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1 Phase 2 in the identification of a gene affecting ovulation rate in swine: genotyping additional animals with additional markers.

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A QTL affecting ovulation rate in swine has been identified on the terminal portion of the short arm of porcine chromosome 8 in a Meishan-White composite crossbred population. The initial results were based on phenotypic data from nearly 300 crossbred females and genotypes from markers spaced at approximately 20 cM intervals. To improve our estimates of the QTL's effect and location in the genome, we have included another 300 pigs in the study and genotyped every available microsatellite marker within the first 20 cM of the linkage group on chromosome 8. Over 650 animals have been genotyped for 10 microsatellite markers and phenotypic records from 599 females were analyzed. Some of the additional microsatellite markers were developed from isolated genomic clones presumed to reside in the region of interest. Most markers were developed from a porcine yeast artificial chromosome library. The probability that a given chromosomal segment derived from Meishan germplasm was calculated based on results from the CHROMPIC option of CRI-MAP. These probabilities were used as regression coefficients in a least-squares analysis. The most likely position for the QTL based on the current data is 1 cM from SW2611, proximal to the centromere with a 95% confidence interval of approximately ± 15 cM. The gene action appears to be purely additive with an additive effect of an allele substitution for the Meishan allele of -1.70 ova. The comparative map between the human and porcine genomes needs to be refined to determine precisely which segment of the human genome contains the QTL and additional swine populations need to be tested to determine the importance of the QTL to the swine industry.

Key Words: Porcine, Ovulation rate, Quantitative trait loci

2 Indication of quantitative trait loci on chromosome 6 affecting porcine reproductive traits.

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Identification of genes for reproduction traits in pigs could be useful for marker assisted selection and be of interest to producers in the future. This project was conducted to identify QTL for reproduction on chromosome 6 in swine. A population of 428 gilts was developed as an F2 cross of a line selected for 10 generations for increased ovulation rate and embryonic survival and a control line. Line differences were 6.7 ova, 3.3 fetuses at 50 days of gestation, and 3.1 pigs at birth. Ten F1 boars and 51 F1 gilts were used to produce F2 gilts. Traits analyzed included ovulation rate and number of nipples (n = 428), age at puberty (n = 295), and total born, number born alive, number of stillborn, and number of mummified pigs per litter (n = 362). Six microsatellite markers were used. They averaged 18.5 cM apart and had information content that ranged from 11.9% to 61.3% . The largest gap between markers was 42 cM. No markers from 91 cM to the end of the chromosome (161 cM) were used. An interval analysis was conducted using least squares to regress phenotype on marker genotype with LOD score as the test statistic. A permutation method was used to establish a chromosome significance level of $P < .05$ (LOD = 2.50). Significant evidence of a QTL (LOD = 2.77) located between the markers HAL and SW1059 (82 cM on USDA-MARC map) for number of mummies was found. The markers in this region were approximately 25-30% informative. Suggestive evidence of a possible QTL at 86 cM (USDA-MARC map) for ovulation rate (LOD = 2.46) was also found. Further studies with more markers are needed to verify this result and to determine accurately the position of the QTL.

Key Words: Pig, Litter size, Gene mapping

3 Evidence for QTL on chromosome 1,8 and 13 affecting reproduction in pigs.

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The objective was to identify chromosomal regions containing QTL which explain a portion of genetic variance of reproduction in pigs. A three-generation resource population was developed by crossing a randomly selected control line (C) with a line selected for an increased index of ovulation rate and embryonic survival (I). At Generation 10 differences between lines I and C were 6.7 ova, 3.3 fetuses, and -4.5% embryonic survival at 50 d of gestation and 3.1 fully formed pigs and 1.6 live pigs at birth. Phenotypic data were collected in F2 females and analyzed 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 per litter. Grandparents, F1, and F2 animals were genotyped for 42 microsatellite markers distributed across chromosomes 1, 3, 4, 8, 13, and 15. Expected number of false-positive outcomes per genome-wide scan was calculated using the method presented by Lander and Kruglyak (Nature Genetics, 11:241-247). A LOD score of 3 represents suggestive linkage indicating an expected number of false-positive outcomes of one per genome scan. A LOD score of 4.5 represents significant linkage indicating an expected number of false-positive outcomes of 0.05 per genome scan. The LOD scores were calculated using least squares including effects of litter and replicate. Suggestive evidence for QTL influencing age at puberty were identified on chromosome 1 (16cM, LOD = 3.92 and 129cM,LOD=3.12) and on chromosome 8 (120 cM, LOD = 3.74) using the USDA-MARC linkage map as reference. Evidence was suggestive for a QTL affecting number of stillborns on chromosome 13 (104cM, LOD = 4.04). Additional markers are needed to better estimate the locations and effects of these putative QTL. Because age at puberty is an economically important trait which is labor intensive to measure, selection for age at puberty using markers linked to QTL may be useful to the pig industry.

Key Words: Pigs, Reproduction, FSH

4 Comparative mapping of human chromosome 12 genes in the pig.

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Comparative mapping between the human and pig genomes has previously indicated that genes on human chromosome 12 (HSA12) are conserved on pig chromosomes 5 and 14 (SSC5 and SSC14). The objective of an ongoing project in our laboratory is to further develop the pig comparative map for HSA12 by identifying pig sequence-tagged sites (STS) for HSA12 genes and mapping each STS in the pig by physical assignment and/or genetic linkage analysis. In the current study, STS were identified for mast cell growth factor (MGF) and phospholipase A2 (PLA2). PCR primers for amplifying MGF and PLA2 were designed as part of the comparative anchor tagged sequences (CATS) and universal mammalian sequence-tagged sites (UM-STS) projects, respectively. Gene identity for each STS was confirmed by sequencing of PCR products. MGF was localized to SSC5q25 with 100% concordance (risk of error less than 0.1%) using a pig-rodent somatic cell hybrid panel (Yerle et al., 1996). This regional assignment was achieved through the concordant segregation of PCR results and chromosome fragments retained in the hybrid cells. A restriction fragment length polymorphism (RFLP) was identified in the PLA2 STS using the restriction enzyme DpnII. Autosomal Mendelian segregation of the PLA2 alleles was observed in 98 pigs from 5 three-generation PiGMaP reference families. A RFLP was also identified in a collagen type II alpha 1 (COL2A1) STS using the restriction enzyme RsaI. This STS was previously reported by our laboratory and was physically assigned to SSC5q12-q25 using the somatic cell hybrid panel. Autosomal Mendelian segregation of the COL2A1 alleles was observed in 69 pigs from 3 three-generation PiGMaP families. Genetic linkage mapping of PLA2 and COL2A1 is in progress. Results from this study will improve the comparative map of HSA12 genes in the pig.

