from 7.5 to 11.1, the average shrunk body weight (SBW) varied from 270 to 346 kg, and the final SBW contained 27% fat. The CNCPS model with the adjustments described above accounted for 92% of the variation in observed ADG with a 2% bias. Without these adjustments, the CNCPS model accounted for 94% of the variation in observed ADG, but the bias was 43% (over prediction) of MP allowable ADG.

Key Words: CNCPS, Ruminal N deficiency, Rumen submodel

598   Effects of feeding an animal by-product protein mixture in high energy feedlot diets on growth performance and composition of gain in Revalor[TM]-implanted beef steers. P. J. Guiroy*[1], D. H. Beermann[1], D. G. Fox[1], and D. J. Ketchen[1], [1]*Cornell University*.

A mixture of four animal by-product protein sources (pork meal, fish meal, blood meal and hydrolyzed feather meal) was formulated based on the NRC 1996 to contain an ideal AA pattern. The 1996 NRC model level 2 was used to develop four high energy diets that met ruminal N requirements, and met or exceeded MP requirement, with addition of 0, 3, 6, or 9% of this UIP mix in the ration DM (diets contained 13.4, 14.3, 15.6, and 16.6 % CP, respectively). Forty yearling Revalor[TM]-implanted crossbred steers with an average weight of 302 kg were randomly assigned to individual pens with 10 steers each being fed ad libitum one of the diets for 119 days. Individual daily feed intake was recorded and live weight was measured every 28 days. Plasma urea nitrogen (PUN) was determined on days 0, 56, and 112. The cattle were commercially slaughtered weighing an average of 528 kg with 79% reaching a small degree of marbling (Choice Quality Grade) or higher. Carcass composition was determined by Hankins and Howe rib dissection. Across all four treatments, ADG and feed efficiency were 2.02 kg/d and 5.76 kg DM/kg gain, respectively, and were not affected by treatment (P = .71 and P = .28). PUN increased linearly with protein level and time (P = .022 and P< .001). Values ranged from 8.0 to 11.2 mg/dL for 0 and 9% UIP, and from 4.9 to 10.4 mg/dL at days 0 and 112, respectively. Yield grade increased (P = .045) from 3.2 to 3.9 as level of UIP supplementation increased. Longissimus dorsi (ld) weight in the primal rib was not affected by treatment. Percentage of carcass lipid and lipid accretion rate were not affected by diet (both P = .17) but a trend for both increasing linearly with increasing UIP level was observed, averaging 29.9 and 33.47%, and .61 and .73g/d for 0 and 9% UIP, respectively. Percentage of carcass protein and protein accretion rate were not affected by diet (P = .32 and P = .44). In this study, performance (ADG and efficiency of gain), carcass traits, ld weight, carcass composition, and composition of gain were not improved by UIP supplementation. The NRC 1996 model level 2 accurately predicted AA and rumen microbial N requirements of these fast growing steers.

Key Words: Cattle, Undegradable intake protein, Protein requirements

599   Degradable intake protein requirement of finishing steers fed a high moisture corn-based diet. R. J. Cooper*, C. T. Milton, T. J. Klopfenstein, and D. J. Jordon, *University of Nebraska, Lincoln, NE.*

A finishing trial was conducted to determine the degradable intake protein (DIP) requirement of yearling steers fed a high moisture corn-based diet. Two hundred and fifty-two crossbred yearling steers (average initial wt = 379 kg) were used in a randomized complete block design. Within three initial weight blocks, steers were stratified to one of four pens (12 pens, 21 steers per pen). Pens were randomly assigned to one of four treatments. Treatments consisted of graded levels of supplemental urea (0, .4, .8, and 1.2% of diet DM). Dietary DIP levels were 6.6, 7.8, 8.9, and 10.0% of DM, respectively. The final diet consisted of 82.5% high moisture corn, 5% alfalfa hay, 5% cottonseed hulls, 2.5% molasses, and 5% supplement (DM basis). High moisture corn was 26% moisture, 9.6% CP (DM basis), and 66% DIP (% of CP). Steers were adapted to

the final diet in 21 d with 50, 40, 30, and 20% alfalfa (DM basis) replacing high moisture corn for 3, 4, 7, and 7 d, respectively. Steers were implanted with Synovex Plus on day 1, and fed for 108 d. Treatment means were separated with linear, quadratic, and cubic contrasts. Dry matter intake was not affected by treatment and averaged 12.2 kg/d. Daily gain increased linearly (P = .01) with DIP level (1.71, 1.72, 1.82, and 1.85 kg/d, respectively). Gain/feed increased linearly (P = .03) with DIP level (.139, .141, .151, and .153, respectively). Twelfth rib fat depth increased linearly (P = .06) with DIP level (.89, .99, 1.0, and 1.07 cm, respectively). As dietary DIP level increased, steers gained faster and more efficiently, with greater fat depth. Based on level one of the 1996 NRC model, all diets exceeded MP requirements of steers by at least 76 g/d. The DIP balances were -63, 74, 211, and 347 g/d, respectively. The NRC (1996) model predicts a requirement of 7.2% DIP (.2% urea). Because gain and efficiency were linear, a DIP requirement cannot be estimated, but appears to be greater than predicted by NRC for highly fermentable corn-based finishing diets.

Key Words: Cattle, High moisture corn, Protein

600   Urinary allantoin excretion as a bacterial crude protein marker for beef cattle. R. A. Mass*[1], D. J. Jordon[1], T. L. Scott[1], D. L. Harmon[2], C. T. Milton[1], and T. J. Klopfenstein[1], [1]University of Nebraska, Lincoln, NE, [2]University of Kentucky, Lexington, KY.

Two metabolism trials investigated urinary allantoin excretion (ALLAN) as a marker of bacterial CP synthesis for beef cattle. Both trials utilized the same set of six ruminally and duodenally cannulated steers (360 kg). The objective of Trial I was to measure the relationship between duodenal purine flow and ALLAN. Steers were utilized in a replicated 3 × 3 Latin square design (21-d periods) with steer as experimental unit and three separate levels of alfalfa hay DMI (24.4% CP, 31.8% NDF, 26.7% ADF) as treatments: 3.9, 5.9, or 7.9 kg/d. Steers were fed every 2 h by timed feeders to establish steady state ruminal fermentation. Duodenal digesta was sampled on days 15-17 (four samples/d composited by d) and total urine was collected on days 18-21. Total ALLAN (mmol/d) for an experimental unit was regressed against duodenal purine flow (mmol/d) for the same experimental unit to yield the equation y = .48x + 205 (R^2 = .56). Standard deviations of purine treatment means were greater than twice as much as those for ALLAN. This discrepancy may explain the moderate fit of the regression equation. The objective of Trial II was to measure the effect of ME level on ALLAN. Steers were utilized in a crossover design (6-d periods). All steers were fed 7.2 kg DMI alfalfa hay (same as Trial I). Treatments were hay alone (CONTROL) or hay plus doses of a VFA solution equivalent to an additional 2.3 kg DMI from alfalfa hay (VFA). Steers on VFA treatment were dosed through the rumen cannula every 6 h throughout the period. Total urine was collected on days 4-6. No differences between CONTROL and VFA were found (P > .1) for both total ALLAN (804 and 734 mmol/d, respectively; SEM=30) and ALLAN per unit of DMI (112 and 115 mmol/kg, respectively; SEM=7). In conclusion, ALLAN is linearly related to duodenal purine flow, less variable than duodenal purine flow, and is unaffected by level of ME. It is an effective marker of bacterial CP synthesis and is a more precise marker than purines.

Key Words: Allantoin, Microbial protein, Cattle

601   The sparing of methionine by alternative methyl groups in cattle is limited. C. A. Loest*, E. C. Titgemeyer, R. H. Greenwood, and D. C. Van Metre, *Kansas State University, Manhattan.*

Five ruminally cannulated Holstein steers (158 kg) were used in a 5 x 5 Latin square to evaluate the sparing of methionine (MET) by betaine (BET) or choline (CH). Steers were fed 2.5 kg DM/d of a diet high in rumen degradable protein (83% soybean hulls, 8% wheat straw). To increase energy supply, ruminal infusions of 180 g/d acetate, 180 g/d propionate, and 45 g/d butyrate and abomasal infusions of 300 g/d glucose were provided. An amino acid (AA) mixture (404 g/d), limiting in MET (restricted to 2 g/d), was infused abomasally to ensure that non-sulfur AA did not limit protein accretion. Periods were 7 d with total fecal and urinary collections for N balance during the final 5 d and blood sample collection on d 7. Treatments were abomasal infusion of 1) water (control), 2) 2 g/d additional L-MET, 3) 8 g/d BET (BET-8), 4) 16 g/d BET (BET-16), and 5) 8 g/d CH. BET was 5- and 10-times the molar amount of MET, and CH was 5-times the molar amount of MET.

Plasma MET concentrations (7.9, 10.8, 10.6, 9.3, and 9.5 μM for control, MET, BET-8, BET-16, and CH, respectively) were not markedly altered by treatment. Retained N (20.0, 29.3, 22.2, 21.9, and 20.4 g/d for control, MET, BET-8, BET-16, and CH, respectively) increased in response to MET (P<.05), demonstrating a deficiency of sulfur AA. Responses to both levels of BET were small (P<.22), and those to CH minimal. The small responses to BET suggest an inefficient replacement of MET. However, responses in this trial to 8 and 16 g/d of BET were similar to those observed to 1.6 g/d BET in a previous trial, suggesting that higher levels of BET cannot be used to overcome the inefficiency in the replacement of MET. The lack of response to CH suggests that either methyl groups were not particularly limiting or that choline synthesis was not a physiologically important drain on methyl groups. Thus, responses to MET were likely due to a correction of a deficiency of MET per se rather than of methyl groups.

Key Words: Methionine, Betaine, Cattle

602   Effects of dietary protein and ruminally protected betaine or choline on productivity of Angora doelings. R. Puchala*, V. Banskalieva, A. L. Goetsch, I. Prieto, and T. Sahlu, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Thirty Angora doelings (22 ± 2 kg initial BW, 6 mo) were used in an experiment with a 2 x 3 factorial arrangement of treatments to investigate the effects of dietary protein level (9 and 15% CP, 2.4 Mcal/kg ME) and supplementation with ruminally protected choline (6 g/d) or ruminally protected betaine (6 g/d) or control (no supplementation) on ADG and mohair growth. Goats were housed in pens (seven or eight per pen) and given ad libitum access to the diet using electronic feeders for 120 d. There was a dietary protein x supplement interaction (P < .05) in ADG. Animals fed 9% CP - control and 9% CP - choline diets had lower (P < .001) ADG (46.7 and 52.1 g/d) than ones consuming the 9% CP - betaine diet (78.8 g/d). There were no differences in ADG (P > .26) among animals fed 9% CP - betaine, 15% CP - control (74.8 g/d), 15% CP - betaine (83.8 g/d), or 15% CP - choline (85.0 g/d) diets. Neither DMI nor mohair growth were affected by dietary treatments (P > .05). It is suspected that increased ADG with betaine supplementation of the low protein, cottonseed hulls-based diet was due to the additional methyl groups, which can be used for homocysteine remethylation and carnitine synthesis (lipid transporter). Supplementation with ruminally protected betaine may be useful to increase efficiency of utilization of poor quality, low protein diets.

Key Words: Betaine, Choline, Angora goats

603   Effects of escape protein and energy deprivation on weight change and carcass quality of white-face lambs. W. Pittroff* and H. D. Blackburn, *U.S. Sheep Experiment Station, Dubois.*

Lamb feedlot diets maximize growth but may lead to overfat lambs. This experiment used escape protein supplementation of a diet deficient in ME$_m$ to induce changes in body composition. Growing white face lambs were fed ad lib a concentrate/alfalfa pellet based feedlot diet to an average weight of 56.56 +/-4.58 kg . Lambs were given 3 treatments: Control (CON) continued feedlot diet ad lib, straw-fishmeal (SFM) (barley straw ad lib, plus 75 g molasses and 150 g fish meal /head/d), and straw ad lib plus 75 g molasses /head/d (STR). 54 head were slaughtered over 5 weeks. Data collected: physical dimensions, body wall, loin eye area, loin eye depth, tail-head fat, shoulder fat, weight of right carcass half, bone weight, meat weight and weight of primal cuts (shoulder, leg, loin and rack). Data were analyzed with the linear model: $y_{ijk}=\mu\alpha_i+\tau_j+\beta(x_{ijk}-x_{..})+\epsilon_{ijk}$ where α is the effect of the i-th nutritional treatment, τ the effect of the j-the slaughter date and x the effect of covariates: hot carcass weight (CW), or live unshrunk body weight at the beginning of experimental treatments (IW). For all but meat/cut weight data CW was used. Weight changes were modeled as four response variables (DW1-4) denoting the percent daily change in weight with weight at the beginning of the period as the base corresponding to weight changes over 5 weeks of serial slaughter. Data for weight change were analyzed with treatment as main effect only. Adjusted means for all saleable lean traits (meat weight, loin eye depth, loin eye area, primal cuts) were higher for SFM than for STR. This difference was significant (p=.0056) only for meat weight. There were significant differences between slaughter dates in backfat, shoulder fat

and tail-head fat. Treatment effects were significant for weight changes DW1 and DW2; differences between the two experimental treatments were not significant. For all DW, weight loss of the SFM lambs was lower, and weight change for these lambs was positive in the last two periods while STR lambs continued to loose weight. Further work is required to elucidate the discrepancies between our results and previously reported work, in particular the effects of stage of maturity in the expression of nutrition effects on body composition.

Key Words: Sheep, Escape protein, Carcass quality

604   Effects of escape protein and energy deprivation on organ mass and body composition of white-face lambs. W. Pittroff* and H. D. Blackburn, *U.S. Sheep Experiment Station, Dubois.*

Lamb feedlot diets maximize growth but may lead to overfat lambs. This experiment used escape protein supplementation of a diet deficient in ME_m to induce changes in body composition. Growing white face lambs were fed ad lib a concentrate/alfalfa pellet based feedlot diet to an average weight of $56.56 +/-4.58$ kg . Lambs were given 3 treatments: Control (CON) continued feedlot diet ad lib, straw-fishmeal (SFM) (barley straw ad lib, plus 75 g molasses and 150 g fish meal /head/d), and straw ad lib plus 75 g molasses /head/d (STR). 54 head were slaughtered over 5 weeks. Proximate analysis of refusals indicated complete consumption of fishmeal. Hot carcass data collected included: weight, weight of organs, weight of GI components, offals including peripheral fat. Body composition was determined by deboning and grinding half of each carcass and proximate analysis of grab samples. Assumptions on fat content of offal fat and bone were based on literature data. Data were analyzed with the linear model: $y_{ijk} = \mu\alpha_i + \tau_j + \beta(x_{ijk} - x_{..}) + \epsilon_{ijk}$ where α is the effect of the i-th nutritional treatment, τ the effect of the j-the slaughter date and x the effect of covariate live unshrunk body weight at the beginning of experimental treatments (IW). The saturated model also included the main effect interaction which was generally not significant. Contrasts were constructed for pre-planned comparisons between the two experimental diets and initial and final slaughter date, when appropriate. Results: Slaughter date was significant for kidney weight; treatment effects (attributable in all variables but empty rumen weight to control vs. exp. diets only) were significant for mass of liver, empty and full GI tract, peripheral fat, empty rumen and small intestine. Treatment effects bordered significance for fat and crude protein percentage (wet), were not significant for dry fat percent, ash, CP dry, and total body fat. Slaughter date was only significant for CP-wet. When carcass weight was excluded as covariate, treatment effects for total body fat were significant. Fat content was numerically higher for STFM than for STR. These results disagree with previous work possibly due to genetic heterogeneity of animals and higher degree of maturity.

Key Words: Sheep, Escape protein, Body composition

605   Effect of high oil corn on digestibility and energy content of finishing diets fed to beef cattle. J. G. Andrae*[1], C. W. Hunt[1], S. K. Duckett[1], G. T. Pritchard[1], F. N. Owens[2], and S. Soderlund[2], [1]*University of Idaho, Moscow,* [2]*Optimum Quality Grains, Des Moines IA.*

Sixty yearling crossbred steers (initial BW 412 kg) were used to determine the effect of feeding high oil corn on total tract digestibility and energy content of finishing diets. Steers were allotted by weight to the following dietary treatments: 1) control corn (**C**; 82% normal corn, 12% triticale silage), 2) High oil corn (**HO**; 82% high oil corn, 12% silage) and 3) high oil corn formulated to be isocaloric to C (**ISO**; 74% high oil corn, 20% silage). Total lipid content was 4.9% on a DM basis for normal corn and 7.0% for high oil corn. Chromic oxide was fed (3 g/d) as an external digestibility marker for 7 d before fecal collection began. Six fecal samples were collected during the subsequent 3-d period. Pre-planned contrasts of HO versus C and ISO versus C were used to assess treatment differences. Digestibility of DM, OM, starch and GE was greater (P < .05) for the HO diet than the control diet. The combined effect of greater GE content and digestibility resulted in greater (P < .01) DE content of the HO than of the C diet. Calculated DE (Mcal/kg) of the corn was 8.3% greater (3.74; P < .01) for the HO diet and 6.5% greater (3.67; P < .01) for the ISO diet than the corn in the C diet (3.25). Dry matter and GE digestibility did not differ (P = .96) between the C and ISO diets, indicating that the diets were similar in available energy content. Steers consuming ISO had greater (P < .05)

starch digestibility than steers fed the C diet. While the HO diet had greater GE digestibility and DE content, steers fed this diet had lower total DM intake, therefore treatment differences were not observed (P = .78) for intake of DE. These data indicate that greater available energy can be obtained from high oil corn, but voluntary feed intake must be maintained at an equal level to that of normal corn.