Key Words: Pig, RFLP, Comparative Mapping

5 QTL mapping with multiple markers in outbred populations.

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Various methods of QTL mapping have been developed for experimental populations obtained from designed controlled crosses. In an outbred population these methods can not be applied due to factors such as unknown linkage phase and allele frequencies. An algorithm was developed to compute the likelihood for QTL mapping with a general pedigree when all the marker genotypes are observed. The basic concept behind this algorithm is to use the Elston-Stewart algorithm to compute the likelihood. Since phase is unknown in outbred populations, the necessary transmission probabilities for each possible phase are computed using the marker information at multiple loci and are summed out of the likelihood. Multipoint mapping increases power because all loci can be considered regardless of their informativeness and also it can assist in determining linkage phase. This method was used in a simulated pedigree of 631 individiduals: One grandsire was mated to 5 unrelated granddams to produce 20 related sires. These 20 sires were each mated to 10 unrelated dams with 2 offspring per mating. Four marker loci located 10cM apart with a single QTL, of additive effect, located in the center were simulated. The estimated likelihood was very similar to the likelihood calculated at the simulated values when the QTL magnitude ranged from 10% to 50% of the phenotypic variance. The estimated residual variance and QTL allele frequency, distance and means were very close to the simulated values. In a few cases, the QTL means were of opposite sign than simulated as the means were not restricted to be additive. This indicated the difficulties associated the unknown linkage phase. When the QTL effect was small (<10% of the phenotypic variation), maximization of the likelihood was difficult due to small power and resulted in poorer estimates of the QTL means. The developed methodology is fast and is flexible in terms of pedigree structures and can be extended to include approximations for polygenetic components.

Key Words: QTL, Outbred, Peeling

6 Evaluation of optimal strategies for selection on a known major gene for a quantitative trait.

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Several studies have shown that standard Marker-Assisted Selection (MAS) for a quantitative trait in an outbred population can increase response to selection in the short term but reduce longer-term response. In standard MAS on a known major gene, selection is on $I = g+h^2(P-G)$, where g is the breeding value for the major gene and $h^2(P-G)$ is an estimate of the animal's polygenic breeding based on own phenotype (P) adjusted for major genotype (G). Recently, Dekkers and Van Arendonk (1998, Genetical Research 71-257) developed methods to optimize selection on a known major gene in outbred populations. Methods were based on a deterministic model that assumed variance contributed by polygenes was unaffected by selection. The objective of this study was to use a stochastic simulation model that does allow for changes in polygenic variance, to evaluate the optimal strategies derived by the methods of Dekkers and Van Arendonk (1998). Models were adapted to simulate MAS in a population that has been under phenotypic selection. Responses to optimal selection were compared to responses to phenotypic selection and to standard MAS. Alternative scenarios were considered by varying the additive effect of the major gene and the degree of dominance. Results confirmed that standard MAS on a known major gene increased response in the short-term, but may result in lower response in the long-term. A comparison with the optimal strategies of Dekkers and Van Arendonk (1998) confirmed the greater response of optimal over standard MAS and phenotypic selection for longer planning horizons.

Key Words: Major gene

7 Localization of a juvenile recessive cataract mutation to proximal chromosome 7 in mice.

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Mice in a heat loss selection line (MH) were found with a spontaneous mutation that causes anterior, nuclear cataracts in juveniles. Initial experimental crosses determined that the inheritance of the mutation fit a model of a single, recessive gene. The objective of this research was to localize the chromosomal position of the cataract mutation (juvenile recessive cataract; symbol *jrc*). A mapping population was developed by crossing homozygous recessive cataract males (albino MH) to homozygous dominant wild-type females (black C57BL/6J). Heterozygous F_1 females were backcrossed to MH males with cataracts. The backcross (B_c; n = 322) generation thus had an expectation of 50% wild-type and 50% cataract phenotypes. Phenotypic data collection of the B_c mice involved recording of coat color and cataract formation. Results confirmed the model of a single, recessive gene (153 cataract, 169 wild-type; χ^2 = 0.8, 1 d.f.). Linkage with coat color was evident (χ^2 = 62.0, 3 d.f.), implicating either Chromsomes 2 or 7 as the location of *jrc*, because of the presence of the *non-agouti* and *tyrosinase* loci, respectively. Analysis of segregating microsatellite DNA markers in the B_c population found significant linkages between *jrc* and several markers on proximal Chromsome 7. Recombinant frequencies between *jrc* and *D7Mit340* (1.2 cM from the telomere), *D7Mit227* (16 cM), and *D7Mit270* (18 cM) were 0.18, 0.02, and 0.03, respectively. Thus the location of *jrc* is likely within the region between 14 to 21 cM from the telomere on Chromosome 7. A dominant cataract mutation has been previously described

in this region of Chromosome 7, likely associated with *Lim2*, a major lens protein. Testing of the B_c animals to determine if the newly discovered juvenile recessive cataract is also associated with *Lim2* is in progress, with the hypothesis that *jrc* may be a new allele with *Lim2*. Once identified and characterized, *jrc* may be a useful model to research the genetics of cataracts in other animal species including humans.

Key Words: Gene Mapping, Eye, Lens

8 Genetic parameters of fatty acid composition of porcine longissimus dorsi muscle. R. N. Goodwin*[1], T. J. Knight[2], D. C. Beitz[2], and P. J. Berger[2], [1]*National Pork Producers Council, Des Moines, IA,* [2]*Iowa State University, Ames, IA.*

The objective was to determine the genetic factors that influence fatty acid composition of porcine longissimus dorsi. Pigs (n=1649) from the 1991, 1992, and 1994 National Barrow Show Sire Progeny Test were the source of pigs and included purebred barrows and gilts of eight breeds (Berkshire, 112; Chester White, 115; Duroc 291; Hampshire, 251; Landrace, 174; Poland China, 107; Spot, 191; and Yorkshire, 438). These pigs were from 255 sires and 864 dams. Pigs were classified for HAL genotype by DNA typing. Diets were uniform within test and across breeds. Pigs were slaughtered at 105 kg body weight, and samples of longissimus dorsi were taken from over the 10th rib 48 hours post slaughter. Fatty acid composition of total lipids was determined by standard gas chromatographic procedures. Data were analyzed by a mixed linear model with fixed effects of season, gender, HAL genotype, breed, and breed x gender interaction. Random effects were sire and dam within breed. Variance components were estimated by using a REML algorithm. Heritabilities were calculated as four times the sire variance divided by total variance. Heritabilities of fatty acids were: myristic, .30; palmitic, .52; palmitoleic, .41; stearic, .44; oleic, .55; linoleic, .69; linolenic, .13; and arachidonic, .44. Differences (P<.05) in fatty acid composition and total lipids were observed for breeds, gender, HAL genotype, and breed x gender interactions. In conclusion, genetic variation is available to select pigs with specific fatty acid composition and lipid content of longissimus dorsi muscle.