Key Words: Corn, Oil, Digestibility

606   Digestibility and net energy of feedlot diets containing steam-flaked high oil corn compared with steam-flaked typical corn plus added tallow. M. J. Jarosz*[1], D. R. Brown[2], D. E. Johnson[1], and S. D. Soderlund[3], [1]*Colorado State University, Ft. Collins, CO,* [2]*Agland/Farmland, Eaton, CO,* [3]*Optimum Quality Grains, Des Moines, IA.*

Eight English/Exotic mixed steers were used in a 4 x 4 Latin square experiment to compare the digestibility and net energy content of 90% concentrate diets containing two steam-flaked corn types, high oil corn (HOC) and typical corn plus added tallow (TC), and two steam-flake densities, 335 and 386 g/L. Fecal and urine output was measured by 7-d collection and heat and methane production by 2-d respiration calorimetry chamber trial. Starch and ether extract digestion averaged 95.9 and 93.5% and did not differ between corn type and/or flake density. The ADF content of the diets was similar, 8% of DM, however, ADF digestibility was 27% greater (P < .02) for the HOC diets than the TC diets and was improved by less intensive processing to 386 g/L compared to the 335 g/L. The net energy for gain content of all diets was similar, each containing approximately 1.3 Mcal/kg DM. Nitrogen retention and protein content of gain of steers fed HOC diets were improved by more intensive processing and were compromised with less processed HOC. Replacing typical plus added tallow in 90% concentrate finishing diets with high oil corn results in similar nutrient digestibilities and net energy for gain values, however, more attention may be needed to meet metabolizable protein requirements when HOC is fed.

Key Words: Corn, Beef Cattle, Net Energy

607   Effects of grain source, grain processing, and protein level on finishing cattle performance. R. D. Hunter*, J. S. Drouillard, E. C. Titgemeyer, K. C. Behnke, T. A. Nutsch, and G. L. Kuhl, .

In Trial 1, crossbred beef steers (n=536; 391kg) were fed diets containing steam-flaked whole grain sorghum (FWGS), steam-flaked rolled grain sorghum (FRGS), dry-rolled corn (DRC) and steam-flaked corn (SFC) for 142 d to compare finishing performance and carcass traits. Diets (92% concentrate) were formulated to contain 13.2% CP, .70% Ca, .30% P, 33 mg/kg monensin, and 11 mg/kg tylosin. SFC was steam conditioned for 60 min and flaked to .335 kg/L. FWGS was conditioned for 90 min and flaked to .310 kg/L. FRGS was dry-rolled to a course texture, approximately cutting the berries in half, then conditioned for 45 min and flaked to .310 kg/L. Steers were fed in pens of 21 to 23 head, with six pens per treatment. Cattle fed FRGS, DRC and SFC grew faster (P<.01) than those fed FWGS. DMI was higher (P<.03) for DRC than other grains. DMI was lower (P<.03) for FWGS than for FRGS. Efficiencies tended to be better for flaked grains than for DRC. FWGS produced lower USDA yield grades than SFC or DRC (P<.01). Marbling scores tended to be lower for FWGS than other treatments (P<.15). Trial 2 evaluated finishing performance of yearling heifers (n=345; 357 kg) fed SFC, FWGS, or a 50:50 mixture of the two grains (MIX). Diets (92% concentrate) were formulated to provide 11 or 13% CP, .68% Ca, .3% P, 33 mg/kg monensin, and 11 mg/kg tylosin. Heifers were allotted to 24 pens (4 pens per treatment) and fed for 100 or 130 d. Heifers fed FWGS had lower ADG and DMI and poorer efficiencies than those fed SFC or MIX (P<.02). Higher dietary protein increased ADG and DMI (P<.02) and tended to improved gain efficiency (P<.1). Treatments had no significant effect on carcass traits except for s.c. fat, which increased with protein level (P<.03). Positive associative effects were observed between SFC and FWGS for efficiency. Rolling grain sorghum prior to flaking can improve feed value while reducing energy expenditure for processing. Dietary protein level of 11% is inadequate for diets based on steam-flaked grains.

Key Words: Grain Sorghum, Corn, Carcass Traits

608 Effects of corn silage hybrid and dietary proportion on yearling steer performance. A. DiCostanzo*[1], C. M. Zehnder[1], J. M. Cassady[1], H. Chester-Jones[2], D. Ziegler[2], and R. Greenwald[2], [1]*University of Minnesota, St. Paul, MN,* [2]*Southern Experiment Station, Waseca, MN.*

This study was undertaken to determine effects of increasing dietary corn silage (CS) proportion of two hybrids (regular dent, R, or high leaf:stalk ratio, L) on feedlot performance and carcass characteristics. Ninety-six medium-frame Angus crossbred steers (412 kg) were stratified by weight and assigned to one of 16 pens. Pens were randomly assigned to one of six dietary treatments resulting from the factorial arrangement of corn hybrid and CS proportion [12% (6 pens), 24% (4 pens), or 36% (6 pens) of diet DM]. Initial BW were taken after an 18-h fast, and final BW were adjusted to a common dressing percentage (62%). There were no interactions between hybrid and CS proportion. No differences (P > .10) between hybrid were observed for ADG, DMI, or feed DM required/kg gain (1.55 vs 1.49 kg/d; 11.22 vs 11.16 kg/d; 7.30 vs 7.56 kg DM/kg gain, respectively, for steers fed R vs L hybrid). Increasing CS proportion beyond 12% decreased (P < .05) ADG, had no effect (P > .05) on DMI, and increased (P < .05) feed DM required/kg gain (1.67, 1.44 or 1.44 kg/d; 11.19, 11.20 or 11.18 kg/d; 6.71, 7.78 or 7.80 kg DM/kg gain, respectively, for steers fed 12%, 24% or 36% CS). Steers were marketed when half of them reached choice grade as assessed visually. Steers fed 12% or 24% CS were marketed after 126 d, while those fed 36% CS were marketed after 142 d on feed; 92 or 87 d, respectively, after implanting (Revalor-S). Ribeye area of steers fed the R hybrid was larger (P < .05) than that of steers fed the L hybrid (89.10 vs 85.29 cm^2). Ribeye area of steers fed 12% CS was larger than that of steers fed 24% or 36% CS (90.71, 85.68 or 85.16 cm^2, respectively, for steers fed 12%, 24% or 36% CS). Steers fed 24% CS had the lightest (P < .05) hot carcass weights (385, 367 or 384 kg, respectively, for steers fed 12%, 24% or 36% CS). Results indicate that choosing to feed a given proportion of corn silage in the diet of yearling steers is independent of the hybrid (R vs L) that is used.

Key Words: Corn Hybrid, Steer, Feedlot

609 Degree of winter restriction on compensatory growth and subsequent slaughter breakevens of beef steers. D. J. Jordon*, T. J. Klopfenstein, C. T. Milton, and R. J. Cooper, *University of Nebraska, Lincoln, NE.*

A trial was conducted to evaluate degrees of winter restriction on subsequent compensatory growth in yearling cattle. Crossbred steers (180 hd) were used in a completely randomized design with treatments FAST, CORN, FAST/SLOW, SLOW/FAST, and SLOW. The winter had two phases. In phase 1 (78 d), steers were fed 2.3 kg DM wet corn gluten feed (WCGF; FAST), 1.8 kg DM corn (CORN), or protein supplement (SLOW) while grazing cornstalks. In phase 2 (68 d), cattle were fed 2.3 kg DM WCGF (FAST), 1.8 kg DM corn (CORN), or mineral supplement (SLOW) and ammoniated wheat straw. After phase 1, half the FAST calves were switched to SLOW, and vice versa, giving degrees of winter restriction. The CORN treatment was used to determine if WCGF in the winter resulted in carry-over effects in grazing or feedlot gains. Winter gains were .63 (FAST), .61 (CORN), .38 (FAST/SLOW), .39 (SLOW/FAST), and .21 kg/d (SLOW). Summer grazing consisted of bromegrass (46 d), native warm-season range (86 d), followed by bromegrass (21 d). Cattle were then placed into the feedlot and finished on 40% WCGF, 48% high moisture corn, 7% alfalfa, and 5% supplement (DM basis). No summer gain differences (P > .10) were found with restricted cattle (FAST/SLOW, SLOW/FAST, or SLOW); however, gains were faster (P < .05) on grass compared to FAST or CORN animals. Summer gains were .47, .43, .53, .56, and .54 kg/d for FAST, CORN, FAST/SLOW, SLOW/FAST, and SLOW, respectively. Summer gains were lower than expected, but compensation on grass did occur. Comparing FAST and SLOW treatments, SLOW cattle compensated 17.4% during grazing. FAST steers had lower (P = .056) slaughter breakevens compared to SLOW (64.05 vs 66.94 $/45 kg, respectively). No other differences in breakevens were found. Due to little compensation by SLOW cattle, FAST cattle had heavier slaughter weights and lower breakevens. Correlation coefficients (r) showed that higher rates of winter gain (r = -.61, P < .10) and increased final weights (r = -.87, P = .0012) resulted in lower slaughter breakevens.

Key Words: Compensatory gain, Slaughter breakeven, Steers

610 Effect of weaning status and implant regimen on performance, carcass characteristics and composition of growth in steers. J. P. Schoonmaker*, F. L. Fluharty, T. B. Turner, S. J. Moeller, D. M. Wulf, J. E. Rossi, and S. C. Loerch, .

Seventy-six Angus × Simmental crossbred steers (initial BW 155.5 ± 5.1 kg) were used in a 2×2 factorial experiment to determine the effects of weaning age and implant regimen on growth, performance, carcass characteristics and composition of gain in steers. Steers were either early-weaned (106 d; **EW**) or normal-weaned (197 d; **NW**), and allotted by weight to an aggressive (**A**) or non-aggressive (**NA**) implant regimen. The A implant regimen consisted of a Synovex-C implant followed by 2 Revalor-S implants. The NA implant regimen consisted of 2 Synovex-S implants. To evaluate initial carcass compostion and characteristics, 4 early-weaned and 4 normal-weaned steers were selected for harvest when BW reached 254 kg (169 and 197 d of age, respectively). Steers were penned individually and fed an 85% concentrate, 13.1% CP finishing diet. Steers were harvested when BW reached 546.5 kg. Compensatory growth experienced by NW steers during period 2 was able to offset their slower growth in period 1 (weaning status × time; P < .01). Normal-weaned steers; therefore, had similar (P > .16) gains to those of EW steers (1.58 vs 1.52 kg/d) for the entire trial (106 d to harvest). Aggressive implant steers gained faster than NA steers (1.43 vs 1.30 kg/d; P < .04) during period 1; however, no significant differences existed for gain in period 2 or for the entire trial. Daily post-weaning DMI was lower for EW than for NW steers, but total post-weaning DMI was higher (P < .01) for EW than for NW steers (1835.2 vs 1401.5 kg, respectively). For EW steers at initial harvest, the A implant regimen resulted in a 54 % increase in backfat depth compared with the NA implant regimen (.50 vs .32 cm, respectively); for NW steers at initial harvest, the A implant regimen resulted in a 52 % decrease (interaction; P < .01) in backfat depth compared with the NA implant regimen (.13 vs .25 cm, respectively). Early weaned steers had higher quality grade than NW (96 vs 82% choice; P < .07). The A implant regimen increased (P < .03) L. dorsi area but did not affect quality grade compared with the NA regimen. In general, weaning staus affected the timing of tissue growth more than the extent of growth. Early weaning resulted in a very high percentage of choice cattle at an average weight of 547 kg and an average age of only 357 d.

Key Words: Early weaning, implant regimen, growth

611 Accuracy of 1996 beef NRC computer program in prediction of cattle performance in western Canada. H. C. Block* and J. J. McKinnon, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

Two trials were conducted at the University of Saskatchewan to evaluate the 1996 NRC Beef Model as a feedlot nutrition management tool for backgrounding and finishing beef steers. Trial 1 utilized 144 Charolais-cross (304.6±16.3 kg) and 144 Hereford-cross (294.8±20.9kg) steers while Trial 2 utilized 88 Angus-cross (289.5±15.0kg), 88 Charolais-cross (299.8±17.7kg), and 88 Hereford-cross (291.1±20.9kg) steers. Rations based on barley grain, barley silage, canola meal, and cereal straw were analyzed according to NRC (1996) methodology. Animal performance and environmental data were collected for 24 pens of steers per trial for backgrounding, finishing and overall feeding periods. Level 2 (rumen simulation) of the 1996 NRC Beef Model was utilized to generate predictions of pen DMI and ADG. Predicted and observed pen DMI and ADG were analyzed using GLM and linear regression. Backgrounding ADG was restricted to 0.93 kg by limit feeding a diet formulated to 3.0 Mcal DE/kg dry matter. Predicted DMI was higher (P<.05) than observed DMI for backgrounding and overall feeding periods. No difference (P>.05) existed between predicted and observed DMI during finishing. Linear regression intercepts not different (P>.05) from zero allowed bias analysis for DMI during Trial 1 finishing, Trial 1 overall, and Trial 2 overall feeding periods. Biases were 0%, 20%, and 13% for Trial 1 finishing, Trial 1 overall, and Trial 2 overall feeding periods, respectively. Predicted ADG was lower (P<.05) than observed in all feeding periods. All linear regression intercepts for ADG were different (P<.05) from zero. This prevented bias analysis for ADG. The model indicated metabolizable energy intake as the limiting factor for ADG in all periods. Discrepancies were noted regarding estimations of bacterial nitrogen balance for the different feeding periods. Further investigation and model refinement regarding animal requirements, effects of limiting

feed intake, and appropriate time period for evaluation may improve estimation of feed digestion and animal performance.

612   Evaluation of the 1996 NRC Beef Model for predicting growth of backgrounding cattle in western Canada. T. A. H. Marx*[1,2], J. J. McKinnon[1], D. A. Christensen[1], and W. Gwayumba[1,3], [1]*University of Saskatchewan, Saskatoon, SK,* [2]*Alberta Agriculture, Food and Rural Development, Camrose, AB,* [3]*Agriculture and Agric-Food Canada Research Centre, Lethbridge, AB.*

Two trials were conducted to evaluate the 1996 NRC Beef Model as a feedlot nutrition management tool for backgrounding calves. Trial 1 utilized 150 (255.2±19.6 kg) medium frame (MF) and 150 (259.5±17.2 kg) large frame (LF) steers while trial 2 utilized 340 (285.0±19.0 kg) LF steers. Western Canadian feed ingredients typical of backgrounding programs were utilized and analyzed according to the Cornell Net Carbohydrate and Protein System (CNCPS) methodology. Diet, animal weights, DMI, feed analysis, measured effective NDF (eNDF), *in sacco* degradability rates, and actual climatic data were entered into the model. Observed ADG and DMI were regressed on the corresponding 1996 NRC Beef Model predictions to determine the variation (adjusted r^2), precision (standard error (S_{yx})) and bias (regression coefficient when the intercept was 0) of each relationship. Deviation of the regression slope from 1 was assessed using a two-tailed t test. Experimentally observed DMI were lower (P<.05) than the predicted DMI (Level 1 and 2). Regression results indicated that the 1996 NRC Beef Model overpredicted DMI of growing steers with an average bias of 11.5% (slope significantly different from 1). Experimentally observed ADG were greater (P<.05) than the predicted ADG (intercept different from 0 (P<.05)). ADG was predicted to be limited by metabolizable energy intake. Revising the carbohydrate B2 (CB2) fraction rates of barley grain (7.6%), brome/alfalfa hay (1.7%), grain screening pellets (trial 1=2.4%; trial 2=3.1%), and barley silage(3.54 and 1.09%) did not improve ADG predictions and reduced dietary energy predictions. Under the conditions of this study, the 1996 NRC Beef Model overpredicted DMI and underpredicted ADG of backgrounding steer calves. It was concluded that further research is required to improve estimates of carbohydrate and protein fractions, degradation rates, rumen metabolic parameters and kinetics of local feedstuffs to improve the model's accuracy of animal performance predictions for use in western Canada.

613   Effects of ionophore type and level on performance by newly received beef calves and effects of ionophore type and management program on performance by finishing beef steers. G. C. Duff*, M. L. Galyean, and K. J. Malcolm-Callis, *Clayton Livestock Research Center, New Mexico State University, Clayton.*

In Exp. 1, 250 crossbred (British x Continental; 177 kg) beef calves were used to evaluate the effects of ionophore (IONO) type and level on performance by receiving calves. Treatments (70% concentrate diets) were: control (no IONO), monensin (M) at 22 mg/kg of diet plus tylosin (T) at 11 mg/kg of diet (M22), M at 33 mg/kg of diet plus T at 11 mg/kg of diet (M33), and lasalocid (L) at 33 mg/kg of diet plus oxytetracycline at 8.8 mg/kg of diet. No differences (P > .10) were noted among treatments for daily gain or feed:gain during the study. Daily DMI of concentrate and total DMI were decreased (P < .04) during d 0 to 14 for IONO treatments vs controls and decreased (P < .05) for M33 compared with M22. No differences were noted among treatments for daily DMI during d 15 to 28. Daily DMI was decreased (P < .08) for IONO treatments compared with control for d 0 to 28. In Exp. 2, 240 yearling British x Continental steers were used to evaluate the effects of IONO type and management during starting and finishing phases on performance. Treatments were (90% DM basis): no IONO (CON), M at 27.6 mg/kg of diet, laidlomycin propionate (LP) at 11 mg/kg of diet, and L at 33 mg/kg of diet during the first 28 d, followed by LP at 11 mg/kg of diet (L/LP) for the remainder of the finishing period. Daily gain (1.56, 1.56, 1.54, and 1.61), daily DMI (9.19, 9.00, 8.91, and 9.21), and feed:gain (5.87, 5.78, 5.80, and 5.71 for CON, M, LP, and L/LP, respectively) did not differ (P > .10) among treatments for the 142-d experiment. Although not statistically significant, finishing diet ionophore altered DMI. Based on our results, both M at 22 or 33 mg/kg and L at 33 mg/kg can be used in the diet of newly-received beef calves

without adversely affecting daily gain. However, decreased DMI should be an important factor to consider when determining the type and level of ionophore to feed to calves.