Key Words: Pigs, Genetics, Meat quality

9 Genetic variation of fatty acid desaturation in pigs. T. J. Knight*[1], R. N. Goodwin[2], and D. C. Beitz[1], [1]*Iowa State University, Ames, IA,* [2]*National Pork Producers Council, Des Moines, IA.*

The objective was to evaluate the variation in desaturation of fatty acids in phospholipids and triacylglycerols of *longissimus dorsi* muscle. Pigs (n=372) from the 1994 National Barrow Show Sire Progeny Test were the source of pigs and included purebred barrows and gilts of eight breeds (Berkshire, 24; Chester White, 16; Duroc, 47; Hampshire, 56; Landrace, 64; Poland China, 31; Spot, 32; and Yorkshire, 120). Pigs were classified for HAL genotype by DNA typing. The same diet was fed to all pigs during the growth period. Pigs were slaughtered at 105 kg body weight, and samples of *longissimus dorsi* muscles were taken at the 10th rib 48 hours post slaughter. Fatty acid composition of phospholipids and triacylglycerols that had been separated by thin-layer chromatography was determined by standard gas chromatographic procedures. Data were analyzed by a mixed linear model with fixed effects of gender, HAL genotype, and breed. Random effects were sire and dam within breed. Total lipids contained about 20% phospholipid and about 80% triacylglycerol. Phospholipids contained a greater proportion of long-chain fatty acids and more polyunsaturated fatty acids than did triacylglycerols. Fatty acid composition data in triacylglycerols show that delta-9-desaturation was greater (P<.05) in gilts than in barrows. Our data indicate that delta-5-desaturation was similar (P>.1) among breeds, gender, and HAL genotypes. Delta-6-desaturation differed among breeds (P<.05), with Berkshire showing the greatest delta-6-desaturation. Additionally, delta-6-desaturation was greater in gilts than in barrows (P<.1) but not different for HAL genotypes. Overall, the variation in fatty acid composition suggests the influence of genetics on amount of unsaturated fatty acids in lipids of porcine *longissimus dorsi* muscles.

Key Words: Fatty acid composition, Genetics, Pigs

10 Correlated response in placental efficiency in swine selected for an index of components of litter size. H Mesa*[1], LT Banner[1], CJ Bracken[1], TJ Safranski[1], RK Johnson[2], and WR Lamberson[1], [1]*University of Missouri-Columbia. Columbia, MO,* [2]*University of Nebraska-Lincoln. Lincoln, NE.*

Recent observations suggest that placental efficiency (PE), measured as the ratio of birth weight (BW) to placental weight (PW), affects litter size. The objective of this study was to evaluate placental efficiency in swine previously selected on an index of ovulation rate, embryonic survival and litter size with a estimated response after 14 generations of 3.0 fully formed pigs per litter. A total of 60 gilts from the selected (S) and control (C) lines was observed at farrowing. Each piglet's umbilical cord was double tagged with numbered mouse ear tags allowing the piglet and placenta to be matched and weighed. Data analyses were performed using the GLM procedure of SAS on the variables BW (n=607), PW (n=563), PE (n=406) and placental vascularity scored 1-5 (PV, n=182). Independent variables in the model were dam pre-farrowing weight and line, with maternal grand sire within line used to test line effects. Litter size was higher (p<.01) for S than C (11.47 ±.47 vs. 8.54 ±.52 piglets, respectively). Line effect for PV was not significant (p=.34). Line affected BW (p<.01) with least-square means of 1218.61 ±34.94 g and 1012.02 ±24.86 g for C and S, respectively. Line effect for PW approached significance (p=.10) with least-square means of 222.09 ±8.07 g and 202.17 ±5.94 g for C and S, respectively. Line effect for PE also approached significance (p=.09) with least-square means of 5.76 ±.15 and 5.33 ±.11 for C and S, respectively. Effect of line on PE was similar when litter size was included in the model as a covariate. Correlated response to index selection resulted in decreased BW and PW in the selected line. Placental weight was affected to a lesser extent than BW, causing PE to be lower in S than C. Since PE is smaller in S but LS is higher, we hypothesize that LS response is achieved through physiological mechanisms not involving placental efficiency. One possible mechanism could be increased uterine capacity that allows survival of more piglets through gestation.

Key Words: Placental Efficiency, Litter Size, Swine

11 Effects of calpain proteolysis and calpain genotypes on meat tenderness of Angus bulls. M.E. Davis*, H.Y. Chung, H.C. Hines, and D.M. Wulf, *Ohio State University.*

Relationships of the calpain system with meat tenderness and carcass traits were examined in 47 purebred Angus bulls from two lines divergently selected for blood serum IGF-I concentration. Genotyping was performed by PCR-SSCP (single strand conformation polymorphism) analysis at the calpain loci. The PCR primers were selected from the calcium binding region of the calpain I large subunit (CANP1L4), and calpain II regulatory subunit (CANP4S). Bulls approximately 13 to 15 mo of age were slaughtered, and carcass traits, including fat thickness (FAT), longissimus muscle area (LMA), percentage of kidney, pelvic and heart fat (KPH), hot carcass weight (HCW), marbling score (MAR) and quality grade (QUL) were measured. Activities of calpastatin (CAC), u-calpain (uCL), and m-calpain (mCL) were measured, and Warner-Bratzler Shear Force (WBS) and myofibril fragmentation index (MFI) were determined. Genetic polymorphisms among individuals were observed for both loci (AA, AB, and BB). Differences in CANP4S genotypes were found (P=.02) for KPH, and CANP1L4 genotypes influenced hot carcass weight (P=.04). Calpastatin activity and quality grades were higher in the high IGF-I line than in the low IGF-I line (P<.05). Least significant differences among CANP4S and CANP1L4 genotypes were found at the P=.05 level for KPH (BB>AB>AA) and HCW (BB>AB>AA), respectively. Positive relationships were detected between MAR and FAT with r=.54 (P=.08). Negative relationships were detected between CAC and FAT with r=-.60 (P=.05), and between LMA and FAT with r=-.65 (P=.03). It may be possible to use calpain genotypes classified by PCR-SSCP in marker assisted selection to improve carcass traits.