614   Effect of feeding *Lactobacillus acidophilus* BG2FO4 (MicroCell) and *Propionibacterium freudenreichii* P-63 (MicroCell PB) on growth performance of finishing heifers. G. L. Huck*[1], K. K. Kreikemeier[2], and G. A. Ducharme[2], [1]*Kansas State University, Garden City, KS,* [2]*Biotal, Inc., Eden Prairie, MN.*

The objective was to determine the effect of feeding *Lactobacillus acidophilus* BG2FO4 (LA) and *Propionibacterium freudenreichii* P-63 (PB) either alone or in sequence on growth performance and carcass traits of finishing heifers. Yearling heifers (n=450; 384 kg) were allotted to 50 pens in a randomized complete block design and fed once daily for 126 d. Blocking factor was pen location: block 1=20 pens, block 2=20 pens, and block 3=10 pens. Treatments were: 1) no microbial feed additive (control); 2) LA, 3) PB, 4) LA, d 1-28, PB d 29-126 (LA/PB), and 5) PB, day 1-28, LA d 29-126 (PB/LA). Microbial feed additives were dissolved in water and added daily to the TMR. We fed LA at 5×10^8 cfu/head/day and PB at 1×10^9 cfu/head/day. Cattle were stepped up (21 d) to a final diet (12.5% CP, 2.5% CP from urea) 10% corn silage, 42% steam-flaked corn, 12% high-moisture corn, 3% soybean meal, 3% mineral supplement. Monensin and tylosin were included at 33 mg/kg and 11 mg/kg, respectively. Initial weight was based on two consecutive daily weights and final weight was determined by dividing hot carcass weight by the average dressing percent (.6261). The experiment took place from September 9, 1998 to January 13, 1999 at the Southwest Research and Extension Center at Garden City, KS. We conclude that greater effectiveness can be achieved by targeting the microbial feed additive to the phase of production.

Item	Control	LA	PB	LA/PB	PB/LA	SE
DMI, kg	8.43	8.41	8.40	8.40	8.52	.10
ADG, kg ab	1.20	1.21	1.18	1.26	1.25	.02
Feed/gain a	7.05	6.99	7.14	6.69	6.81	.14
Carcass backfat, cm	1.15	1.21	1.17	1.09	1.16	.04
Choice + Prime, % c	64.15	59.55	76.96	66.15	68.20	4.6

[a]LA/PB vs. Control, P = .06; [b]PB/LA vs. Control, P = .10; [c]PB vs. Control, P = .05.

615   Rumen protected choline and free betaine effects in finishing feedlot steers. S. R. Goodall*[1] and J. R. Brethour[2], [1]*Gladwin A. Read Company,* [2]*Kansas State University.*

Rumen protected choline and free betaine effects in finishing feedlot steers. S.R. Goodall and J.R. Brethour, Gladwin A. Read Company, Elgin, IL and Kansas State University.
This experiment evaluated the effects of feeding 4.5 g/hd/d rumen protected choline (RPC), 20 g/hd/d free betaine (FB), the combination of 4.5 g/hd/d RPC plus 20 g/hd/d FB or a control diet (C) on finishing performance and carcass characteristics of yearling crossbred steers (n = 290 and BW = 463 kg). Initially, steers were allotted to three optimal days on feed (DOF) blocks based on a projection model that included weight and ultrasound estimated backfat and marbling score (DOF = 99, 126, 148). Within each DOF block, steers were sub-blocked by initial weight and source, then randomly allotted to the four treatments (C, RPC, FB, RPC+FB). Each treatment contained three pen-replicates with 24 steers/ pen. Cattle were fed milo-based finishing diets until reaching their optimal DOF targets and were then harvested. Final weights were determined from carcass weights divided by a constant dressing percent. Feedlot performance measurements included average daily gain (ADG), DM intake (DMI) and gain/feed (G/F). Carcass measurements included backfat thickness (BF) and marbling score (MS). Performance and carcass data were analyzed by two-way analysis of variance after obtaining the best estimate of location within each pen with GLM and non-parametric procedures. There were no significant differences in ADG, DMI, G/F, BF or MS (grand mean = 1.47 kg, 11.9 kg, 0.12, 9.85 mm, 5.04, respectively) among diets. DOF block effects were found to differ (P<.01) for ADG, DMI, G/F, BF and MS as predicted by the ultrasound optimal DOF model. Rate coefficients (k) for

BF accretion (k = (ln final - ln initial)/DOF) were also determined within each pen for steers with low versus high initial BF thickness. Subsequent AOV of these two BF sub-groupings revealed that RPC, FB and RPC + FB treatments significantly increased k values for steers with high initial BF thickness, but not for steers with low initial BF thickness. These findings suggest the RPC, FB and their combination causes cattle with a greater BF accretion propensity to fatten at a faster rate.

Key Words: Choline, Betaine, Fattening

616   Assessing fermentation efficiency and variations in cattle types. D. Boadi*[1] and K. M. Wittenberg, *University of Manitoba Winnipeg, Manitoba*.

Six dairy (meanweight 310.9±15.3kg) and six beef (mean weight 310.8±10.0) yearling heifers were used to compare daily methane (CH_4) emissions relative to animal type (dairy vs beef), forage quality (High vs Medium vs Low NDF) and feeding regime (ad libutum vs restricted). On a DM basis, the forage NDF content were High=69%; Medium=58%; Low=42%. The trial was conducted as four 3x3 latin squares, where each period consisted of 14 days during which animals were individually fed their assigned forage at ad-lib, and 9 days during which feed intake was restricted to 2%BW. Methane emissions, based on the sulfur hexaflouride tracer gas technique, were collected for 5-24h periods at both level of intake. Mean daily CH_4loss (ld^{-1}) was higher (p $\leq$0.05) on ad-lib (258.3±23.7) than restricted (205.5±25.9) with day to day variations of 9.2% and 12% respectively. Methane production (ld^{-1}) was not different (p$\geq$0.05) between breeds on ad-lib and restricted intakes. Animals within breed differed (p$\leq$0.05) in daily methane output due to differences (p$\leq$0.05) in daily DMI and GEI, which was absent between breeds in either feeding regime. When fed ad-lib, forage quality influenced (p$\leq$0.05) CH_4 output with Low=Medium>High NDF. This difference, however , was absent on restricted intake (p$\leq$0.05) possibly due to the significant forage quality x feeding level interaction observed. Daily CH_4 (%GEI) was similar (p$\geq$0.05) on ad-lib (6.7) and restricted (7.3) intakes, and was not affected (p$\geq$0.05) by cattle type or forage quality for each feeding regime.

Key Words: Methane production, Efficiency, Cattle type

617   Nutritional flushing to increase ovulation and kidding rate in Spanish meat goats. S. Hart*, M. Cameron, L. Dawson, I. Prieto, T. Gipson, and T. Sahlu, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK*.

Prebreeding supplementation was used to study the effect of flushing on ovulation and conception rate and litter size. Multiparous Spanish does were divided into four groups of 24 animals based on previous litter size, BW, and body condition score (avg. 2.3). Treatments included long term energy (LE; 40 d .25 kg corn-based supplement), short term energy (SE; 20 d .25 kg corn-based supplement), short term protein (SP; 20d .25 kg supplement with 20% menhaden fishmeal), and an unsupplemented control (C). All does were offered millet hay (6.6% CP) *ad libitum* throughout the study. Does were weighed and body condition scored prior to breeding, and does from each treatment were randomized to one of three bucks for breeding. All does received .25 kg of corn-based supplement for the first 3 wk of breeding. Corpus lutea, pregnancy status, and litter size were determined by ultrasound. Flushing with protein (SP) increased body condition prebreeding more than C, with LE and SE being intermediate (.57, .30, .38, and .39; P <.10). However, flushing did not increase (P > .5) fetal number or ovulation rate (1.59, 1.74, 1.88, 1.78; 2.45, 2.17, 2.21, .2.29 for LE, SE, SP, C, respectively). Conception rates were greater than 92%. Neither body condition, body weight, nor change in body condition or bodyweight were associated with fetal number. Nutritional flushing did not improve ovulation rate, conception rate or litter size of Spanish does.

Key Words: Goats Flushing, Ovulation, Fertility

618   Effect of eu-, hypo- and hyperthyroidism and bst on mohair growth, ADG, and hormone status. R. Puchala, I. Prieto*, V. Banskalieva, A. L. Goetsch, M. Lachica, and T. Sahlu, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK*.

Forty eight Angora goats (24 wethers and 24 doelings; 5 mo old; 16 ± 0.5 kg initial BW) were used in an experiment with a 2 x 3 factorial treatment arrangement (n = 8) to evaluate two levels of recombinant bST (0 and 100 μg/d) and three thyroid hormone statuses (euthyroid, hypothyroid, and hyperthyroid) on ADG and mohair growth. The bST was a slow release zinc-based suspension designed to sustain delivery of bST over a 14-d period. Hyperthyroidism was maintained by treatment with thyroxine (T_4; 150 μg/kg BW/d) and hypothyroidism by treatment with propylthiouracil (6 mg/kg BW/d). The experiment that consisted of a 2-wk pre-treatment period and 8 wk of bST treatment was performed during the summer (July to September). Goats were given ad libitum access to a mixed diet (15.0% CP; 2.34 Mcal/kg ME; DM basis) and were housed in raised, individual indoor stalls under ambient lighting. There was an interaction between bST and thyroid hormone status (P < .01) in plasma T_4, triiodothyronine (T_3) and insulin-like growth factor I (IGF-I). Hypothyroid-bST and hypothyroid-control animals had highest (P < .01) concentrations of plasma T_4 (38.6 and 38.0 μg/dL, respectively) and T_3 (406 and 385 ng/dL, respectively). No differences were observed between euthyroid-control, euthyroid-bST, and hypothyroid-bST animals in plasma T_4 (11.1, 11.5 and 9.8 μg/dL, respectively) or T_3 (232, 251, and 226 ng/dL, respectively). The hypothyroid-control group had the lowest (P < .01) concentration of both T_4 (5.1 μg/dL) and T_3 (144 ng/dL). Increased plasma IGF-I (P <.01) was observed in euthyroid-bST (1080 ng/mL) and hypothyroid-bST (1,028 ng/mL) animals; however, hyperthyroid-bST animals had plasma IGF-I concentrations similar to those observed in euthyroid-control, hypothyroid-control, and hyperthyroid-control groups (78, 74, 74, and 78 ng/mL, respectively). The ADG for hyperthyroid goats (11.3 g/d) was lower (P < .01) than for hypothyroid and euthyroid goats (72.4 and 72.6 g/d, respectively). Mohair production was higher (P < .01) in hyperthyroid goats (0.13 g/100 cm^2/d) than in hypothyroid and euthyroid goats (0.10 and 0.10 g/100 cm^2/d, respectively). Strong interactions exist between growth and thyroid hormones in the body; however, manipulation of their status had a very limited effect on productivity of Angora goats.

Key Words: Growth hormone, Thyroid hormones, Angora goats

619   Energy expenditure of Angora does during the late trimester using the doubly-labelled water technique. C. A. Toerien*[1], T. Sahlu[1], and W. W. Wong[2], *[1]E (Kika) de la Garza Institute for Goat Research, Langston, OK, [2]USDA/ARS Children's Nutritional Research Center, Houston, TX*.

The double-labeled water (DLW) technique was used to compare CO_2 production and energy expenditure (EE) of non-pregnant (NP) (31 ± .9 kg BW; n = 4) and pregnant (PREG; single fetus) Angora does (32 ± 3.1 kg BW; n = 4) for 10 d (130 ± 1 to 140 ± 2 d) in the late trimester of pregnancy. Animals were housed individually in metabolism crates. Diets for PREG and NP were 2.62 and 2.48 Mcal/kg DM of ME and 80.4 and 76.9 g/kg DM of metabolizable protein, respectively; DMI was greater (P < .01) for PREG (932 ± 47 g/d) than for NP (564 ± 7 g/d). After determination of baseline plasma isotope levels, does were infused into the jugular vein with $^2H_2^{18}O$, providing 200 mg ^2H and 250 mg ^{18}O/kg BW for NP and 250 mg ^2H and 300 mg ^{18}O/kg BW for PREG. Isotopic estimates were performed at 6 h post-infusion and at 2- to 4-d intervals. The ^2H and ^{18}O dilution spaces were calculated using the multi-point model, and isotopic estimates of ^2H_2O and $H_2^{18}O$ fluxes were corrected for isotope losses in feces and methane (^2H) and products of gestation (^2H and ^{18}O). Fiber growth rate (g/d) was determined from a mid-side patch sample extrapolated to whole-body production, and energy expended on mohair production (EE_{moh}) was calculated as 10.95 kcal ME/(g d^{-1}). In NP, maintenance EE (EE_m) was assumed to be total DLW-derived EE (TEE) - EE_{moh}. Energy expended for pregnancy (EE_p) was similarly assumed to be TEE - EE_{moh} - EE_m. Ratios of isotope distribution spaces (N_D/N_O) for NP (1.043 ± .013) and PREG (1.029 ± .012) were acceptable, and kid birth weight (3 ± .1 kg) was similar to that of the main herd (2.9 ± .1 kg; n = 33). The EE_m for NP was 98.4 ± 3.8 kcal ME/(kg $BW^{.75}$ d^{-1}). Fiber production and diameter were lower (P < .05) for PREG (5.5 ± .8 g/d and 31.4 ± 1.3 μm, respectively) than for NP (11 ± 1.1 g/d and 37.1 ± 1.8 μm, respectively). The EE_p for PREG was 65.2 ± 13.6 kcal ME/(kg $BW^{.75}$ d^{-1}). In conclusion, pregnancy suppressed mohair production and elevated whole-body energy expenditure to approximately 1.67 times that for maintenance.

Key Words: Energy requirements, Pregnancy, Angora goat

620   Effects of abomasal casein or essential amino acid infusions on splanchnic metabolism in lactating dairy cows. C. K. Reynolds*[1], B. Lupoli[1], P. C. Aikman[1], D. J. Humphries[1], L. A. Crompton[1], J. D. Sutton[1], J. France[1], D. E. Beever[1], and J. C. MacRae[2], [1] The University of Reading, Reading, UK, [2] The Rowett Research Institute, Aberdeen, UK.

Milk production and splanchnic metabolism were measured in 6 multiparous, catheterized, rumen cannulated, early-lactation Holstein X Friesian cows (653 BW) during 4-d abomasal infusions (18 L/d) of water followed by either casein (CAA) or essential amino acids (EAA) equal to 800 g milk protein/d for 6 d in a balanced single-reversal experiment with a 5 wk interval. Hourly measurements (6) of splanchnic (portal-drained viscera [PDV] and liver [LIV]) blood flow and net nutrient flux (mmol/h) were obtained on the last day of water and treatment infusions. Dehydrated lucerne, grass silage and concentrates (33, 17 and 50 %, respectively, on a DM basis) were fed hourly at 97 % of ad libitum DMI. Infusions had no effect (P = .29) on DMI (23.3 kg/d), but milk yield (kg/d) was decreased (P < .07) by CAA (36.1 vs 35.4) and EAA (38.2 vs 37.2). Milk protein (g/kg) was increased (P < .01) by CAA (33.1 vs 34.2) and EAA (31.1 vs 32.0). Blood flow for PDV and LIV (2050 and 2509 L/h, respectively) and their oxygen removal (-4160 and -4224, respectively) were not affected (P > .38), but CAA and EAA increased (P < .05) LIV glucose release (818 vs 901 and 775 vs 855, respectively) and changed (P < .05) LIV lactate flux from removal to release (-24 vs 4 and -24 vs 40, respectively). The recovery of total EAA infused as increased PDV release was 68 % for CAA, but only 22 % for EAA. For nonessential amino acids (NEAA) in CAA the recovery as increased PDV release was 72 %, but increased LIV removal of NEAA and EAA exceeded the increase in their PDV release. The EAA infusion had little effect on NEAA flux for PDV and LIV, or LIV uptake of most EAA, but LIV uptake of Met and Phe were increased (P < .03) by both infusions. The net recovery of infused EAA as increased splanchnic release was low, but this may in part be due to increased splanchnic uptake of EAA from arterial blood.

Key Words: Splanchnic, Cows, Amino Acids

621   Milk protein response to abomasal and mesenteric vein infusions of essential amino acids in dairy cows fed low protein concentrates. P. C. Aikman[1], C. K. Reynolds*[1], D. J. Humphries[1], J. D. Sutton[1], J. France[1], D. E. Beever[1], and J. C. MacRae[2], [1] The University of Reading, Reading, UK, [2] The Rowett Research Institute, Aberdeen, UK.

Comparison of separate experiments suggests that the milk protein response to supplemental essential amino acids (EAA) is greater for i.v. compared to abomasal or duodenal infusion. Our objective was to directly compare the milk protein response to supplemental EAA provided via abomasal or mesenteric vein infusion in 5 multiparous, ruminally cannulated, multicatheterized Holstein X Friesian cows (676 kg BW and 17 wk postpartum). Cows were fed dehydrated lucerne, grass silage and low protein concentrates at 30, 20 and 50 %, respectively, of DM offered at 95 % of ad libitum DMI. Daily total-mixed rations (14 % CP) were fed as equal meals at 8 h intervals. The design used was a single reversal of site with two 10-d infusion periods separated by a 10-d rest period. Four-d control infusions (mesenteric vein saline [2.2 ml/min] and abomasal water [9 L/d using tubing inserted via the rumen]) were followed by 6-d infusions of a mixture of EAA equal to 400 g milk protein/d into one site. Control infusions were maintained for the site not used for EAA infusion. Milk yield and composition and DMI were measured for the last 3 d of control and EAA infusions. Intakes (19.9 kg/d), milk yield (28.7 kg/d) and milk fat concentration (39.5 g/kg) were not affected (P > .36) by EAA infusions. Milk protein concentration (g/kg) was increased (P < .005) by both abomasal (32.8 vs 34.0) and mesenteric vein (33.1 vs 34.6) EAA infusions, but the response was not affected by infusion site (P > .47). Milk lactose concentration (g/kg) was decreased (P < .03) by abomasal (47.6 vs 46.8 g/kg) and mesenteric vein (47.2 vs 47.0 g/kg) EAA infusion, but the response was greater (P < .03) for abomasal infusion. At the level infused in these cows, the recovery of EAA infused as increased milk protein output (11.9 %) was not enhanced by i.v. compared to abomasal delivery.

Key Words: Milk Protein, Amino Acids

622   Expression of multiple glutamate transport proteins in sheep and cattle epithelial tissue. J. A. Howell*, A. D. Matthews, K. C. Swanson, D. L. Harmon, and J. C. Matthews, University of Kentucky, Lexington.

The objective of this study was to characterize the potential expression of four transport proteins (GLAST1, GLT-1, EAAC1, EAAT4) capable of mammalian System X^-_{AG} amino acid transport activity (high affinity; Na^+-dependent; L-glutamate, D- and L-aspartate) in tissues important to intestinal absorption and gluconeogenic metabolism of glutamate in ruminants. The expression of mRNA for these proteins by sheep and cattle tissues, and their homology to rat cDNAs, was demonstrated by reverse trancription-polymerase chain reaction and(or) Northern analyses, as appropriate. Membrane-bound cellular proteins were isolated from the scraped epithelium of rumen, omasum, duodenum, jejunum, ileum, cecum, and colon, and from homogenates of liver, kidney, and pancreas, of growing wethers (n = 4, mean BW = 28.4 kg) and steers (n = 3, mean BW = 426 kg) fed forage-based diets. After separation by 7.5% SDS-PAGE, the expression of GLAST1, GLT-1, EAAC1, and EAAT4 proteins was evaluated by immunoblot analysis, using antibodies designed against rat proteins (Matthews et al., 1998, Am. J. Physiol. 274:C603-C614). For both sheep and steers, GLT-1 (>203, 188, and 142 kDa) and EAAC1 (93 and 62 kDa) were expressed by all tissues examined. In contrast, GLAST1 (140 kDa) was expressed only by the pancreas, whereas EAAT4 was not detected in any tissue of either species. These results indicate that the examined sheep and cattle epithelia display the same pattern of glutamate transporter expression, which differs among tissues and transporters. The size and tissue distribution profiles for sheep and cattle glutamate transporters are consistent with those reported for non-ruminants, when applicable. This study provides the physiologic knowledge necessary to study the role of glutamate transporter expression in ruminant N metabolism.

Key Words: Ovine, Bovine, Excitatory Amino Acid

623   A primary cell culture method for bovine pancreatic acinar cells to study α-amylase secretion. K. C. Swanson*, J. C. Matthews, C. J. Richards, and D. L. Harmon, University of Kentucky, Lexington.

Pancreata collected from steers (BW~200 kg) are perfused (40 mL/min) through the vascular system with Ham's F12 medium that contains 160 U/mL collagenase (Type 1, Sigma) and hyaluronidase (Type I-S, Sigma) for 2 × 25 min. The tissue is then mechanically dispersed and cells filtered through sterile gauze. Cells are recovered by centrifugation at 900 × g for 4 min at 25°C and rinsed 3 times with Ham's F12. Acinar cells are separated from other cells by centrifugation through 40% Percol gradients at 900 × g for 15 min. The acinar cells from each gradient are resuspended and pooled in culture medium consisting of Waymouth's 752/1 medium, 25 mM HEPES buffer, 1% bovine serum albumin, and antibiotics (100 U penicillin, 100 mg streptomycin and .25 mg amphotericin B/L). Typically more than 1.5×10^8 acinar cells are recovered per pancreas with greater than 90% viability. Cells are cultured at 37°C with 5% CO_2/95% air in 1 mL of culture medium per well using rat tail collagen-coated 24-well tissue trays. After 2 h, non-attached cells are removed by changing the culture medium. To determine appropriate cell seeding densities for α-amylase secretion, cells were seeded from .125 to .750 × 10^6 cells/well. After 24 h, the media was changed (.5 mL/well). One h later, the fresh media was assayed for α-amylase activity and cellular protein was determined. Secreted α-amylase activity (U/g protein*h) and cellular protein (mg/well) were linearly (P <.001) proportional to seeding density. Therefore, .5 × 10^6 cells were seeded per well in subsequent experiments. To determine the appropriate time for measuring α-amylase secretion, activity was measured in media collected 4, 8, 12, 16, 20, and 24 h after cell attachment. α-Amylase activity increased (quadratic effect, P <.001) by 87% up to 12 h. This procedure describes a method for the isolation and primary culture of viable pancreatic acinar cells that secrete differing levels of α-amylase and may prove useful for evaluating substrates mediating α-amylase secretion.

Key Words: Cell Culture, Bovine, Pancreas

624 Effects of plane of nutrition on blood metabolites and hormone concentration in goats. B. Kouakou*[1], O. S. GAzal[2], T. H. Terrill[1], G. Kannan[1], S. Gelaye[1], and E. A. Amoah[1], [1]*Agricultural Research Station, Fort Valley State University, Fort Valley, GA 31030,* [2]*Department of Biological Sciences, Saint Cloud State University, Saint Cloud, MN 56301.*

A study was conducted to determine the effects of plane of nutrition on blood metabolites and hormone concentrations in goats. Sixteen mature dairy bucks (51 ± 7 kg) were selected and fed a concentrate diet (2.9 Mcal, DE; 16% CP) for two weeks to maintain their body weight. They were then blocked by weight and randomly assigned to two groups. Group I bucks (n = 8) were fed at maintenance for two consecutive periods (treatment 1) while group II animals (n = 8) were fed at 50% of their maintenance intake during period 1 (treatment 2) and then at 25% of maintenance during period 2 (treatment 3). During the third period, animals in both groups were allowed ad libitum feed consumption (treatment 4 for group II, and 5 for group I). At the end of each dietary treatment period, blood samples were collected and serum was assayed for non-esterified fatty acid (NEFA), blood urea nitrogen (BUN), luteinizing hormone (LH), testosterone (T), and growth hormone (GH). Overall, bucks fed at 25% of maintenance intake had significantly greater (P < .02) serum NEFA than when fed at 50% maintenance, or during refeeding. During ad libitum consumption, goats previously at 25% maintenance had a significantly lower (P < .01) serum NEFA than those previously fed at maintenance (402 vs 632 ng/dL). Also submaintenance feeding increased (P < .002) BUN. Blood urea nitrogen level in ad libitum fed goats was dependent (P < .003) upon the previous level of feeding. Serum LH and GH were not affected by the plane of nutrition. Serum T was basal during both submaintenance and maintenance feedings. However, T concentration in ad libitum fed goats were higher (P < .05) for maintenance- than in submaintenance-fed goats. These results suggest that effects of plane of nutrition on metabolic and hormonal changes in the goat are manifested at different times. Furthermore, short-term refeeding did not reverse the effect of previous underfeeding on LH and GH secretion, but increased T secretion with magnitude dependent upon previous plane of nutrition.

Key Words: Submaintenance, Maintenance, Metabolites

625 Differences in blood metabolites and glucose metabolism in hair sheep and meat goat females during late pregnancy and lactation. S. Wildeus*[1] and J. M. Fernandez[2], [1]*Virginia State University, Petersburg, VA,* [2]*Louisiana State University Agricultural Center, Baton Rouge, LA.*

This experiment compared pre- and postprandial plasma metabolite concentrations, and i.v. glucose tolerance (IVGTT; 250 mg glucose/kg BW) in Katahdin hair sheep ewes (n=10) and Myotonic, Nubian, Pygmy and Spanish meat-type does (n=10/breed) during late-pregnancy and early lactation. Females were bred to like-breed sires in November and sampled in March (pregnant) and May (lactating). Data were analyzed in a repeated measures model that included species, breed, litter size, and physiological status as main effects. Ewes were heavier (50.1 vs 38.3 kg; P<.001) and had a higher body condition score (3.7 vs 2.7; P<.001) than does, but BW varied markedly (P<.001) between goat breeds (26.0 to 49.6 kg). Ewes had higher (P<.01) pre- and postprandial plasma urea-N concentrations does (11.1 and 12.2 mM vs 8.72 and 9.55 mM, respectively). Similarly, pre- and postprandial plasma glucose concentrations were higher (P<.01) in ewes (3.94 and 4.07 mM) than does (3.27 and 3.31 mM), however, there was a decrease in plasma glucose from pregnancy to lactation in ewes and increase in does (interaction: P<.001). Plasma NEFA concentrations were higher in preprandial does (.40 mM) than ewes (.28 mM), and increased from pregnancy to lactation in ewes (.21 to .30 mM), but remained unchanged in does (interaction: P<.05). Plasma albumin was lower (P<.001) in ewes than does postprandial (23.7 vs 29.6 g/L). Glucose and insulin clearance (2.02 and 3.75 %/min) and half-life (34.6 and 18.9 min) following glucose infusion were not affected by species or physiological status. Basal insulin concentrations were similar between species, but higher (P<.001) in pregnant (19.2 uU/ml) than lactating females (12.1 uU/ml). In the present experiment, hair sheep and meat goat females managed similarly differed in some key blood metabolite levels, but exhibited similar glucose kinetics in response to an IVGTT.

Key Words: Hair Sheep, Meat Goats, Metabolic Profile

626 Seasonal changes in body weight, condition and serum glucose and urea nitrogen in Brangus, Charolais and Simmental cows grazing semi-arid lands. E. M. Romero-Treviño[1], E. Gutierrez-Ornelas[1], A. M. Garcia-Garza[2], and H. Bernal-Barragan[1], [1]*Universidad Autonoma de Nuevo Leon, Mexico,* [2]*Union Ganadera Regional de Nuevo Leon, Mexico.*

A study was conducted in Northern Nuevo Leon, Mexico to determine changes in body weight (BW), body condition score (BCS), glucose (GLU) and blood urea nitrogen (BUN) in Brangus (BR, n = 5; BW = 548± 36 kg), Charolais (CH, n = 12; BW = 591± 77 kg) and Simmental cows (SI, n = 15; BW = 545 ± 68 kg). Blood samples and animal data were collected on April, July, October of 1998 and January of 1999 to represent spring (SP), summer (SU), autumn (AU) and winter (WI). Cows were exposed during 1998 to severe drought (rain = 386 mm) and their grazing diet was mainly buffelgrass (Cenchurs ciliaris) during SP and AU, burned pricklypear (Opuntia spp) on SU and dry buffelgrass on WI. Simmental cows grazed sorghum residue during December. Animals were daily supplemented (500 g/animal) on SU with a mixture of cottonseed meal-salt. A free choice mineral mix was provided all time. Blood samples were collected by coccygeal venipuncture, they were drawn from 09:00 to 15:00 hrs. and put on ice until centrifugation at 2000 x g for 10 min. Serum was separated the same day of collection and stored at -20°C until analysis. Breeds had the same (P>.05) BW and BCS throughout the year. Cows were heavier (P<.05) on SU but it was associated with pregnancy or early lactation. It was an interaction (P<.01) breed x season for GLU and BUN. Blood GLU was higher during SP and it was reduced to the lowest point during SU. Simmental cows maintained their GLU level on AU and WI (41 and 44 mg/dl) but GLU was reduced in BR (50 to 32 mg/dl) and CH (47 to 38 mg/dl). All cows had the lowest level of BUN on SU (6.2 mg/dl). The highest levels of BUN were measured on AU with 18.2, 14.8 and 19.1 mg/dl for BR, CH and SI cows; respectively. Brangus and CH cows reduced their BUN to 9.9 and 6.4 mg/dl; respectively, but SI cows maintained a high level (17.2 mg/dl) on WI. Blood GLU and BUN were very low during SU and they can negatively affect cow productivity.

Key Words: Glucose, Blood Urea Nitrogen, Beef Cows

627 The effect of supplementing dextrose in the drinking water of transition cows on dry matter and water intake and blood metabolites. V. R. Osborne*, B. W. McBride, and R. R. Hacker, .

An experiment was conducted to test the effect of supplementing the drinking water of transition dairy cattle with dextrose had on dry matter intake (DMI), water intake and blood metabolites. Thirty multiparous Holstein dairy cows were randomly assigned to one of three treatments for a trial period from -10 d preparum to 21 d postpartum. The treatments were control and two supplementation levels of dextrose (1 and 2 % dextrose per litre of drinking water). Cows were fed a total mixed ration twice daily through the pre- and post-partum period. DMI and water intake was recorded daily and coccygeal blood samples were collected every other day throughout the trial period. Data was analyzed using repeated measures anlaysis of variance. DMI was depressed for all cows and although not significant cows treated with 2 % dextrose solution had lower depression than the 1% group or control (29, 31.6, and 39.5 % DMI reduction for 2%, 1% and control respectively). Water intake was not affected by treatments (34.7±2.02, 33.6±2.2, 40.2±2.02 and 63.2±2.4, 65.7±2.4, 65.0±2.4 litres per day for control, 1% and 2% treatments pre and post calving). Serum glucose levels in cows supplemented with a 2% dextrose solution were consistently higher throughout the prepartum period and reached a significant difference at one day before calving (3.95±.12, 3.49±.12 and 3.48±.12 mmol/L for 2%, 1% and control respectively). Serum NEFA levels were significantly higher in the control cows at calving than the two treatment groups (1.25±.14, .64±.14 and .62±.14 mEq/L for control, 1 % and 2% respectively). The results of this trial indicate that water can be used as a vehicle for supplmentation of energy particularly when transition cattle experience the characteristic DMI reductions prepartum.

Key Words: Transition Cow, Water Supplementation, Blood Metabolites

628 The impact of diet composition on gastrointestinal tract ornithine decarboxylase activity and tissue polyamine concentrations. K. A. Johnson* and J. J. Michal, *Washington State University, Pullman, WA.*

To examine the impact of diet on gastrointestinal tract ornithine decarboxylase (ODC) activity and tissue polyamine concentrations, 3 diets were fed to twelve, 3-yr-old open beef cows (n=4/diet). The diets were (DM basis), 100% alfalfa hay (A), 40:60 alfalfa hay and barley (AB), and 75:25 barley and alfalfa haylage (BH). Cows were fed their assigned diets for 60d and were then sacrificed. Ruminal, duodenal, jejunal and ileal tissue and fluid were collected within 20 min of exsanguination and homogenized for immediate determination of ODC activity, and concentrations of protein, DNA and RNA. An aliquot of each tissue sample and ruminal or luminal fluid was frozen immediately and later extracted for analysis of polyamines. The haylage provided substantial levels of polyamines: ornithine, 69 umol/g; putrescine, 50 umol/g; spermine, 44 umol/g; spermidine, 56 umol/g; and cadaverine, 18 umol/g. The hay contained only spermine (1.7 umol/g) and spermidine (2.1 umol/g) while the barley contained only spermine (2 umol/g). Ruminal ODC activity was greater (P<.005) in cows fed the BH diet compared to the A and AB-fed cows, 80.70, 22.71 and 31.58 ± 6.43 pmol CO_2.mg protein^{-1}.hr^{-1}, respectively. Jejunal (P<.20) and ileal (P<.03) ODC activity tended to be greater in tissues from cows fed the A diet, 30.53 ± 8.05 and 23.64 ± 4.43 pmol CO_2.mg protein^{-1}.hr^{-1}, respectively when compared to diets AB and BH. Concentrations of tissue RNA and DNA were unaffected by dietary treatment (P>.1). Duodenal tissue protein content was lowest in animals fed the A diet (P<.05) and ruminal tissue protein content was lowest in animals fed the BH diet (P<.02) compared to tissues of animals fed the other diets. Protein levels of jejunal and ileal tissue were not affected by dietary treatment (P>.1). Additionally, there was no difference (P>.1) in duodenal tissue polyamine concentrations associated with diet. These data provide evidence that ruminal tissue may be impacted to a greater extent by the level of dietary polyamines than other intestinal tract tissue.

Key Words: Cattle, Polyamines

629 Differential ^{15}N-labeling of nitrogen fractions excreted by ruminants. S. Fernandez-Rivera*[1], J. M. Powell[2], A. Bationo[3], C. B. Christianson[3], and D. T. Hellums[3], [1]*International Livestock Research Institute, Niamey, Niger,* [2]*USDA-ARS Dairy Forage Research Center, Madison WI,* [3]*International Fertilizer Development Center, Muscle Shoals AL.*

The objective was to develop procedures to label with ^{15}N three nitrogen (N) fractions excreted by ruminants. Insoluble fecal N was labeled using maize residues grown with ^{15}N- fertilizer. Preparations were made in four replicates with two plant parts (leaf, stem) treated with two levels of incubation in the rumen (without, with) each followed by three types of treatment (control, neutral detergent solution-NDS- and NDS followed by acid detergent solution-ADS). Both ADS and incubation in the rumen reduced (P<.01) ^{15}N % atom in leaf and stem. After incubation in the rumen NDS or ADS had little or no effect on ^{15}N. Fecal soluble and urinary N were labeled by dosing four Peuhl Oudah rams (37.7 kg BW) with 15 g of 5 % ^{15}N-urea. Feces and urine were collected every 4 hours for 7 days and analyzed for ^{15}N. Excess ^{15}N (Y, %) data were fitted to the model $Y = C \times (e^{-k1(t-T)} - e^{-k2(t-T)}) \times (k1/(k2-k1))$, where C (%) is a constant, k1 (h^{-1}) and k2 (h^{-1}) are turnover rates, t (h) is time after dosing and T (h) is time delay. Model parameters were: C=.53 (SD=.03), k1=.1324 (SD=.0371), k2=.0234 (SD=.0022) and T=14.9 (SD=.5) for fecal ^{15}N and C=1.76 (SD=.39), k1=1.6637 (SD=1.3432), k2=.0530 (SD=.0092) and T=3.2 (SD=1.0) for urinary ^{15}N. Total mean residence time of ^{15}N was 65.8 and 23.7 h (SE=2.0, P<.01) when excreted in feces and urine, respectively. The distribution of ^{15}N in the soluble and insoluble fractions of plant tissues is not homogenous. To investigate the path of N excreted by ruminants in the agro-ecosystem the urinary and fecal soluble N can be labeled by dosing animals with ^{15}N-urea or other soluble source of ^{15}N. The insoluble fecal N, which decomposes slowly in the soil, can be prepared by incubating ^{15}N-labeled forage in the rumen and treating the residue with NDS.

Key Words: Fecal nitrogen, Urinary nitrogen, ^{15}N

630 Ruminal versus abomasal carbohydrate infusion alters glucose metabolism in steers. C. J. Richards*[1], K. C. Swanson[1], J. A. Howell[1], J. C. Matthews[1], D. L. Harmon[1], A. D. True[1], G. B. Huntington[2], S. A. Gahr[3], and R. W. Russell[3], [1]*University of Kentucky, Lexington,* [2]*North Carolina State University, Raleigh,* [3]*West Virginia University, Morgantown.*

Six beef steers (236 ± 15 kg) were used in a crossover design to quantify interorgan and whole body glucose metabolism in response to site of starch infusion. Steers with permanent ruminal and abomasal cannulas were infused ruminally or abomasally with 800 g/d of partially hydrolyzed starch (SH; 160g/L) for 14 d. The first 6 d were used for adaptation by infusing 25, 50, and 75% of the final SH quantity. Equal quantities of tap water were infused opposite the SH. A pelleted diet containing orchard grass (89%), corn gluten meal (5%), and Soypass® (5%) was fed at 1.5x the maintenance energy requirement in 12 equal portions daily. On the last day of SH infusion, primed continuous 10 h jugular infusion of [U-^{14}C] glucose and 7 h primed continuous mesenteric infusion of p-aminohippuric acid (PAH) were performed. Hourly sets of arterial, portal venous and hepatic venous blood samples were taken the final 6 h. Samples were analyzed for hemoglobin, oxygen, glucose, lactate, and PAH to determine nutrient flux in the portal drained (PDV), hepatic, and total splanchnic tissues. Specific activity of glucose was determined to evaluate glucose production and utilization within tissues, whole body irreversible loss, and total glucose turnover. Shifting carbohydrate supply to the small intestine increased portal (P=.02) and hepatic (P=.06) blood flow, PDV (P=.04) and total splanchnic (P=.08) glucose flux, total glucose turnover (P=.02), whole body irreversible loss (P=.01), portal glucose production (P=.02), and peripheral glucose utilization (P=.09). No changes were observed in PDV glucose utilization (P=.58) whereas net hepatic lactate flux was reduced (P=.10) with SH infusion into the abomasum. These results indicate shifting starch digestion to the intestine increases glucose uptake across the PDV and peripheral glucose utilization without increasing PDV glucose utilization.