Key Words: Calpain, Carcass Traits, Meat Tenderness

12 Relationship of a PCR-SSCP at the bovine calpastatin locus with calpastatin activity and meat tenderness. H.Y. Chung*, M.E. Davis, H.C. Hines, and D.M. Wulf, *Ohio State University*.

This study was designed to investigate the effects of calpastatin activity and myofibril fragmentation index on meat tenderness and the effects of calpastatin genotypes determined using PCR-SSCP (polymerase chain reaction - single strand conformation polymorphism) analysis on these variables. Forty seven purebred Angus bulls were slaughtered at approximately 13 to 15 mo of age. Longissimus muscles were prepared to determine myofibril fragmentation index (MFI), Warner-Bratzler Shear (WBS) Force, pH and calpastatin activity. The PCR primers for the calpastatin (CAST) segments were selected based on exons of the bovine calpastatin cDNA sequences as CAST1 (exon 1C and 1D), CAST5 (exon 5 and 6), and CAST10 (exon 10 and 11). Polymorphisms were detected in the all of calpastatin segments examined. Genotypes were AA, AB, and BB for CAST1 and CAST5, and AA, BB, CC, AB, AC, and BC for CAST10 segments. Allele frequencies were tested for chi-square goodness of fit for Mendelian inheritance with no significant departures from expected values. Statistical significance of CAST1, CAST5, and CAST10 genotypes was not detected for calpastatin activity, shear force, myofibril fragmentation index, or pH. A strong negative residual correlation (r=-.83; P=.02) between calpastatin activity and myofibril fragmentation index was obtained. Myofibril fragmentation index and WBS were slightly related (r=-.59; P=.17). A weak positive correlation (r=.26; P=.57) between calpastatin activity and shear force was observed.

Key Words: PCR-SSCP, Bovine Calpastatin, Meat Tenderness

13 Divergent Selection on the Basis of Blood Serum Insulin-like Growth Factor I Concentration in Angus Cattle: Response in Female Reproductive Traits. A. Yilmaz*[1], M. E. Davis[1], and R. C. M. Simmen[2], [1]*Department of Animal Sciences, The Ohio State University,* [2]*Department of Animal Science, University of Florida*.

This study was designed to examine the effects of divergent selection for blood serum insulin-like growth factor-I (IGF-I) concentration on reproductive performance of spring- and fall-calving Angus cows. Data were obtained from an ongoing selection experiment involving 100 spring-calving (50 high and 50 low line) and 100 fall-calving (50 high and 50 low line) purebred Angus cows. Calving rate was slightly higher in the high IGF-I line (P = .07), but did not differ between spring- and fall-calving cows (P = .47) when only natural service matings were considered. Postweaning IGF-I concentrations of heifers that subsequently had data for calving rate were significantly higher in high line heifers (P = .0001), but did not differ between spring- and fall-calving heifers. Therefore, the slightly higher calving rate found in high line females may have been associated with their higher IGF-I concentration. Mean age of heifers at first calving did not differ between the high and low IGF-I selection lines (P = .54). Spring born heifers were significantly older than fall-born heifers at first calving. Linear regressions of age of heifers at first calving on IGF-I concentration at different ages were negative, but nonsignificant, for all measures of IGF-I. Residual correlations between age of heifers at first calving and IGF-I concentrations were also negative but nonsignificant. Thus, divergent selection for blood serum IGF-I concentration tended to influence calving rate of Angus females and had small, albeit desirable, effects on age at first calving. Season had a large influence on age of heifers at first calving but not on calving rate.

Key Words: Beef Cattle, Insulin-like Growth Factor, Reproduction

14 Trends in stillbirth rates for Holsteins in the United States. C. L. Meyer*[1], P. J. Berger[1], J. R. Thompson[2], and C. G. Sattler[3], [1]*Iowa State University, Ames, IA,* [2]*Genex Cooperative, Inc., Ithaca, NY,* [3]*National Association of Animal Breeders, Columbia, MO*.

The objectives for this study were to: 1) determine if there is an increasing trend in stillbirths for the U.S. Holstein population; and 2) to examine which factors lead to stillbirths. A national sample of 613,808 births were used to examine the influence of sire, herd, year, season, sex of calf, parity of dam, calving ease, and gestation length on the livability of the calf. Parity was scored as an ordered variable (1, 2, 3+). Calving ease was scored on a scale of 1(= no problem) to 5 (= extreme difficulty). All scoring was completed by personnel observing the births. Gestation was limited to 262 to 286 days. The overall proportion of stillbirths in 157,811 heifers was 0.11, while the overall proportion of stillbirths in 455,997 cows was 0.06. Heifers and cows were analyzed separately to determine if stillbirths were a different trait between the two groups. Initial research using logistic regression has suggested that the factors significantly contributing to stillbirths may be different in heifers than cows. The variability in stillbirths was greater in heifers than cows, causing larger year to year fluctuations in heifers than cows. The proportion of stillbirths in cows increased from 0.04 in 1984 to 0.07 in 1996; 0.002 per year. In heifers the proportion of stillbirths nearly doubled, 0.08 in 1984 to 0.14 in 1996; 0.004 per year. The increase across years was significant ($P < 0.05$) for heifers and cows.

Key Words: Gestation length, Holstein, Stillbirth

15 Identification and mapping of sequence-tagged sites for human chromosome 2 genes in the pig. S. R. Wesolowski*[1], N. E. Raney[1], and C. W. Ernst[1], [1]*Michigan State University, East Lansing*.

Comparative mapping between the human and pig genomes has previously indicated that genes on human chromosome 2 (HSA2) are conserved on pig chromosomes 3 and 15 (SSC3 and SSC15). The objective of this study is to further develop the pig comparative map for HSA2 by identifying and mapping pig sequence-tagged sites (STS) for several HSA2 genes. PCR primers designed as part of the universal mammalian sequence-tagged sites (UM-STS) project (Venta et al., 1996) were used to identify pig STS. Seven HSA2 UM-STS primer pairs were tested and pig STS for apolipoprotein B (APOB) and non-erythrocytic beta spectrin 1 (SPTBN1) were successfully amplified. Pig PCR products for APOB and SPTBN1 were approximately 140-bp and 1000-bp, respectively. PCR products were sequenced using an ABI 373 automated sequencer and gene identity for each STS was confirmed by comparison to previously published sequences in the GenBank database. APOB has previously been mapped to SSC3q25-q26 (Sarmiento and Kadavil, 1993). The SPTBN1 STS was physically mapped using a pig-rodent somatic cell hybrid panel (Yerle et al., 1996) and regional assignment was achieved through the concordant segregation of PCR results and chromosome fragments retained in the hybrid cells. SPTBN1 localized to SSC3q21-q27 with 92% concordance (risk of error less than 0.1%). Regional mapping of SPTBN1 further confirms the conserved synteny between HSA2 and SSC3. Results from this study will improve the comparative map between these chromosomes.

Key Words: Pig , Physical Mapping, Comparative Mapping

16 Association Between the Estrogen Receptor Gene and Reproductive Components in Swine. B.J. Isler*, K.M. Irvin, S.M. Neal, S.J. Moeller, and M.E. Davis, *The Ohio State University, Columbus*.

Previous studies have shown that a specific allele (B allele) of the estrogen receptor (ESR) locus is associated with increased litter size in swine (Short *et al.*, 1997, J. Anim. Sci. 75:3138). The objective of this current study was to investigate the association between ESR genotype and the reproductive system itself. The ESR genotype of 36 Yorkshire (Y × Y), 28 Large White (LW × LW), and 43 crossbred (17 LW × Y, 26 Y × LW) females was determined to be either AA, AB, or BB using a PCR-RFLP procedure. All 107 animals were mated to Hampshire boars. At approximately day 75 of gestation, the animals were slaughtered and their reproductive tracts collected. Data collected included ovulation rate, horn length, number of fetuses, fetal mass, uterine mass, number of mummies, fetal sex, fetal placement, fetal survival, and fetal space. Data were analyzed using a model that included the effects of ESR genotype, slaughter date, breed, parity, and all significant two-way interactions. Data were also analyzed to determine the presence of between horn differences for all measured traits; in this case, an additional effect of uterine horn was added to the model. Significant ($P < 0.1$) two-way interactions involving ESR genotype were not detected in any of the analyses. Number of fetuses per horn was significantly ($P = 0.051$) different between animals of AA (5.14 ± 0.32) and BB (6.03 ± 0.35) genotype. LW × LW animals had a significantly ($P < 0.1$) larger number of fetuses and fetal weight per horn (6.06 ± 0.28 fetuses, 2014.3 ± 41.0 g) than Y × Y (5.45 ± 0.24, 1893.9 ± 34.4). LW × LW animals

also had a significantly lower (P < 0.12) uterine length and fetal space per horn (284.0 ± 7.0 cm, 48.8 ± 3.3 cm/fetus) than Y × Y (298.5 ± 5.9, 63.3 ± 2.8). Other traits also displayed favorable, but not statistically significant, trends with respect to ESR genotype: fetal survival, total uterine length, total fetal weight, and ovulation rate within horn. The ESR gene appears to have a positive effect on several reproductive components.

Key Words: Swine, Genetic Marker, Reproductive Traits

17 Multiple trait analysis of resistance to gastrointestinal nematode parasites in pure and crossbred Red Maasai and Dorper sheep.

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Variables related to immunological response to gastrointestinal nematode parasites (predominantly *Haemonchus contortus*) in Red Maasai (R, 191), Dorper (D, 273) and crossbred (1153) sheep were studied under hot/humid African conditions. Crossbreds were: RxD, DxR, Rx(RxD) and Dx(RxD). Log-transformed fecal egg count (LFEC), packed cell volume (PCV) and live body weight (LWT) were analyzed from records taken at 30, 60 and 90 days of age, and five times post-weaning until lambs were one-year old. A 3-variate model had: a) fixed effects of breed type, sex of lamb, birth year, and age of ewe at lambing; b) a fourth-order Legendre polynomial describing trajectory as lambs aged; c) additive genetic random effects for all traits and a random maternal effect for LWT and, d) a covariance between residuals. Restricted maximum likelihood was used to estimate (co)variances. R were lighter and more resistant to parasites (lower LFEC and higher PCV) than D. Lambs sired by D had higher LWT and LFEC and lower PCV than R-sired ones. Highest LWT was in Dx(RxD) followed by D and DxR lambs. Ranking for PCV was: D < Dx(RxD) < DxR < RxD < Rx(RxD) < R. The trend was opposite for LFEC. Females were less susceptible than males; lambs from 4-year-old and older ewes were less prone to parasite infestation than those out of younger ewes. Heritabilities were 0.06 (LWT), 0.06 (PCV) and 0.04 (LFEC). Maternal heritability for LWT was 0.07. Genetic correlations were 0.00 (LWT and LFEC), 0.15 (LWT and PCV) and -0.94 (LFEC and PCV).

Key Words: Sheep, Gastrointestinal parasites, Multiple-trait analysis

18 Heritability of peak race performance in Quarter Horses.

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Race records of sire and their progeny were downloaded from the American Quarter Horse Association (AQHA) to find efficient methods to define age and time at peak performance (APP and TPP). Data were sampled such that each sire was required to have a minimum of 20 progeny with at least 20 racing events per progeny. Fifty sires were randomly sampled (1001 progeny). Sire, sex, distance, jockey weight, track, track condition, wind, age × sex and distance × sex significantly affected racing times (P<.001). Age and distance effects were found to be linear. Distance alone accounted for approximately 99% of the total variation in race time (P<.001). Age alone accounted for approximately 10% of the total variation (P<.001). Non-linear effects of age and distance accounted for .72% and .35% of the total variation, respectively (P<.001). Records were adjusted for all significant effects except age to derive an adjusted time on all racing events within the data set. Seven methods were evaluated to find APP and TPP: rolling averages of 2, 3, 4, and 5 events, fastest single adjusted time, first derivative of quadratic regression and best selection index. Sire and residual variances were calculated for each of the 7 methods. Four methods were selected to define APP as those that maximized sire variances and model R-square while minimized residual standard error: rolling averages of age of four events (**AveAge**), first derivative of quadratic regression (**EstAge**), age of the fastest single adjusted time(**AdjAge**) and age at best selection index (**BSIAge**) as defined by AQHA. The estimates of h^2 of APP and TPP defined by each of the 4 methods were estimated by REML using a sire model. The h^2 estimates for AveAge, EstAge, AdjAge and BSIAge were .009, .013, .000, .000, respectively. The h^2 estimates for **AvePerf**, **EstPerf**, **AdjPerf** and **BSIPerf** were .107, .120, .124 and .181, respectively. In conclusion, APP did not appear to be under additive genetic control while TPP is lowly to moderately heritable.