Key Words: Bovine, Metabolism, Glucose

631 Effect of dietary chromium-L-methionine on glucose metabolism of beef calves. E. B. Kegley*[1], D. L. Galloway[1], and M. T. Socha[2], [1]*University of Arkansas, Fayetteville,* [2]*Zinpro Corp., Eden Prairie, MN.*

Thirty-six crossbred steers (288 ± 3.7 kg initial BW) were used to determine the effect of chromium as chromium-L-methionine (CrMet) on glucose tolerance and insulin sensitivity in beef calves. Calves were fed a control diet or the diet supplemented with 400 or 800 μg chromium/kg of diet as CrMet. Calves were kept in drylots (6 calves/pen; 2 pens/dietary treatment). Calves were caught twice a day in locking headgates and individually fed their respective diet for a period of 22, 23, or 24 d prior to the metabolic challenges. Calves received a totally mixed ration containing 55% corn, 38% cottonseed hulls, and 5.2% soybean meal. On d 21, 22, and 23, 4 calves/dietary treatment were fitted with an indwelling jugular catheter. Approximately 24 h after catheterization, an intravenous glucose tolerance test (500-mg glucose/kg of BW) followed 5 h later by an intravenous insulin challenge test (.1 IU insulin/kg of BW) was conducted. There was no effect (P > .10) of dietary treatment on ADG or ADFI. After the intravenous glucose tolerance test, serum insulin concentrations were increased by supplemental CrMet (linear effect of Cr; P < .05). There was a time by treatment interaction (P < .05) on plasma glucose concentrations after the glucose infusion. Plasma glucose concentrations of calves fed 800 μg chromium were greater than controls immediately after the glucose infusion, but by 30 min after the infusion calves supplemented with 800 μg chromium had plasma glucose concentrations that were lower than controls. Supplemental CrMet increased the glucose clearance rate from 0 to 10 min after the insulin challenge test (linear effect of Cr; P < .05). Glucose half-life from 0 to 15 min after the insulin infusion was decreased by supplemental CrMet (linear effect of Cr; P < .03). These data indicate that supplemental chromium as chromium-L-methionine increased glucose clearance rate after an insulin infusion, and increased the insulin response to an intravenous glucose challenge in growing calves with functioning rumens.

Key Words: Chromium, Cattle, Glucose Tolerance

632   The effects of level of inorganic and organic mineral sources on in vitro dry matter disappearance of starch. G. B. Salyer* and M. L. Galyean, *Texas Tech University, Lubbock TX.*

The sulfate form (SUL), a polysaccharide complex (POLY), two proteinates (P1, P2), and an amino acid complex (AAC) of both Cu and Zn were used in an in vitro system with a starch substrate. Each source of Cu or Zn was included at levels of .5, 1, 2, and 3 times the NRC (1996) recommendation (.5X, 1X, 2X, and 3X, respectively), and the percent change in IVDMD (PDMD) above no added mineral was measured at 4, 8, 12, 24, and 48 h of incubation. At 4 h and 1X, 2X, and 3X levels of Cu, PDMD was greater ($P < .02$) with P1 and P2 than with AAC. Similarly at 8 h and 1X, PDMD was greater ($P < .02$) for P1 and P2 than for AAC, and PDMD for POLY was less ($P < .03$) than for other organic sources at 3X Cu. The 48-h PDMD for SUL was less ($P < .04$) than for other organic sources at 3X Cu, but not different at other levels or times. For POLY, 4-h PDMD decreased (linear, $P < .01$) with increasing Cu level, whereas P2 responded quadratically ($P < .01$) to Cu level. At 24 h, PDMD for AAC increased linearly ($P < .04$) with increasing Cu. With the .5X level of Zn, 4-h PDMD for POLY was greater ($P < .02$) than for the average of P1, P2, and AAC, and PDMD of P1 and P2 was greater ($P < .01$) than AAC. For 1X Zn, PDMD was less ($P < .02$) for SUL than for the average of organic sources at 4 h, but greater ($P < .03$) for SUL than organic sources at 8 h. Mean PDMD of P1 and P2 was greater ($P < .01$) at 8 h than PDMD of AAC for 1X Zn. For .5X and 3X Zn, 24-h PDMD for SUL was less ($P < .05$) than for organic sources, and P1 and P2 had a lower ($P < .04$) 24-h PDMD than AAC at 2X Zn. Similarly, SUL had a lower ($P < .05$) 48-h PDMD than organic sources for 1X and 2X Zn. The 4-h PDMD of SUL responded quadratically ($P < .04$), whereas PDMD with AAC increased linearly ($P < .04$) with Zn level. At 8 h, P2 responded quadratically ($P < .05$) and AAC responded linearly ($P < .03$) to Zn level. The PDMD with P1 responded quadratically ($P < .02$) to Zn level at 12 h and linearly ($P < .02$) at 48 h. Results suggest that all sources of Cu and Zn were used by ruminal microbes, but effects on IVDMD varied among sources and levels.

Key Words: In Vitro, Zn, Cu

633   Effects of pasture applied biosolids on performance and mineral status of grazing beef heifers. M. E. Tiffany*, L. R. McDowell, G. A. O Connor, F. G. Martin, N. S. Wilkinson, E. C. Cardoso, S. S. Percival, P. A. Rabianski, and H. Nguyen, *University of Florida, Gainesville, FL.*

Fifty Angus x Hereford crossbred heifers were randomly assigned to bahiagrass pastures treated with biosolids varying in mineral content, and evaluated for mineral status, with special attention to Cu. Biosolids were applied to .81 ha pastures for the following treatments: 1) Baltimore biosolids (B1X) applied at 22.4 t/ha, 2) Baltimore biosolids (B2X) applied at 44.8 t/ha, 3) Tampa biosolids (T1X) applied at 16.8 t/ha, 4) Tampa biosolids (T2X) applied at 33.6 t/ha, or 5) control NH_4NO_3 applied at two times. Copper loads varied from 8.8 to 42.2 kg/ha, and Mo loads varied from .27 to1.11 kg/ha. Heifers (two per pasture) grazed their assigned pastures exclusively for 153 d. Liver biopsies were taken at d 1, 99, and 176, and blood samples on d 1, 50, 99, 135, and 176. Liver and plasma were analyzed for selected mineral contents, and blood was analyzed for hemoglobin (Hb) and hematocrit (HCT). Experimental animals were generally low in mineral status upon arrival and deficient in Se and P. By d 50 plasma Ca, Mg, Se, P, and Zn were adequate for all treatments. Plasma Cu declined ($P<.03$) for all treatments from d 50 to 176. Plasma Cu reflected depleted liver Cu storage, with treatments B2X, T1X, and T2X treatment means lower in plasma Cu than the control at 176 d. Liver Fe concentrations were adequate for all treatments, and Mo concentrations (<2.18 mg/kg) did not approach levels indicative of toxicity. Liver Cu declined ($P<.05$) with time for all treatments. By d 99, animals receiving treatments B1X, B2X, and T1X had lower ($P<.05$) liver Cu than the control, and all treatments were lower at 176 d. The decline of animal Cu status (liver and plasma) reflects the low Cu status of bahiagrass and the possibility of high forage S (.30-.47%) interference with Cu metabolism. Forage Mo was low, but slightly higher in biosolids treated pastures. Biosolids application to bahiagrass pastures were not detrimental to mineral status except Cu, which generally declined in plasma and for all biosolids treatments declined in liver.

Key Words: biosolids, mineral status, pasture

634   Effect of vitamin E and Chromium-Methionine supplementation on growth performance response of calves recently arrived to feedlot. R. Barajas* and L. Almeida, *Universidad Autonoma de Sinaloa (Mexico).*

To determinate the effect of Vitamin E and Chromium-Methionine supplementation on growth performance response of calves recently arrived to feedlot, sixty Drought Master bull calves (BW=134 kg) just arrived to feedlot after 330 km truck transported, were used in a 28 days randomized design experiment with a 2x2 factorial arrangement of treatments. Fifteen calves (three groups of five calves) were assigned to consume one of four diets in that consist the treatments: 1)Reception corn-based diet (14% CP) with 35:65 roughage:concentrate relationship(Control); 2)Control diet supplemented with 150 IU of Vitamin E/kg(Vit.E); 3)Control diet supplemented with 1.0 ppm of Chromium from Chromium-Methionine(Cr); and 4)Control diet supplemented with Vit.E and Cr (Vit.E+Cr). Vitamin E supplementation had not effect ($P>0.25$) on final weight, average daily gain of weight(ADG), dry matter intake and feed/gain ratio. Chromium-Methionine supplementation had not effect on final weight and dry matter intake, but Chromium-Methionine supplemetation increased ($P<0.01$) 21% the ADG (0.977 vs 1.189 kg), and improved ($P=0.04$) in 15% the feed/gain ratio (5.402 vs 4.569). An interaction ($P=0.03$) Vit.E x Cr was observed in feed/gain ratio, with values of 5.677, 5.128, 4.565, and 4.573 for Control, Vit.E, Cr, and Vit.E + Cr treatments respectively. It is concluded that Chromium supplementation from Chromium Methionine improve the growth performance response of calves recently-arrived to feedlot.

Key Words: Chromium, Methionine, Calves

635   Levels of calcium for growing kids. Calcium excretion and phosphorus true absorption. M. S. Bueno*[1], E. A. Cunha[1], L. E. Santos[1], and D. M. S. S. Vitti[2], [1]*Instituto de Zootecnia, Nova Odessa, SP, Brazil,* [2]*Centro de Energia Nuclear na Agricultura - USP, Piracicaba, SP, Brazil.*

This study aimed to evaluate the influence of Ca intake on Ca metabolism and P true absorption. Growing kids raised for twelve weeks (from six to nine months old) in individual pens on high concentrate diet were changed to digestibility cages and Ca and P metabolism studied. Sixteen nine month old Saanen male goats, averaging 48.2 kg of live weight (LW), were fed diets with forage concentrate ratio of 40:60 (16%CP, 0.52%P) with increasing levels of Ca (66.2, 163.5, 341.2, 532.7 mg/kg LW/d). Radioactive phosphorus (^{32}P) were injected into each animal through the jugular vein to determine P true absorption. Blood samples were collected, and feces and urine were measured and sampled during seven days. The increase in Ca intake (X) (mg/kg LW/d) led to a linear increase in fecal Ca excretion (g/d), described by the equation $Y = 2.02 + 0.0188X$ (R^2=0.64, $P<0.01$); a linear increase in Ca percentage in feces, described by the equation $Y = 0.314 + 0.00533X$ ($R^2= 0.92$, $P<0.01$); a linear increase in Ca balance (mg Ca/kg LW/d), described by the equation $Y = -141 + 1.38X$ (R^2=0.82, $P<0.01$) and a quadratic increase in urinary Ca excretion (mg Ca/kg LW/d), described by the equation $Y = 1.23 + 0.0124X - 0.000021X^2$ (R^2=0.39, $P<0.05$). Ca intake did not affect plasmatic Ca (12.3 ± 1.7 mg/dl), plasmatic P (9.68 ± 0.95 mg/dl) and P true absorption (132.2 ± 15.3 mg/kd LW/d). The intake of Ca affects Ca fecal excretion and does not influence on P absorption.

Key Words: Calcium, Phosphorus, Goats

636   Effects of Copper Supplementation on the performance of two-year-old cows and their calves. E. L. Muehlenbein*[1], G. H. Deutscher[2], D. R. Brink[1], M. P. Carlson[1], and A. B. Johnson[3], [1]*University of Nebraska, Lincoln,* [2]*West Central Research and Extension Center, North Platte, NE,* [3]*Zinpro Corporation, Eden Prairie, MN.*

A two-year study was conducted to evaluate if supplemental Cu in an organic or inorganic form affected performance of two-year-old cows and their calves. Two hundred MARC II cows were randomly allotted to three treatments: (1) a copper depletion supplement (600 mg Fe, 5mg Mo), (2) an inorganic supplement (600mg Fe, 5mg Mo, and 200mg $CuSo_4$), and (3) an organic supplement (600mg Fe, 5mg Mo, 100mg Availa-Cu, Zinpro$^{'}$). Cows were individually fed the supplements for at least 45 days prior to and 30 days after calving. Blood samples were

taken from both cows and calves at calving and colostrum samples were collected for IgG and mineral analyses. Liver biopsies were taken to determine the trace mineral status of cows prior to the initiation of the trial and on both cows and calves at 10 and 30 days ±3 after calving. Cow liver Cu levels were 49 ppm (DW basis) before supplementation. By 30 d after calving, cow liver Cu levels in Trt. 1 had declined to 14 ppm (Cu deficient). Trt. 2 levels had increased to 95 ppm, (P<.05) and Trt. 3 levels were similar to base levels at 54 ppm. At 30 d of age, calf liver Cu levels were all normal with 99 ppm for Trt. 1 compared to 149 ppm for the other two treatments (P<.05). No differences were found in colostrum Cu or IgG levels, or in the incidence of calf sickness among treatments. No differences were found in cow or calf serum Cu concentrations, cow weights and condition scores or in reproductive performance of the cows. A numerically greater percentage of cows in Trt. 3 conceived early in the breeding season; however, a numerically greater percentage of cows in Trt. 1 conceived during a 60-d breeding season. The organic and inorganic sources appeared to be equally available to the cows. Cu supplementation did not impact passive transfer of immunity to the calf or calf growth rate. Results indicated that feeding supplemental Cu did not improve cow reproduction or the health and performance of the their calves.

Key Words: Copper, Cow, Reproduction

637   Effect of level of chromium-Methionine in receiving diets on growth performance of brahman bull calves. R. Barajas, A. Felix*, and A. Estrada, *Universidad Autonoma de Sinaloa (Mexico).*

This study was conducted to determine the effect of level of chromium-methionine (Cr-Met) in receiving diets on growth performance of bull calves. Sixty four brahman bull calves (BW=219 kg) were used in a 28-day feedlot experiment. Groups of 16 calves were randomly assigned to consume one of four receiving diets consisting of: 1) Corn based diet with 14%CP, and 35:65 roughage:concentrate ratio, without supplemental chromium (control); 2) Control diet supplemented with 0.4 PPM of chromium from chromium methionine (Cr=0.4); 3) Control diet supplemented with 0.7 PPM of chromium from Cr-Met (Cr=0.7); and 4) Control diet supplemented with 1.0 PPM of Cr from Cr-Met (Cr=1.0). Supplementation with 0.4 PPM of chromium increased (P<0.05) final weight (255 vs 264 kg) and average daily gain (1.425 vs 1.765 kg/day) relative to control. Compared to control the Cr=0.7 treatment, tended (P<0.10) to increase final weight (255 vs 260 kg) and average daily gain (1.425 vs 1.607 kg/day). Compared to control the CR=1.0 treatment had no effect (P>0.10) on final weight (255 vs 258 kg) nor average daily gain (1.425 vs 1.418 kg/day). Dry matter intake and feed/gain were not affected (P>0.10) by supplemental chromium level. It is concluded that supplementation with 0.4-0.7 PPM of chromium from chromium-methionine improved the growth performance response of bull calves during their first 28 days in the feedlot, but an excess of supplemental chromium (1.0 ppm) did not show a response.

Key Words: Chromium, Calves, Feedlot

638   Impact of dietary salt concentration on feed and water intake and physiological measurements of feedlot cattle. A. F. La Manna, F. N. Owens, and S. Janloo, *Oklahoma State University, Stillwater, OK.*

Nine ruminally cannulated heifers (510 kg) in a triplicated 3 by 3 Latin square were given ad libitum access to 85% concentrate feedlot diets based on cracked corn with one of three levels of supplemental salt (0, .25, .50% of DM). Effects of salt level on intake and blood and ruminal measurements were monitored. Latin square periods included two weeks for diet adaptation and one week for sampling and measurement. Although water intake was not significantly ($P = .27$) increased by added salt, water intakes averaged 14 and 30% more with the .25 and .5% salt levels than without added salt. Daily dry matter intakes also tended to increase with added salt (8.9, 10.2 and 10.4 kg with 0, .25, .50% salt, respectively). The water to dry matter intake ratio was not ($P = .55$) significant (4.45, 4.15 and 4.53 with 0, .25, .50% salt, respectively). Arterial blood pH tended to respond quadratically ($P =.09$) and partial pressure of oxygen increased ($P = .08$), while partial pressure of carbon dioxide decreased ($P = .07$) linearly with added salt. Added salt linearly decreased arterial blood potassium ($P = .06$). None of the serum macrominerals were altered by added salt. Although total VFA concentrations were not altered, the butyrate percentage was lower ($P < .05$)

with the 0% salt diet than the diets with .25 or .50% added salt (8.5 vs. 10.8 and 11.2%). Added salt linearly increased percentages of butyrate ($P = .03$) and isobutyrate ($P = .05$) leading to an increased ($P < .05$) energy charge of ruminal VFA. Effects of dietary salt concentration on ruminal pH, evacuated weights of ruminal liquid and solids, and urinary pH were not significant.