Key Words: Horse, Performance, Heritability

19 Pair-wise correlations of dystocia scores among different parities of Holstein cows.

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A set of 131910 DHIA records of dystocia from 76615 Holstein cows were analysed to estimate the correlations of dystocia scores among parities. Dystocia scores ranged from 1(= no problem) to 5(= extreme difficulty). Records of up to 6th parity (birth of the 6th calf) were included. Pearson correlation coefficients (pair-wise) of scores were estimated between each pair of parities (i.e. Parity I versus Parity J, I=1, 2, ...,5;J=I+1, ..., 6). For each pair-wise analysis, only the cows with records on both parities (I and J) were considered. Results are as follows where upper diagonal values are estimates of pair-wise correlations(r) of scores between parities and the lower diagonal values are the statistical significance levels corresponding to those estimates (Ho: r=0). The results indicate that recurrence of dystocia (recording the same score) in successive lactations in the same cow is low and even lower when the lactations are far apart.

Parity			Parity J			
I	1	2	3	4	5	6
1		0.17	0.13	0.13	0.10	0.09
2	0.01		0.15	0.14	0.16	0.08
3	0.01	0.01		0.15	0.16	0.16
4	0.02	0.01	0.01		0.16	0.05
5	0.02	0.02	0.01	0.01		0.15
6	0.04	0.04	0.05	0.04	0.04	

Key Words: Correlations, Dystocia, Holstein

20 Potential for international type evaluation of Jersey sires in the United States, Denmark and New Zealand.

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International genetic evaluations of dairy sires for milk production traits are routinely available from the Interbull Centre. In addition, the University of Guelph and the Holstein Association USA have recently developed international type trait evaluations for Holstein sires. However, international type evaluations are not yet available for other dairy breeds. International sourcing of genetics may be more beneficial for numerically smaller dairy breeds, such as the Jersey breed, because it can facilitate inbreeding avoidance and increase selection intensity. The purpose of the present study was to investigate the possibility for international Jersey type evaluations. August 1998 national sire evaluation data of 3443 Jersey bulls from the USA, Denmark and New Zealand were used. Genetic ties between countries were limited; only 28, 18 and 9 bulls had at least 45 progeny in the USA and New Zealand, USA and Denmark, and New Zealand and Denmark, respectively. Genetic correlations between countries were approximated as the correlation between EBV adjusted for average reliability in each country. Type traits were well harmonized between USA and Denmark, with 13 traits in common and estimated genetic correlations ranging from .62 and .99. However, the USA and New Zealand had only seven traits in common, with estimated correlations ranging from .57 to .98. Denmark and New Zealand also shared seven traits in common, with correlations ranging from .50 to .99. It appears that enough harmonization exists in type trait definition and recording in Jersey cattle to allow a reasonable implementation of international sire evaluation methodolgy. However, harmonization is somewhat behind that of the Holstein breed, and further improvement in this area will be necessary.

Key Words: Jerseys, Type Traits, International Evaluation

21 Genetic correlation between milk yield in five regions of USA.

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In international genetic evaluation of dairy sires for milk yield, records from the USA are treated without distinction between region of production. Genetic correlations between some regions within a country may be smaller than those between the USA and some other Interbull

member countries. Data were first lactation records of daughters of AI sires in five parts of the USA(Midwest=1, Northeast=2, Southeast=3, Southwest=4, Northwest=5). After edits (10 or more records per sire and days in milk, DIM > 275) the file included 3,465,334 lactations from 43755 sires. A multiple-trait model viewed production in each region as a different trait. Explanatory variables were: herd-year-season, age at calving, DIM and sire. A Bayesian analysis via Gibbs sampling was undertaken, using bounded uniform priors for location (other than sires, where the prior was multivariate normal)and dispersion parameters. Heritability (.21-.24) was lower than in other studies, probably due to the use of a sire model. The lowest genetic correlation was .93 (regions 4 and 5).

Key Words: Genetic correlation, Regions, Holsteins

22 Comparison between traditional and fuzzy logic definitions of Herd-Year-Season groups in Holsteins.

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The definition of contemporary groups can affect prediction of breeding values. In genetic evaluation of dairy cattle, such groups are herd-year-season (HYS) classes. In areas where herds are small this leads to high variance intra herd comparisons. A fuzzy logic classification can attenuate this problem by sharing information between "adjacent" contemporary groups. About 307,000 first lactation Holsteins records were used in the analysis. Two models were compared. In model I, a crisp classification was used. Here, each record belonged to a single HYS, where season classes were defined using a 2-month period of calving, starting in December. In model II, a fuzzy classification was employed, where each cow had a membership of x ($\geq$ .5) in her season of calving class, and 1-x in an adjacent class. Bayes factor and predictive distributions were used to compare the two models. Heritability of milk yield was 0.28 and 0.30 for the two models, respectively. This was due to a reduction in residual variance in the fuzzy assignment. A cross-validation analysis based on the probability that a predicted observation fell in its expected range indicated a better performance of model II. The Bayes factor was 2.8, favoring the model with fuzzy classification. Correlation between observed and predicted records by models I and II were 0.88 and 0.91, respectively. The correlation between predicted breeding values from the two models was 0.94

Key Words: Fuzzy logic, Contemporary groups, Holsteins

23 Effects of Genotype Percentage and Progeny Size on Breeding Value Estimates and Accuracy for Maine-Anjou Cattle.

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The objective of the study was to investigate the effects of including performance records of cattle with less than 50% Maine-Anjou (MA) parentage on EBV and accuracy (ACC). Data included 42,373 birth weight (BW) and 30,556 weaning weight (WW) records on Maine-Anjou (MA) cattle from the American Maine-Anjou database. Cattle with 50% or more MA accounted for 88% and 90% of data for BW and WW, respectively. A single trait animal model including herd-year-season, percentage of MA breeding, sex, dam age, random animal, maternal, and permanent environment effects was fitted. The model for WW also included weaning age as a covariate. Breeding values (EBV) and accuracies (ACC) were estimated using the MTDFREML software. Direct and maternal mean differences between EBV for all animals and EBV for animals with 50% and more MA were calculated for sires with high (> 93.8%) MA breed percentage within progeny size sub-classes and are shown in Table 1. Significant differences in mean EBV and mean accuracy (not shown) for direct and maternal effects between results were found. These differences increased with the number of progeny per sire. Negative mean direct EBV differences between all animals and animals with 50% and more MA for WW suggested that including all animals had resulted in a drop in the mean EBV for that trait. Rank correlations in EBV and ACC ranged from .57 to .96 for the top 25% of the animals in Table 1. Subject to resource limitations, including all animals can be beneficial particularly for sires with low numbers of progeny.
Table 1. Mean differences of direct and maternal estimated breeding value (EBV) between all Maine-Anjou cattle (MA) and >50% MA for birth weight (BW) and weaning weight (WW) for high percentage (>93.8%) MA.

Trait	No. of Progeny	N	Direct EBV	Maternal EBV
BW	0-5	1663	.31±.008*	.23±.005*
	5-10	114	.40±.044*	.27±.019*
	>10	224	.43±.032*	.28±.018*
WW	0-5	1667	-1.56±.073**	3.6±.062**
	5-10	104	-1.69±.695*	4.84±.257**
	>10	172	-2.92±.324**	5.03±.224**

*$P<0.01$, **$P<0.0001$

Key Words: Genetic Evaluation, Maine-Anjou, Growth Traits

24 Genetic parameters for age at puberty and stayability in crossbred cattle.

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Heritabilities and genetic correlations for age at puberty and five measures of stayability of beef cows were estimated with linear mixed models. Data for animals born in years 1970-1972 were collected from Cycle I of the Germ Plasm Evaluation Program at the U.S. Meat Animal Research Center. The females were two-breed crosses representing seven breeds of sire. Records on a total of 788 females from 192 sires were used. The stayability traits considered were probabilities of a female having 2 (S(2—1)), 3 (S(3—1)), 4 (S(4—1)), 5 (S(5—1)) and 6 (S(6—1)) calves, given that she calved once. Stayability traits were coded as 1 if the cow had a calf at or after a given age, and 0 otherwise. Variance components were estimated using REML. A sire model with no relationships among the sires was assumed. Models included fixed effects of breed group, year of birth, and Julian birth date as a linear covariate. Estimates of heritability and genetic correlations were obtained from single- and two-trait analyses. Heritability estimates were 0.60 for age at puberty and 0.00, 0.00, 0.00, 0.02 and 0.01 for S(2—1), S(3—1), S(4—1), S(5—1) and S(6—1), respectively. Genetic correlations between age at puberty and stayability traits were -1.0, -1.0, -1.0, -0.6 and -0.2, although such estimates have little meaning when heritability is next to zero. The small estimates of heritability suggest that selection for stayability would be difficult.

Key Words: Beef Cattle, Genetic Parameters, Stayability

25 Genetic correlations among average daily gains of ram and ewe lambs fed under typical conditions and rams fed in Pinpointer units.

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When lamb performance is recorded in facilities that measure individual feed intake, such as Pinpointer units, a legitimate question is the degree to which daily gain is genetically correlated with daily gain achieved under typical group-feeding conditions. Lambs were from a composite population (1/2 Columbia, 1/4 Suffolk, and 1/4 Hampshire germ plasm) and of the F2 or more advanced generations. Data were daily gains of 1,101 rams (PR) fed in Pinpointer units (11 to 17 wk of age) and 2,021 rams (TR) and 3,513 ewes (TE) fed in a typical manner (9- or 10- week period starting at 9 wk of age). The TR and TE lambs were born from 1983 through 1995, whereas the PR lambs were born from 1986 through 1995. Measurements of PR, TR, and TE were considered to represent three correlated traits. Random effects in the model were animal direct genetic, dam maternal genetic, and dam maternal permanent environmental. Fixed effects were associated with age of dam (1 to 6 yr), type of rearing (1 to 4), and contemporary group (test date). Variances due to maternal genetic effects with single trait analyses were near zero so that factor was eliminated from the three-trait analyses although a random uncorrelated effect due to dam was included in the model. Estimates of heritability were .22, .14, and .23 for PR, TR, and TE, respectively, with fractions of variance due to dam effects ranging from .02 to .05. Estimates of genetic correlations were .86 for PR with TR, .83 for PR with TE, and 1.00 for TR with TE. Estimated phenotypic variances were similar for PR and TR but one-third less for TE. Unadjusted means were .411, .406, and .326 kg/d for PR, TR, and TE, respectively. The similarity of heritability estimates and estimates of genetic correlations all exceeding .83 suggest that average daily gain of rams fed in Pinpointer

units can be used to predict genetic value for average daily gain in both ram and ewe lambs fed under typical conditions.

Key Words: Sheep, Growth, Genetics

26 Nonlinear mixed effects models for indicators of resistance to internal parasites in sheep. S. L. Rodriguez-Zas*[1], R. L. Baker[2], and D. Gianola[1], [1]*University of Wisconsin, Madison WI,* [2]*International Livestock Research Institute, Nairobi, Kenya.*

Factors affecting longitudinal patterns of resistance of sheep to gastrointestinal nematode parasites in Africa were studied. Data were from Red Maasai (R, 191), Dorper (D, 273) and 1153 crossbred lambs: RxD, DxR, Rx(RxD) and Dx(RxD). Indicators of resistance were log-transformed fecal egg count (LFEC) and packed cell volume (PCV). Traits were recorded from 30d to about 365d of age; number of records per lamb ranged from 1-8. Age trajectories of LFEC and PCV were described with two-stage linear and nonlinear functions. The first stage accounted for within-lamb variation. At the second stage, all parameters of a function were modeled with fixed (breed type and sex of lamb, birth year and age of ewe at lambing) and random (lamb) factors to account for variation between-animals. Estimation was by restricted maximum likelihood using a Laplacian approximation. Likelihood criteria indicated that a 5-term random regression model, based on Legendre polynomials, and another 5-parameter random regression model with linear and quadratic terms on age of lamb (A) and on log (1/A) were supported better by the data. Breed type and sex of lamb, and age of ewe were significant for some parameters and models. The R lambs, females and lambs from 4-year-old and older ewes had higher levels of PCV than other lambs. Effects of fixed factors on LFEC were not as clear as for PCV. In general, factors associated with higher levels of PCV were associated to lower levels of LFEC. There was significant variation between trajectories of individual lambs. Results suggest that modifying patterns of disease resistance indicators may be possible by exploiting variation between and within breeds.