Key Words: Salt, Intake, Feedlot Cattle

639   Phosphorus and calcium status in goats grazing the semiarid region of Zacatecas, Mexico. I. Mejia-Haro*[1], R. Espinoza[2], A. Mejia[3], and J. Mejia[3], [1]*University of Nebraska,* [2]*CIGA-ITA 20,* [3]*UAZ.*

To determine the P and Ca status in goats grazing the semiarid region of Villa de Cos, Zacatecas, Mexico, soil, forage and animal samples were collected. Samples of 20 forage species were hand-collected monthly for 1 year, and blood serum samples from 70 adult female goats were obtained by puncture of the jugular vein. Twelve bone samples were collected from dead animals, and 22 soil samples were taken at the beginning of the study. A completely randomized design was used with sampling times as treatments and each sample as an experimental unit. Data were processed by analyses of variance, and differences among treatments were assessed with the multiple range test of Tuckey. Student's t distribution was used to compare Ca and P contents of the samples against normal and adequate values as reported in the literature. Perennial forages presented deficient P contents (mean values ranged from .05 to .09%) and high Ca levels (mean values ranged from .97 to 1.81%) through the year, and no differences (P >.05) among sampling times were found. However, P content of annual forages was higher (× = .14%, P<.05) during the months of the rainy season than during the dry season (× = .09%). Phosphorus content in blood serum collected in the rainy season was normal (× = 57 ppm) and higher (P <.01) than those collected in the dry season (× = 42 ppm), which were considered deficient in P. Mean values of mineral content in soil samples were 1ppm for P and .97% Ca, the former was considered deficient and the latter high. Low P content (× = 15.6%) and high Ca (× = 40.4%) were found in ash of the bone samples. Low amounts of P and high amounts of Ca in soil were reflected in low P and high Ca content in forages collected in the dry season, as well as the blood and bone samples of goats. P content in forages and blood samples collected in the rainy season was higher than those of the dry season. Calcium content of forages was not different (P>.05) among sampling times.

Key Words: Mineral, Content, Grazing

640   The feeding value of *Phyllanthus discoideus* and its effects on fermentation parameters when fed to West African Dwarf sheep. I. I. Osakwe*, H. Steingass, and W. Drochner, *Institute of Animal Nutrition, University of Hohenheim, Stuttgart, Germany.*

There is dearth of information on sheep performance on diets containing *Phyllanthus discoideus*. Farmers feed this multi-purpose tree (MPT) to their livestock without any knowledge of their potential benefits or anti-nutritional factors (ANF). The objective of this study was to investigate the effects of *Phyllanthus discoideus* supplementation to a basal hay diet on fermentation parameters, digestibility and nitrogen balance. Eight West African Dwarf sheep, all castrates with mean liveweight (28.8±4.2 kg) were used in repeated measurement analysis in a completely randomised design. Four of the sheep were ruminally fistulated and used for ruminal ammonia and volatile fatty acid (VFA) determination. Dried leaves of *Phyllanthus discoideus* were offered at two levels (25% and 50% of DM requirement) as supplements to a basal hay diet. Rumen liquor was sampled one hour before and one, three and five hours after morning feeding. Sheep fed the control diet had a higher (P<0.05) ammonia concentration in the rumen than those fed the diet supplemented with 25% (D25%) and 50% (D50%) *Phyllanthus discoideus* respectively, although N content of *Phyllanthus d.* (2.5% in DM) was higher than that of hay (1.8% in DM). The ruminal pH decreased significantly (P<0.05) with increase in the level of supplementation, parallely the VFA concentrations of sheep fed D25% and D50% diets were higher (P<0.05) to those fed the control diet both indicating a higher rate of fermentation. On the other hand, total tract OM digestibility slightly decreased with higher levels of *Phyllanthus d.* The nitrogen balance showed a trend of increased retention with increasing level of supplementation.

It was concluded that *Phyllanthus discoideus* has a great potential as a fodder tree for supplementation because of the contribution of its nitrogen to the nutrient economy. This could be probably due to its low content of condensed tannins (12.8g/kg) and high crude protein (156g/kg) content.

Key Words: *Phyllanthus discoideus*, Sheep, Fermentation parameters

641 Effect of ruminally protected choline on productivity of Angora goats. T. Shenkoru*[1], F. N. Owens[2], R. Puchala[1], and T. Sahlu[1], [1]*1E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK,* [2]*Animal Science Department, Oklahoma State University, Stillwater, OK.*

Twenty-five Angora wethers (29 ± 6 kg initial BW and > 1 yr of age) were used to evaluate effects of ruminally protected choline (PC) on BW gain, blood metabolites, and mohair production. Animals were randomly allocated to five treatments and had *ad libitum* access to 55% concentrate diet (oat-based, 13% CP) for 90 d. Treatments were 1, 2, and 3 g/d of PC, 3 g/d of unprotected choline (UP), and no added choline (control). In situ ruminal disappearance of PC was 7%, whereas disappearance of UP at 2 h was complete. Total tract digestibility of PC was 56%. Dry matter intake and feed efficiency were similar among treatments ($P > .10$). Body weight gain for 3 g PC was greater ($P < .05$) than for the control and UP. No difference in grease fleece weight was observed among treatments. Mohair diameter differed ($P < .05$) between UP and PC and between UP and 3 g PC. Ruminal VFA concentration was higher for 3 vs 1 ($P < .01$) and 2 g PC ($P < .07$). The molar percentage of butyric acid was lowest for 3 g PC ($P < .05$). Plasma protein concentration was higher ($P < .05$) for 2 g PC than for C, UP, and 1 g PC. Plasma cholesterol concentration for the control was lower ($P < .05$) than for 2 and 3 g PC. The level of NEFA in plasma was decreased by PC supplementation ($P < .05$). In conclusion, supplementation of growing Angora wethers with 3 g/d of protected choline increased ADG without change in DMI, but had no effect on mohair growth or quality. Effects of PC on plasma NEFA and cholesterol levels suggest altered lipid metabolism.

Key Words: Angora goat, Rumen protected choline, Body weight gain

642 Effects of methylpalmoxirate in mature sheep. W. Pittroff*[1], M. Friedman[2], S. Das[3], and H. D. Blackburn[1], [1]*U.S. Sheep Experiment Station, Dubois,* [2]*Monell Chemical Senses Center, Philadelphia,* [3]*Idaho State University, Dept. of Pharmaceutical Sciences, Pocatello.*

Interference with long-chain fatty acid oxidation by methyl 2-tetradecylglycidate, methylpalmoxirate (MP, Johnson Pharmaceutical) has been shown to reduce plasma levels of circulating ketone bodies and increase food intake during the activity period of MP in monogastric animals. MP binds irreversibly to CPT I and thus inhibits mitochondrial uptake and oxidation of long-chain fatty acids. In sheep liver, but not in monogastrics, methyl-malonyl-CoA, is a quantitatively significant inhibitor of CPT-1. Therefore, examination of the effects of MP on ketogenesis and correlated feeding responses may produce results different from monogastrics. This experiment examined the effects of MP on plasma ketone bodies, plasma glucose and cumulative feed intake for 4 h and 28 h post-administration in mature sheep. 14 mature ewes were randomly allocated to MP treatment at 50 mg/kg fasted body weight i.m., and to control (vehicle only). Initial tests indicated that MP takes effect approx. 4 h post i.m. administration in sheep. Sheep were fed ad libitum a pelleted diet containing 70% straw, 20% alfalfa hay, 3% molasses, 4% rumen-protected fat, 2% casein and 1% urea (w/w). Sheep were fasted for 12 h prior to administration and during sample collection but had access to water at all times. Plasma samples were collected just prior to administration, and hourly for 7 hours starting 4 hours post administration. Samples were analyzed for ketone bodies and glucose. Metabolite data were analyzed with linear MANOVA and a repeated measures linear model; feed intake data were analyzed with one-way ANOVA. Within-subject effect (time) bordered significance (p=.0677) when analyzed with MANOVA. Between subject effect MP treatment on plasma concentration of ketone bodies was highly significant. There was a tendency for glucose to be depressed under MP but the difference to controls was not significant. Cumulative feed intake (kg/kg body weight) measured over 28 hours with an automated self-feeder, tended to be lower for MP treated animals but the difference was not significant. Cumulative feed intake in the first 4 h p.a. did not differ between

groups. This is the first report of effects of MP on long-chain FA oxidation in ruminants. More detailed analysis of feed intake responses and metabolism hormone activities is required.

Key Words: Sheep, Methylpalmoxirate, Feed Intake

643 Serum α-tocopherol concentrations for Venezuelan dairy cattle. O. Rosendo*[1], L. R. McDowell[2], N. S. Wilkinson[2], and A. Boning[2], [1]*Universidad Centroccidental 'Lisandro Alvarado', Barquisimeto. Lara, Venezuela,* [2]*University of Florida, Gainesville.*

A survey of three dairy herds in Lara state, Venezuela determined α-tocopherol serum concentration(α-T; μg/mL) of cows as related to breed (Holstein = H & Jersey = J), location (mountain = M & valley = V), and both lactation (LS) and reproductive stages (RS). Cows from each herd were grouped into five RS: C) 21 to 1 d prepartum (pp), F) 1 to 21 d postpartum, O) open, G1) $\leq$150 d pregnant (pn), and G2) > 150 d pn to < 21 d pp. Herds had similar feeding systems based on fresh-cut forages, corn silage, and grass hay as forage sources. Concentrate was separately offered twice a day. None of the herds received supplemental vitamin E. Data was analyzed as factorial models. A first and second model included herd, RS, and herd by RS interaction effects to analyze α-T for H and J, respectively. Since α-T values for H in two herds were similar ($P > .10$),α-T data were pooled, and a third model with location, breed, RS, location x breed, location x RS effects was examined. α-T were 8.0 vs. 4.4 (M vs. V), and 7.1 vs. 5.4 (H vs. J) for location and breed, respectively ($P = .0001$). α-T for C and F groups did not differ within locations ($P > .10$). For group C, α-T did not differ between locations ($P > .10$), but for F, O, G1, and G2, α-T was higher at M than at V ($P < .05$). For V, α-T of G1 group was higher than C and F but not different from O and G2, while for M, O group was the highest ($P < .05$). To evaluate α-T for H as affected by LS, an additional model compared the following LS groups based on days in milk (DIM), f) $\leq$21, e) 22 to 100, m) 101 to 200, and l) > 200 DIM. α-T values were 3.0, 4.6, 7.4, and 7.2 for f, e, m, and l groups, respectively. α-T were similar for e and f, and for m and l groups ($P > .10$) but, m or l was higher than e ($P < .05$) or f ($P = .0001$). Results suggested that location and RS were important factors in determining variation in α-T among herds. α-T in peripartum cows was the lowest, and open cows or those in early to mid gestation had the highest values. Holstein fresh cows or early in lactation had lower α-T values than those in mid or late lactation.

Key Words: α-Tocopherol, Dairy cows, Reproductive stages

644 Effect of a dietary supplement of folic acid on net flux of urea N, ammonia N and α-amino N across the ruminal wall of lactating dairy cows. C. Benchaar*[1], A. Desrochers[2], J. J. Matte[1], and C. L. Girard[1], [1]*Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville,* [2]*FMV, Universite de Montreal, St-Hyacinthe.*

Our previous studies demonstrated that an exogenous supply of folic acid increases milk production and milk protein yield in multiparous dairy cows, suggesting that dairy cow requirements for folic acid can not be met only by rumen microbial synthesis. However, before making a recommendation on the dose of folic acid to include in dairy cow diet, it is necessary to evaluate the effect of supplementary folic acid on rumen metabolism. This study was therefore undertaken to determine the effects of dietary supply of folic acid on the net flux of nitrogenous compounds (urea N, ammonia N and α-amino N) across the ruminal wall of dairy cows. Five lactating cows (574±45 kg) fitted with catheters in the right ruminal vein and the ileo-colic artery and with an ultrasonic flow probe around the right ruminal artery were used in a cross-over design. They were fed ad libitum in seven equal meals daily a TMR based on 60% of silage (corn and grass). Dietary supplements of folic acid were 0, 1.8 and 3.9 g/d. A total of fourteen sets of arterial and venous blood samples were collected simultaneously at 30-min intervals over 6 consecutive hours. During the sampling period, right ruminal artery blood flow was recorded continuously. Ammonia N, urea N and α-amino N were analyzed on whole blood samples immediately after sampling. Blood flow in the right ruminal artery was not affected (101 L/h; P=.58) by the addition of folic acid in the diet. Arterial and ruminal venous concentrations of ammonia, urea and α-amino N were not changed by treatments (P>.20). Ammonia net release and urea net uptake were not affected by supplements of folic acid (+35 and -38 mmol/h; P=.72

and .81; respectively). Ruminal net flux of α-amino N was not different between treatments (-7 mmol/h; P=.21). Results of this study indicate that supplementation of dairy cow diets with folic acid did not affect ruminal net flux of nitrogenous compounds.

Key Words: Dairy Cow, Folic Acid, Ruminal Net Flux

645   Effect of Agrado^{TM} on the Health and Performance of Transport-Stressed Heifer Calves. T. C. Stovall*, H. Han, and D. R. Gill, *Oklahoma State University, Stillwater, OK.*

Six hundred ninety mixed breed heifer calves (196 kg average initial BW) were used to determine the effect of adding Agrado^{TM}, an antioxidant produced by Solutia, St. Louis, MO., to the receiving ration on rate and efficiency of gain, and response to medical treatments. Heifers were blocked by weight within each of 7 truckloads of cattle and randomly assigned to one of two diets (0 or 150 ppm added Agrado^{TM}) within each weight block with eight pens of 10 to 16 head per load. All cattle, purchased at sale barns in Oklahoma and Arkansas by order buyers, were given free choice access to a moderately high energy receiving diet (51 Mcal NEg / cwt) consisting of 32% soybean hulls, 27% corn, 16% wheat middlings, and 10% cottonseed hulls. Health and performance were monitored for 42 days following arrival. Diets were supplemented with 15 IU vitamin E/kg and either 0 or 150mg Agrado^{TM}/kg. Cattle were observed for signs of morbidity daily and frequency, duration, and extensiveness of medical treatments were recorded. Morbid heifers fed supplemental Agrado^{TM} required fewer medical treatments for recovery (1.2 vs 1.0; P<.05) indicating that Agrado^{TM} may reduce medical cost. No significant effects of Agrado^{TM} supplementation on rate and efficiency gain during these 42-day receiving trials were detected.

Key Words: Agrado^{TM}, shipping stressed cattle, feedlot

646   Impact of Agrado^{TM} on Tocopherol Metabolism by Transport-Stressed Heifers. H. Han*, T. C. Stovall, and D. R. Gill, .

Eighty mixed crossbred heifers (5-7 months old, 196 kg initially) were selected from a group of 690 heifers used in receiving trials in order to investigate effects of Agrado^{TM} on tocopherol metabolism. Cattle, purchased by order buyers from Oklahoma and Arkansas sale barns, were given ad libitum access to a moderately high energy diet composed of soybean hulls, whole corn, wheat middlings, and cottonseed hulls with either 0 or 150 ppm added Agrado^{TM}. Diets were supplemented with 15 IU vitamin E acetate/kg. Jugular vein blood was collected on days 0, 14, 28, 42 and 68 after arrival in Stillwater. Plasma alpha tocopherol concentration was analyzed by HPLC. On day 0, plasma tocopherol levels were 7.2(control) and 8.5 μg/ml(Agrado^{TM} treatment); by day 14, tocopherol had significantly (P<.05) dropped to 2.0 (control) and 2.2 μg/ml (Agrado^{TM} treatment). Through day 42, tocopherol concentration level remained below 3 μg/ml; this is below the level considered to be normal. The drop from day 0 to day 14, 28, and 42 tended to be higher for heifers receiving 150 ppm Agrado^{TM} (5.2, 4.8, and 4.8 μg/ml vs 6.3, 6.0, and 5.9 μg/ml) indicating that even though Agrado^{TM} is an effective antioxidant, it did not increase the blood tocopherol concentration. However, there was no significant difference between treatments(P>.05). On day 68, plasma tocopherol had significantly (P<.05) increased to 7.0 and 6.5 μg/ml for heifers receiving Agrado^{TM} and control diets, respectively. Results indicate that transport and other changes occurring at this time (mixing of cattle, diet changes, vaccination, and respiratory challenges) are associated with decreases in plasma tocopherol levels that do not return to pre-transit concentrations for more than 42 days. Whether increases in plasma tocopherol concentrations are responsible for performance and health benefits sometimes noted with diet supplementation of shipping stressed calves with vitamin E needs further study.

Key Words: Agrado^{TM}, tocopherol, shipping stress

647   Influence of dietary vitamin A restriction on growth performance, concentrations of plasma thyroid hormones, carcass characteristics, and marbling scores in Japanese Black steers. K. Hodate[1], T. Odawara[2], Y. Sasae[2], and M. Yosiiwa[2], [1]*National Institute of Animal Industry., Tsukuba,* [2]*Oita Animal Experimentatal Station, Japan.*

The objective of this study was to determine the effect of dietary vitamin A restriction on growth performance, plasma concentrations of thyroid hormones, carcass characteristics, and marbling scores in Japanese Black steers. Ten half-sib Japanese Black steers (13 mo of age, 422 kg initial body weight) were randomly assigned into two treatments. The treatments were no vitamin A supplementation (DA) or oral vitamin A supplementation of 700,000 IU per100 kg of body wt every 28 d (CN). The ten steers were fed a diet (90% concentrate) ad libitum during the 252 d period. Feed intake was measured daily and body wt was recorded biweekly. Blood samples in each steer were obtained on d 0,28,56,84,140,196 and 252. Concentrations of retinol in plasma were determined using HPLC. Concentrations of plasma triiodothyronine (T_3), thyroxin (T_4), growth hormone (GH) and cortisol were measured by RIA. Twelve levels of marbling scores and ribeye area in all carcasses were evaluated following 24-h chill. From d 28 of the trial, greater than 50% decreases (p<.05) in plasma concentrations of retinol in DA steers compared to CN steers were found, however no clinical symptoms of vitamin A deficiency were found during the study period. No differences (p>.05) between vitamin A treatments were found in average daily gain (DA=.86, CN=.91 kg), daily feed intake (DA=9.31, CN= 9.33 kg), feed efficiency (DA=10.8, CN=10.3 kg) during the 252 d period, and carcass weights (AD=378, CN=389 kg). However, DA steers had higher marbling score (5.0 vs 3.2, p<.05) and greater ribeye area (46.2 vs 39.4 cm^2, p<.05) than CN steers. T_3 concentrations were lower (p<.05) in DA steers than CN steers on d 56, 84, 140, 196, and 252. T_4 concentrations were lower in DA steers than CN steers on d 84 (6.12 vs 7.58 ug/dl, p<.05). No treatment differences were found in plasma GH and cortisol. Our findings suggest that low concentrations of blood retinol and altered metabolisms in thyroid hormones during the fattening period increase intramuscular fat deposition in Japanese Black steers.

Key Words: Vitamin A, Marbling, Thyroid hormone

648   Mineral availability and ruminal fluid pH of crossbred steers fed BIOSAF$^{®}$. A. Garcia-Estefan*, L. W. Greene, and N. K. Chirase, *Texas A & M University System, Amarillo.*

Six crossbred steers (mean wt 355.7 kg) of similar genetics were used in a replicated 2 X 2 Latin square design to determine mineral balance and ruminal fluid pH when fed .26% BIOSAF$^{®}$ (Saccharomyces cerevisiae 8 X 10^9 CFU/g). BIOSAF$^{®}$ was substituted for .26% of the corn in a feedlot finishing diet. During each period, the steers were group fed (11.4 kg.head$^{-1}\cdot$d^{-1}) the control or BIOSAF$^{®}$ diets containing 80% steam rolled corn, 10% cottonseed hulls, and 10% protein-mineral supplement for a 21-d diet adjustment period. Following the diet adjustment period, steers were fed 9.08 kg/d and housed in metabolism stalls for a 7-d stall adjustment period and a 7-d collection period. Mineral intake, excretion (fecal and urine), apparent absorption, and retention were determined. On the last day of the collection period, a ruminal fluid sample was obtained via rumenocentesis and pH was measured. Apparent absorption and retention of Ca were increased (P=.0307) 8% with the addition of BIOSAF$^{®}$. There was no difference (P=.9566) in apparent P absorption; however, P retention as a percentage of absorbed P was increased (P=.0584) by BIOSAF$^{®}$ (67.7 vs 52.6 %). BIOSAF$^{®}$ increased (P=.0013) apparent Na absorption (10.7 vs 8.4 g/d) and (P=.0074) retention (4.3 vs 1.1 g/d). Steers fed BIOSAF$^{®}$ had a greater (P=.0069) apparent Mn absorption (147 vs 70 mg/d) and (P=.0002) retention (146 vs 69 mg/d). There were no differences in absorption or retention of N, K, Mg, Fe, Zn, and Cu when either of the diets were fed. BIOSAF$^{®}$ increased (P=.0176) ruminal fluid pH (6.47 vs 5.48). The results of this research indicates that BIOSAF$^{®}$ has a positive effect on Ca and P utilization in feedlot steers and may be valuable in reducing P excretion in concentrated animal feeding operations.

Key Words: Mineral, Steers, Yeast

649   Effects of source and level of ruminally protected choline on performance and carcass characteristics of finishing beef steers. G. A. Nunnery*, M. L. Galyean, S. C. Harris, G. B. Salyer, and P. J. Defoor, *Texas Tech University, Lubbock, TX*.

Two hundred eighty British x Continental crossbred steers (initial BW = 362.1 kg) were used to examine the effects of source and level of ruminally protected choline (RPC) on performance and carcass characteristics. Steers were divided into two blocks (light and heavy) with 140 steers per block. Within each weight block, steers were stratified by BW and assigned randomly within BW strata to one of the seven dietary treatments. After steers were assigned to treatments, pens (four pens of five steers each per treatment within each weight block) were assigned randomly to the seven dietary treatments. Treatments included 90% concentrate (steam-flaked corn base) diets with: 1) Control (no added choline); 2) RPC from Source A at .137% of dietary DM; 3) RPC from Source A at .274% of dietary DM; 4) RPC from Source B at .137% of

dietary DM; 5) RPC from Source B at .274% of dietary DM; 6) RPC from Source C at .137% of dietary DM; and 7) RPC from Source C at .274% of dietary DM. Percentages of RPC were designed to supply 2.5 (.137%) or 5 g (.274%) of ruminal escape choline per steer daily. Steers were fed for 112 (heavy block) or 140 d (light block), and carcass data were collected. From d 0 to the end of the trial, there were no differences ($P > .10$) in ADG (1.66 kg/d across all treatments). Dry matter intake ranged from 8.96 to 9.29 kg/day and did not differ ($P > .10$) among dietary treatments. Feed:gain ratio also did not differ ($P > .10$) among treatments. Control steers had more ($P < .01$) fat over the 12th rib and higher ($P < .01$) yield grades than the average of steers fed all RPC treatments. Longissimus muscle area tended ($P = .11$) to be less for Control steers than for steers in the average of all RPC treatments. Feeding RPC did not affect performance but decreased carcass fatness and thereby decreased carcass yield grade.

Key Words: Choline, Beef Cattle Performance, Carcass

TEACHING

650   Regionalization within the Northeast and MidAtlantic: today's reality and tomorrow's vision. P. A. Schoknecht* and H. D. Hafs, *Rutgers University, New Brunswick, NJ*.

The field of animal science is expanding from our traditional production agriculture base to include the study of laboratory and exotic animals, biotechnology, wildlife, and companion animals. For academic departments to meet the needs of this diverse clientele without sacrificing quality, we must create ways to cooperate rather than compete. For the last 3 years, Animal Science departments throughout the Northeast and MidAtlantic have been meeting to discuss and implement programs in regionalization. Our four-year plan calls for us to develop mechanisms to share students, faculty, and courses, with agreements presently in place among three regional schools. We are creating computer-based and computer-assisted instruction to share expertise, with work progressing in animal genetics and animal nutrition. We have developed regional extension training in dairy herd health, with more programs planned. We are building a database of internships to help students find opportunities across the region and increase the employee pool for regional industries, and we are linking this effort to a regional course in careers to help students understand the breadth of available choices. Some schools have also begun sharing research animals and research facilities, an endeavor that will truly transform those institutions. These efforts are being supported in part by the Kellogg Foundation, but primarily by the institutions and departments themselves. These departments believe that they can no longer "be everything to everyone". Instead, they must each create incentives and develop mechanisms to cooperate so that they can continue to progress in their areas of strength, while relying on others in the region to provide assistance where they are weak. We believe that by developing mechanisms to institutionalize this type of cooperation, the Animal Science departments in our region will become stronger and more focused, while meeting the increasingly diversified needs of our stakeholders.

Key Words: Regionalization, Education, Animal Science

651   A regional approach to career seminar in animal science. G. E. Dahl*[1] and P. A. Schoknecht[2], [1]*University of Maryland, College Park, MD,* [2]*Rutgers University, New Brunswick, NJ*.

Numbers of animal science undergraduates continue to grow within the Mid-Atlantic/Northeast regions, with over 90% of these students preparing for application to veterinary school. However, only 15-20% are actually successful in pursuit of entry to veterinary school, thus, a large number of students are left to find other careers. Our approach to increasing student knowledge of alternative careers in animal science is one of exposure and experience. First, students are exposed to alternative careers by participation in a Regional Career Seminar. Second, we will increase students' ability to experience these opportunities by use of a Web-based regional database for internships. The career seminar course was initiated in the spring semester of 1999. A variety of stakeholder participants have been recruited to make presentations in the career seminar course; internship placement is also sought from these stakeholders. Delivery of the seminar course is via interactive video conferencing. Thus, the efficiency of stakeholder recruiting efforts will

be maximized while maintaining student-stakeholder interaction. The course emphasizes resume writing and interview skills development at each local site. A website has been developed as a clearing-house for internships in animal agriculture within the Mid-Atlantic/Northeast regions, and access to the site is emphasized in the career seminar course. Changes in student participation rate in internships is being evaluated as well as student and stakeholder satisfaction with the course and internships. Additionally, stakeholders will provide input on the preparedness of animal science students for jobs within their industries, and asked for feedback regarding curriculum changes needed to better prepare students. We believe this approach will enhance the undergraduate experience, strengthen university-stakeholder ties, and promote the movement of animal science students into agriculture and related careers. In addition, the project will further enhance the regionalization of animal science activities in the Mid-Atlantic and Northeast regions.

Key Words: Career Course, Internship, Regional

652   Developing a multimedia program that emphasizes applications of functional anatomy. H. G. Kattesh*, M. H. Sims, R. W. Henry, E. K. Jackson, P. M. Ockenfels, D. K. Haines, and B. R. Harbison, *The University of Tennessee, Knoxville*.

This project is designed to produce a multimedia compact disk (CD) program for the purpose of enhancement and mastery of anatomical and physiological concepts by undergraduate students in animal science and related agricultural sciences. A problem-oriented approach for the presentation of fundamental principles of functional anatomy in farm animals is used. Students are presented text, graphics, animation, and audio and video aspects relative to the anatomy and physiology of the somatic portion of the peripheral nervous system in nine lessons. Mastery level of the lessons is assessed by 20 randomly selected multiple-choice questions. Four real-life case studies of neuromuscular abnormalities in the horse and cow are documented. Expert prompts, including history and details pertinent to each case, are provided in video and text format to aid the student in formulating initial observations. Upon successful completion of the lesson material and test, the students are permitted to enter conclusions as to the nature of the abnormality. This information, along with student's notes and quiz responses, are stored on a diskette and subsequently reviewed by the instructor. At the end of the program the expert gives a synopsis of the neuromuscular involvement in each case. This program underscores the practicality of understanding structural and functional relationships of the nervous and skeletal muscle systems that underlie commonly occurring neuromuscular abnormalities in farm animals. Experience in this mode of instruction will improve problem-solving skills of students as they practice applying physiologic concepts to their own observations. This program should significantly reduce the number of animals used in teaching laboratories and in addition, provide institutions that have limited access to animals and/or prepared specimens similar advantages commonly afforded to larger universities directly associated with colleges of veterinary medicine.

Key Words: Teaching, Multimedia, Functional Anatomy

653 Designing feeds and feeding for internet delivery. K. K. Ragland* and R. M. Hales, *University of Kentucky, Lexington, KY.*

Long a popular correspondence course for students seeking to enter schools of veterinary medicine, Feeds and Feeding needed to make the leap from its traditional paper offering to an interactive, multimedia format available to students via the Internet. Faculty with expertise in animal nutrition and distance learning course design worked with Web designers to create a version specifically for pre-veterinary medicine students with almost all course materials being located within the course software package (TopClass). All interaction, homeworks, quizzes, and tests are submitted and graded within the TopClass framework. The structure is fully interactive with students responding to questions and activities on-line and interacting with the instructor and one another via personal messages, announcements, and a discussion list. The Web-based platform supports not only text, graphics, and still images, but animation, audio clips, and full-motion video. A text, supplementary NRC tables, and a study kit of feedstuffs round out the course materials. After a year in development, the course was first offered to UK students in the spring of 1999 with five enrolled. On-line demonstration of the course structure, highlights of the TopClass version, and student responses to the initial offering will be presented.

Key Words: Distance Learning, Internet, Feeds and Feeding

654 Use of web pages to both enhance animal science courses and serve as outreach mechanisms. A. D. Herring* and B. L. Barham, *Texas Tech University, Lubbock.*

Web pages for two upper-level animal science courses, one animal breeding and genetics course and one beef production course, have been utilized since 1997. During this time use of internet resources and e-mail has increased among students. A survey of students in 1998 in beef production showed that 44.7% used e-mail and 80.9% used the internet regularly. Survey of students in the same course in 1999 showed that 75.4% used e-mail and 93.4% used the internet regularly. Average number of e-mail messages sent per week was 3.9 in 1998 and 6.2 in 1999. Average internet accesses per week was 2.4 in 1998 and 3.7 in 1999. The primary purposes for which these web pages were created were to (1) provide supplemental information to students, (2) give students more accessibility to instructors and (3) allow more flexibility for students to monitor grades. These objectives have been effectively accomplished, based on student feedback. However, another use of these web pages has been determined, university outreach. A commercially available web page tracking program was obtained to monitor our web page activity beginning in 1997. This program tracks usage by time of day, day of week, and country of origin. The computer addresses of the last 100 visitors are also shown. As of February 1999, visitors from 19 countries outside the United States have viewed our web pages, which are not advertised on any internet search engines. Students at all levels are increasingly using internet resources. There is no certain way to estimate how many potential new students in high schools and transfer students at junior colleges may see these course web pages, but they are sure to get some sort of impression from ones they do find. The primary focus of course web pages should be to effectively enhance classroom experiences, with these other potential uses secondary. However, in times when faculty accountability is increasingly important, documentation of course web page usage can provide additional quantitative data in assessment of faculty activities and workload.

Key Words: Teaching, Internet, Outreach

655 The integration of the world wide web in undergraduate and graduate education. J. J. Parrish*, *University of Wisconsin, Madison WI.*

World wide web based instruction was integrated into three animal science courses (http://www.wisc.edu/animalsci/faculty/parrish.html). The first course was an equine laboratory within the freshman introductory animal science course with 110 students. The equine laboratory site was designed to stand alone as there were no equine lectures in this course. The lab exercise was intended to provide an experience in equine handling and routine management. Students were able to view color images of the breeds and photos of the safety and handling procedures that were part of the lab. This proved useful in being able to conduct the laboratory during the allotted 3 hours. A particularly

successful application of the web-based instruction was in the health management section. Students isolated internal parasites and used computers to view an image map within the web site to classify parasites and identify treatments. The next course was reproductive physiology. The course is offered at the junior/senior level with 42 students. The site is much more extensive containing the course syllabus, lecture outlines and notes, lab exercises along with supporting handouts and answer keys, old exams in both text and interactive formats, and information on how to conduct and present the required group research projects. One of the goals in the development of this class site was to completely replace all handouts with digital material. Although this was accomplished, the students still printed material from the site. However given time, familiarity with digital material should increase and the need for hard copies should decrease. Students were enthusiastic about the use of the web site during the laboratories. The last course was a graduate level class in gamete and embryo biology with 9 students. A unique objective of the web site was to provide a forum for students to present their term papers as mini-web sites. Student manuscripts were prepared using Adobe PageMill. The students were excited about this opportunity and produced excellent work demonstrating quality and unique creativity in web site design. Web sites are useful in a variety of educational settings but require student access to and knowledge of technology.

Key Words: Teaching, Computers, Technology

656 Evaluation of an email discussion list used in a senior-level cow-calf management course. B. A. Reiling* and C. R. Johnson, *University of Florida, Gainesville FL.*

A survey of students (STU; n = 17) and faculty (FAC; n = 9) who participated on an email discussion list for a senior-level cow-calf management course was conducted to evaluate the usage of email discussion as a teaching tool. The activity was required of all STU in the course, and additional beef cattle FAC and graduate students were encouraged to participate. One question per week (total of 10 questions/semester) was posted to the list. Students had one week to respond by email and their response was immediately posted to the list. Questions concentrated on beef industry issues and either paralleled lectures or were current in the popular press. Prior to enrollment in the course, 82.4% of STU had a current email account and 11.8% had previously subscribed to an email discussion list. A post-survey conducted during the last week of class indicated that STU spent approximately 30 min/week preparing responses for the discussion, and 88.2% stated that the time spent was beneficial to their understanding of industry issues. Students were not required to seek outside references, however 82.4% did. Most commonly used references included websites, popular press articles, and communication with producers. Approximately half ($4.8 \pm .45$) of the questions exposed STU to new issues that they had not previously considered. For other questions, STU stated that the email discussion enhanced their understanding of the topic (100%). Students enjoyed FAC participation and 100% wanted more interaction with the FAC. Participating FAC read about 50% of the STU responses, but responded to the list less than 3 times each. Of the FAC respondents, 100% said they would participate again and found the list to be an effective method of ascertaining STU comprehension of industry related issues ($4.22 \pm .22$, scale 1-5). Faculty thought the list was appropriate for a senior level capstone course (100%) and useful for increasing student understanding of issues (100%). Usage of email proved beneficial as a teaching tool for the introduction and discussion of beef industry issues.

Key Words: Email, Discussion, Beef industry issues

657 Electronic Storage of Journal Articles and Technical Manuals on Personal Computers. R. D. Muller*[1], J. E. Weatherford[1], M. M. Glassburn[1], and T. Moore[2], [1]*Elanco Animal Health,* [2]*Purdue Univ.*

An evaluation was conducted on methodologies for storage of journal and related scientific articles on personal desktop and portable computers. A separate study was undertaken to evaluate storage of internally created desktop publications such as technical manuals.
A high priority was given to the ease with which documents could be electronically searched and retrieved once made electronically resident. Particularly important was the ability to search simultaneously within the contents of many documents as opposed to searching only the bibliography-type information: (title, author, keywords, etc.). High

priority was also given to the ease with which information could be exported out to other programs should technology changes demand, thus preventing obsolescence of the data files. Also important was the ease with which documents could be imported into the system (either from electronically resident files or from scanners). Labor requirements for reworking the information once it had been made electronically resident were also considered. Once made electronically resident, the information should be able to be distributed via a number of methods - CD, client-server databases, internet distribution, etc. Somewhat lower priority was placed on software and hardware costs to fulfill these objectives.

Five major publications (technical manuals) were electronically published with Folio Views (^{TM} Open Market Inc.). Several projects involving a total of some 30,000 pages of journal articles, university and experiment stations reports, internal reports etc. were scanned to a TIFF file format and electronically indexed with LaserFiche (^{TM} Compulink Management Center).

These technologies have proven to be a highly effective means of storing and retrieving documents for the individual animal scientist as well as being economical to implement.

658   Teaching Styles: "Active Learners" Make the Best Learners. W. W. Ellis*, *Missouri State University, Cape Girardeau*.

Dr. Craig Nelson's workshop on critical thinking presented at the 1998 Animal Science Meeting in Denver further stimulated interest in using more "classroom active learning". Thus, in the fall of 1998 a course offering in Animal Science was converted from high percentage lecturing to an active group participation style of teaching. Dr. Nelson indicated less material would be covered, but student understanding would be greater. Thus, as an instructor, a major concern was the volume of material that would be covered with active learning. It was determined that the disciplines of animal breeding, reproductive physiology, nutrient-digestion, and feeding management would be the course content of comparison. The same examinations were used as students were not permitted to retain the previous years. Class size was 51 for 1998 and 49 in 1997. The average ACT score for 1998 was 23.2 compared to 23.0 in 1997. The text, laboratories and classroom were the same. Students in 1998 were assigned to groups of six, changed three times during the term. Changes in teaching style led to several conclusions. Students scored higher on exams (79.9% and 84.3% in 1997 and 1998, respectively). Problem solving activities were very popular as a group learning activity. Students adapted quickly to group changes but preferred to stay within a group. Non-traditional students demonstrated less comfort in the group setting. While course content was sacrificed, students were more open to class discussion and the instructor became more involved with the class. Active learning increased teaching effectiveness at the expense of additional preparation time for the instructor.

659   A freshman seminar in animal and veterinary science. A. T. Mallilo and M. M. Nippo*, .

A one-credit course called "A Freshman Seminar In Animal and Veterinary Science" has been developed at the University of Rhode Island. The class meets one hour per week and has five specific student directed goals: enhance the student's knowledge of the role of the animal scientist and veterinarian in everyday life; develop the student's understanding of the scientific method by critically evaluating current "in the news" research; work together collaboratively in small groups; further writing and speaking skills; and enjoy a "special experience". As instructors we had the following goals: retain a higher proportion of students; develop a close relationship with students early on in their education; and share the "special experience" with our students. The class is taught in sections of 12-15 students. All students have taken an introductory animal science course or are concurrently enrolled. The course is available only to freshmen (without exception). The classes generally employ one of three approaches. The first is skills based where students are asked to analyze something in the animal sciences that has been in the news recently and report on it orally, in writing or both. This is done in a group discussion format. A second strategy is the use of electronic media. While not computer intensive a personalized web page is written for the class that gives them a jumping off point in terms of future opportunities in the field as well as things of immediate interest. Web

use begins in a class held in a computer lab. This allows students to interact with each other as well as the instructor. The last type of class involves outside speakers. These include a veterinarian, a veterinary student, students who have done internships and graduate students. This is designed to show some of the choices students have for the future.

660   Linking graduate and postdoctoral training in equine reproduction to client outreach and service: the South Texas experiment. G. L. Williams*, .

The nature and progress of modern science has by necessity evolved in an environment of reductionism. This reductive approach spills over into the training of graduate students and postdocs, as graduate mentors must usually maintain an independent, extramurally-funded research effort that is narrowly-focused. In animal science, this often involves only a single species, resulting in graduates that have limited expertise outside their narrow sphere of graduate training, thus limiting employment opportunities. Similarly, veterinarians are often confronted with client demands that exceed their disciplinary or species knowledge base. In 1989, a program was begun at the Animal Reproduction Laboratory, Texas A&M University Agricultural Research Station, Beeville, to simultaneously address regional deficits in availability of equine reproduction expertise and to provide expanded opportunities for graduate and postdoctoral training in a second species. Transmitted by word of mouth only, these services were made available to local and regional veterinarians who wished to refer clients, as well as to non-referred inquirees willing to comply with requirements of the program. In particular, client services involving palpation, ultrasound, or other female reproductive manipulations require the client to 1) allow at least one trainee to examine mares, and 2) sign a hold-harmless agreement releasing faculty, students, and The Texas A&M University System from damage liabilities. Since 1989, 9 graduate students and 4 postdoctoral trainees have participated in the program. Current clientele includes 62 horse owners and about 12 veterinarians. The number of client interactions has increased exponentially since inception, with a 73% increase in activity over the last 2 years. In 1998, this included 359 palpation/ultrasound examinations. Other components of the program include consultations and assistance with ovulation induction, induction of parturition, estrous synchronization, management of twin embryos, handling and use of cooled semen, behavioral anomalies, endocrine diagnostics, and nutrition. An added benefit of the program is an increased willingness of owners to loan or donate mares for research.

661   Providing hands on experience in a senior-level beef cattle science course with cooperator-owned cattle. F. A. Thrift*, .

Most students enrolled in Animal Sciences at the University of Kentucky come from an urban background, have high expectations of being a veterinarian and little experience working with large animals, especially cattle, which poses some unique problems in teaching a senior-level beef cattle course. To deal with this situation, the first part of a beef cattle science course, which is taught during the fall semester, is devoted to all aspects of beef cattle handling equipment. Also, one lab is devoted entirely to equipment design, layout and usage. Thereafter, almost all labs involve hands on contact with various classes of cattle (identification, pregnancy diagnosis, castration, implanting, deworming, vaccinations, selection protocols, body condition scoring). Most of the labs involve usage of cooperator-owned cattle and may or may not involve usage of cattle equipment depending on cattle worked and facilities at each cooperator location. Utilization of cooperator-owned cattle not only provides students with opportunities to gain hand on experience but has the added advantage that students are exposed to different management sceranios. Student response to the opportunity to gain hands on experience in the course has been excellent and students have, beyond expectation, embraced moving the classroom outside in the real world, rain or shine, each Friday afternoon of the fall semester.

662 Undergraduate internship in reproductive management of beef cattle. T. A. Strauch*[1], J. E. Williams[1], M. F. Smith[1], P. A. Kunkel[2], R. F. Hill[2], G. K. Bates[2], and D. J. Patterson[1], [1]*Department of Animal Science, University of Missouri-Columbia*, [2]*Select Sires, Inc., Columbus, OH.*

Internships promote active learning among undergraduate students and provide students with opportunities to develop critical thinking and problem solving skills. An internship program was developed in cooperation with Select Sires, Inc. and the University of Missouri-Columbia (F. B. Miller Endowment Fund) to provide students with practical training in reproductive management of beef cattle. Objectives of the internship are: 1) provide students with practical training in the development and execution of estrous synchronization (ES) and artificial insemination (AI) programs, and 2) provide extensive hands-on experience in ES, estrous detection (ED), semen handling (SH), and AI. Selected students receive classroom and on-farm instruction with emphasis on ES, ED, SH, and AI. The majority of students do not have extensive experience in the preceding techniques prior to the internship. Students are required to attend weekly training sessions and a 3 d Select Sires AI Training School. Other responsibilities include: formulating a statement of specific learning objectives, a written protocol of overall plans, participation in ES, ED, SH and AI on designated farms, and a written report of individual experiences. Students accompany Select Sires personnel to assist in on-site ES, ED, SH and AI and are exposed to diverse beef production systems. In the past 3 years, 26 students have participated in ES, ED, SH, and AI on farms and ranches in MO, KY, MT, OR, and SD. Students in the first two years worked with 15,722 heifers and cows. Of the students involved in the first two years, 10 of 15 pursued graduate degrees or veterinary medicine. Student-faculty interaction and student-producer interaction was facilitated through this internship. Participation fostered greater working appreciation of beef cattle reproductive management, created links for students with allied industry, and expanded career opportunities following graduation.

Key Words: Reproductive Management, Internship, AI

663 Experiential learning in the animal sciences: A multi-species large animal management and production practicum. B. A. Reiling*, T. T. Marshall, J. H. Brendemuhl, J. A. McQuagge, and J. E. Umphrey, *University of Florida, Gainesville, FL.*

Students enrolled in Introduction to Animal Science (n = 270) were surveyed to ascertain current experience and career goals in animal agriculture. Over half (52%) of students were primarily interested in the study of large animals. Disciplinary interests included animal behavior (34%) and animal management (21%), and the primary career goal involved veterinary medicine (65%). Still, only 37% of students had livestock experience, and only 8% had extensive experience. Of animal science majors (50.8% of respondents), 65% were enrolled in the animal biology option (a pre-professional program) and did not possess a livestock background. Thus, a multi-species large animal management and production practicum was developed to give students hands-on experience working with livestock. This is an elective course (1-2 credits), and students are encouraged to enroll for 2 semesters. Once enrolled, students are subdivided into teams of 8 students each. Within each team, each pair of students has specific responsibilities associated with one of the livestock species (beef, dairy, equine, or swine) for a period of 3 wks. Upon conclusion of the period, pairs within each team rotate responsibilities, which include daily feeding and monitoring of feedlot cattle and finishing swine, farrowing assistance and baby pig processing, and equine training and foaling assistance. Students are also involved with all facets of a working dairy. A journal of observations and written summarization reports are required of all activities. Weekly class meetings allow for instruction and are used to manage the varied course activities. After two semesters, student evaluations revealed that the course stimulated their interest in the animal sciences (4.87 ± .47 based on a 5-pt scale), and the overall course evaluation was 4.82 ± .51. Many introductory animal science students no longer possess an agricultural background and experiential learning is critical to their understanding of the livestock industries.

Key Words: Experiential learning, Practicum, Hands-on

664 Use of a lamb feeding trial to integrate nutritional principles and practice. A. W. Bell and D. J. R. Cherney*, *Cornell University, Ithaca, NY.*

Energy and protein are primary nutritional requirements of all classes of animals and types of production, including growing ruminants. A semester-long animal feeding trial has been conducted as an integral part of the introductory Animal Nutrition course for nine years with approximately 150 students per year participating. An important principle demonstrated in the trial is that an animal's ability to productively use protein may be limited by its energy supply and vice versa. Specific objectives of the trial are to demonstrate effects of dietary energy and protein level on voluntary feed intake, average daily gain and efficiency of feed utilization in growing lambs and explain performance responses in terms of measured effects of dietary treatments on apparent digestibility of dry matter and on plasma concentration of selected metabolites. Thirty-two weaned lambs (3 mo, 25 kg, 16 male, 16 female) are ranked according to liveweight, semi-randomly allocated to one of four dietary treatments and housed in pairs in floor pens. Dietary treatments consist of 1) high energy, high protein, 2) low energy, high protein 3) high energy, low protein and 4) low energy, low protein. All diets meet or exceed NRC requirements for maintenance. Students weigh lambs and sample blood via external jugular venepuncture on a weekly basis. In addition each student is assigned to regularly feed, water and examine lambs throughout the 7-wk trial. Students measure plasma urea nitrogen and glucose concentrations by enzymatic, colorimetric assays. One lab session is devoted to collation and summary of results for each individual lamb. Each student is then required write a report attempting to relate results to nutritional principles discussed in lectures and laboratories, and described in recommended textbooks. Many students feel that the report allows them to integrate theoretical lecture material with practical laboratory material, allowing them to leave the class with a much more thorough understanding of nutrition. An additional benefit is the experience students gain in handling and care of farm animals.

Key Words: Nutrition, Teaching, Animal Feeding

665 Use of peer-graded student projects in an introductory course. J. A. Moore*, *North Carolina State University, Raleigh.*

Introduction to Equine Science (ANS 110) is a 3-credit course taught for the first time in Spring 1998. Students (n=75) were required to complete a horse-related project (40 points, 6.7% of final grade), the most popular being a scrapbook or construction of the "visible horse" model. Mid-semester, the instructor decided projects would be peer-graded, and each student graded 5 projects during the class period dedicated as "project day." Three students asked for a re-grade by the instructor, who found each was the victim of an "outlier" (one low grade and four high grades). On course evaluations, 3 students complained about having their projects graded by peers, one indicating the instructor was "lazy." For Spring 1999, students (n = 62) were told on the first day that projects (50 points, 6.8% of final grade) were to be peer-graded, and a "project day" was included on the syllabus. Student classifications for 1998 and 1999, respectively, were 83%, 84% female; 27%, 26% non-majors; 35%, 47% freshmen (FR); 31%, 26% sophomores (SO); 18%, 21% juniors (JR); and 16%, 6% seniors (SR). Project scores in 1998 were not influenced (P = .20, protected LSD) by gender (P = .68), class (P = .07), or major (P = .56), but did tend to be lower for freshmen. Final grade in the class (expressed as a percentage of total points) was influenced (P < .05) by all three, with females (89%) scoring higher than males (82%; P = .03); FR (80%) scoring lower than SO (89%) or SR (90%) (P < .01) [JR at 84% were not different than any other class; P > .10], and Animal Science majors (89%) scoring higher than non-majors (82%; P = .02). In summary, it is recommended that students be made aware of a peer-grading policy at the onset of the semester, and that the instructor check for outliers prior to recording project grades. Gender, class, and major did not influence student scores on the project, but did influence final grade in the class.

Key Words: Students, Class projects, Peer grading

666   Using editorial boards to peer review: enhancing scientific writing of undergraduate students. R. C. Rhodes III*, *University of Rhode Island*.

Writing intensive, undergraduate courses typically require that students receive frequent feedback. Providing feedback can be instructor- and time-intensive. A strategy to provide students with meaningful feedback about their writing, minimize instructor time commitment, yet encourage active student engagement is through the use of students as peer reviewers. We have designed a peer review system that is based on a model used in professional scientific writing. All students in our *Anatomy and Physiology*, *Introductory Endocrinology* and *Physiology of Reproduction* courses are required to write a scientific review paper. At the beginning of the semester, each student selects a topic of their choice. Explicit written directions for writing the paper are given to each student. Additionally, students are also provided with the *Journal of Animal Science* (*JAS*) guidelines for authors (*JAS* Style and Form). Importantly, students are given a timetable for paper submissions and reviews. Students are assigned to serve on editorial boards (composed of 4 students) and trained by the instructor to review papers. Afterward, each student on each board reviews two papers. (Thus, each paper is reviewed by half the members of each board.) The editorial board discusses the reviews, then visits with the student writers, providing the writers with relevant feedback. During the semester, all papers are read by two reviewers (on one of three different editorial boards) on three different occasions. Hence, each paper is read by six different reviewers. As the end of the semester approaches, students submit a last rough draft to the instructor for a final review. The writing exercise culminates in the submission of all rough drafts (7), comments of review boards as well as the final copy of the paper. This packet of materials constitutes a scientific writing portfolio. The keys to success of peer reviews include: dedicating traditional seat time to peer reviews, training student reviewers and providing frequent opportunities for review of student writing. The value of peer review includes engagement of students in active learning and improvement of scientific writing.

Key Words: Teaching, Writing Intensive Courses, Peer Review

667   A new writing intensive (WIC) course involving ethical issues in animal agriculture. S. L. Davis* and L. V. Swanson, *Oregon State University*.

We have recently developed a new course that combines the WIC concept with a brief discussion of how ethics can be used to resolve socially contentious issues related to animal agriculture. (All OSU students must complete a senior-level WIC course in their major.) The writing intensive portion of the course was designed after the writing activities previously described by Aaron (J. Animal Sci. 74:2810-2827, 1996). In brief, the students write 'Letters to the Editor' on assigned topics; they participate in 'Animal Advisory Committee Hearings' in which they serve both as one testifying before a mock advisory committee and as a member of a different advisory committee on assigned issues previously discussed in lectures; and they write a term paper on a topic of their choice and then give a 15-minute oral summary of their term paper using PowerPoint graphics. Writing the term paper is a multi-stage process, including peer reviews of each other's papers at the draft stage. Students are encouraged to search the scientific and popular press literature for information, using the library computer databases. The major focus of the term paper must include a discussion of the ethical components of the issue. The course content is delivered by lectures and discussions on issues such as factory farming, animal biotechnology, environmental problems, animal welfare, animal rights, etc. To describe ethics and the role of a social contract, lectures are presented on the nature of contentious issues, similarities between the scientific method and the philosophical method, fundamental ethical theories and how a social ethic can change over time. The course objectives are, therefore: (1) Help students develop written and oral communication skills, (2) Develop critical thinking skills, (3) Learn more about current contentious issues in animal agriculture, (4) Consider how ethics (moral reasoning) may be used to resolve contentious issues.

Key Words: Ethics, Writing Intensive, Contentious Issues

668   Teaching Values and Ethics in Agriculture and Forestry. R. Dailey* and R. Cochrane, .

We have taught a section of the University Honors Program Senior Seminar, which is required for graduation, since fall 1986. The course, Values and Ethics in Food and Fiber Production, has a limited enrollment. Class size has ranged from 4 to 17 students, mostly non-agricultural majors (e.g. education, english, sociology, pharmacy). Topics range from animal usage, or environmental issues, to human concerns (education, diet, health and nutrition). Class meets weekly for three hours. The instuctors serve as catalysts in a discussion format. Each week, a different topic is discussed. In the spring, we teach a writing- intensive class that follows a similar format. This class is primarily agricultural majors. Enrollment had grown from 17 to 99 and is now capped. In both classes, students keep a journal and read three novels on issues in agriculture and forestry. In the spring class, they write reports on three case studies, discuss three other cases in class through role playing, write three distinctively different letters and write an eight page paper on a controversial issue. Each student presents his(her) paper orally in one of the class meetings. Entrance/exit summaries serve to keep roll and have students formulate short opinions. The classes are well received by students and serve as capstone courses to enhance knowledge and understanding of issues critical to agriculture.

Key Words: values, ethics, agriculture

ADDENDUM
The following abstract from the Nonruminant Nutrition section was inadvertently omitted from that section.

242A   Pigs fed phytase-supplemented diets are more prone to the adverse effects of an elevated Ca:P ratio than those fed inorganic P-supplemented diets. C. H. Stahl*, J. M. Porres, T. Xiang, K. R. Roneker, W. G. Pond, and X. G. Lei, *Cornell University, Ithaca, NY*.

This experiment was designed to compare the effects of two Ca:P ratios in phytase or inorganic P-supplemented diets containing 800 mg Fe/kg on pig growth, body P status, and bone strength. Forty-eight weaning crossbreds were fed one of the four dietary treatments from weaning to finishing. Diets 1 and 2 were a P-deficient (.36%) corn-soybean meal basal diet, plus .15% inorganic P with a Ca:P ratio of 1.2:1 and 2:1, respectively. Diets 3 and 4 were the basal diet plus phytase (Natuphos, BASF, 1,200 U/kg diet) having the 1.2:1 and 2:1 Ca:P ratio, respectively. Body weights (BW) were recorded monthly, and blood samples and radius and metacarpal bones were collected at 7 wk and the end of experiment. At wk 7, pigs fed Diet 4 had lower (P < .01) BW than pigs fed Diet 1, as well as higher (P < .01) plasma alkaline phosphatase activity (AKP), and lower (P < .01) plasma inorganic phosphorus concentration (PP) than all other treatment groups. There were no significant differences in these measures among the other groups. Pigs fed Diet 1 had greater (P < .05) strength of both bones than pigs fed either phytase-supplemented diet. Pigs fed Diet 2 had bone strengths that were similar to those of pigs fed Diet 3, but that were greater (P < .05) than those of pigs fed Diet 4, which showed clinical signs of severe P deficiency. At the end of the trial, there were no significant differences in AKP, PP or metacarpal bone strength among pigs fed Diets 1, 2 and 3. Pigs fed Diet 1 had higher (P < .05) BW than pigs fed Diet 3. Compared with those fed inorganic P-supplemented diets, pigs receiving a P-deficient diet supplemented with phytase might be able to maintain similar P status and bone strength, but appeared to be more susceptible to the adverse effects of a high dietary Ca:P ratio on body P status and bone strength.

Key Words: Pigs, Phytase, Bone