Key Words: Gastrointestinal parasites, Nonlinear mixed effect, REML

27 Economic values for meat quality traits. P. Chen*, J. C. M. Dekkers, L. L. Christian, and T. J. Bass, *Iowa State University, Ames, IA.*

A method was developed to calculate economic values for pork quality traits for use in genetic selection. The method considers the normal variability of pork quality traits within a herd or population. The parameters required for this method are the mean, standard deviation, and range of the quality trait within the herd or population, and the relationship of the level of the quality trait with price received for pork at the consumer lever. The method was applied to results from a consumer preference study of quality traits of pork loin that was conducted by the National Pork Producers Council. Resulting economic values of percentage of lipid (lipid%), Instron score, and ultimate pH were $.9112, $-.4040, and $-.3469, respectively, per kg loin per unit increase in the trait. Results indicate that efforts to increase lipid% and to decrease Instron score can result in extra revenues for swine production. The sign of the economic value for ultimate pH was opposite to expectations, which is a reflection of the results of this specific consumer preference study. Alternative methods to select for quality traits, such as optimum linear indexes and indexes based on a quadratic aggregate genotype, were discussed.

Key Words: Economic Value, Pork Quality, Quality Trait

28 Correlated responses of uterine and ovarian traits to selection for ovulation rate or uterine capacity in swine. K. A. Leymaster*[1] and R. K. Christenson[1], *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

The objective was to estimate correlated responses of prepubertal uterine and ovarian traits to selection for either ovulation rate (OR) or uterine capacity (UC) in swine. Two replicates (A and B) were established for each OR, UC, and control (CO) line from a four-breed composite population. OR at the estrus of conception was recorded on dams of the OR line. UC per uterine horn was measured as the number of fully-formed pigs born to dams of the UC line that were unilaterally hysterectomized-ovariectomized (UHO) prior to puberty. Boars and gilts from OR and UC dams with the highest records were selected for 11 generations in replicate A and 10 generations in replicate B. Then, intact replicate A gilts were mated within line to replicate B boars; correlated responses of litter size to selection for OR or UC were 2.0 or 1.5 pigs, respectively. UHO were performed at 164 d of age on random samples of 66 CO, 66 OR, and 65 UC gilts produced from crossing of replicates. The length of a uterine horn of each gilt was measured in situ (ISLGTH), excised (ELGTH), and hanging (HLGTH); CV ranged from 16 to 19%. Weights of the excised uterine horn (UWT) and ovary (OWT) were relatively more variable, with CV ranging from 28 to 36%. Differences between means of selected and CO lines were expressed in phenotypic SD and the SE of the difference included terms for drift variance. Gilts from selected and CO lines did not differ significantly for BW at surgery. Selection for OR increased ($P < .01$) ISLGTH (1.2 SD), ELGTH (1.1 SD), HLGTH (1.2 SD), and UWT (1.1 SD), but not OWT (.6 SD, $P > .1$). Effects of selection for UC on ISLGTH (.5 SD), ELGTH (.4 SD), HLGTH (.7 SD), UWT (.2 SD), and OWT (-.2 SD) were not detected ($P > .05$). This is the first swine selection experiment designed to evaluate conceptual interactions between OR and UC that affect fetal survival and litter size. Selection for increased OR at the estrus of conception in an annual production system enhanced prepubertal uterine development.

Key Words: Swine, Selection Responses, Reproductive Traits

ENVIRONMENT AND LIVESTOCK PRODUCTION

29 The behavioral and physiological responses of pigs to segregated early weaning. Y. Yuan*, M. Tauchi, and A. J. Zanella, *Department of Animal Science, Michigan State University, East Lansing, MI.*

Segregated early weaning (SEW) is a management system developed to control diseases and increase reproductive efficiency. The swine industry is adapting SEW system rapidly with little information about its potential effects on pig welfare. The concentration of cortisol, a stress hormone, in urine and saliva samples and the development of abnormal behavior were monitored in pigs weaned at different ages. In experiment 1, pigs were weaned between 9 and 13 d of age (SEW, n=23), or kept with the sows (control, n=23). Behavior observation was carried out immediately after weaning, and at days 1, 2 and 3 post-weaning. Urine samples were collected one day before weaning and at days 1, 3 and 5 post-weaning. In experiment 2, pigs were weaned between 9 and 12 d of age (SEW, n=24) or between 20 and 23 d of age (CW, n=23). Pigs were video recorded daily for a week after weaning, then weekly until they were 8 weeks old. Data were collected for 5 min every half-hour from 900 to 1800 h. At 10 weeks of age, pigs were mixed, loaded and transported for 20 min. Basal and post-transportation saliva samples were collected. The SEW pigs in experiment 1 spent less time lying on day 1 post-weaning than control pigs (% of observation time, 44.68±0.04 vs. 65.23±0.04, $p<0.001$). Belly-nosing behavior started 2 days after weaning in SEW pigs and no occurrence of this behavior was recorded in control pigs. The urinary cortisol concentration (nmol/l) was higher in SEW pigs than in control pigs both at days 1 and 3 post-weaning (456.8±92.7 vs. 102.5±17.9, 521.6±75.3 vs. 168.4±40.0 respectively, $p<0.005$). In experiment 2, transportation caused a 7-fold increase in salivary cortisol, but there were no differences between treatments in basal and post-transportation samples. The SEW pigs showed a higher frequency of belly-nosing than CW pigs in both week 5 and week 7 of age ($p<0.01$). That is 30 and 44 d post-weaning for SEW pigs, 19 and 33 d post-weaning for CW pigs, respectively. The sustained high levels of urinary cortisol in SEW piglets suggests that stress may be associated with the development of behavioral abnormalities. However, cortisol response to transportation was similar for both SEW and CW pigs, indicating a lack of long term consequences of weaning age on the control of the stress axis.

Key Words: Segregated early weaning, Abnormal behavior, Cortisol

30 Effect of housing systems on pig performance in the nursery and grow-finish stages.

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Two trials (Summer and Winter) were conducted in which littermate (17-d of age) barrows and gilts (PIC line 355 x Camborough 22) were allotted to either a nursery unit for five weeks and then transported to a grow-finish unit (NF), or to a grow-finish unit from weaning to market (WF). Both trials were 2 x 2 factorials (barrows or gilts; location of weanling pigs, nursery vs grow-finish unit) involving 240 pigs per trial. Pigs weaned into the nursery unit were allocated .17m^2 per pig, whereas those pigs in the grow-finish unit (NF and WF) were provided .68m^2 per pig. The grower-finisher building was mechanically ventilated with fully slatted floors. Heat lamps (250 and 150 watts) were provided, for 1 and 4 weeks, respectively for the WF pigs. All pigs were fed standard commercial diets that exceeded NRC recommendations. During the initial five weeks (starter phase) of trial 1 (Summer trial initiated on June 29, 1997) pigs in the grow-finish unit had significant ($P \leq .05$) improvements in ADG (10.1%) and ADFI (7.2%) compared to those in the nursery unit. There was no significant difference, however, throughout the grower-finisher stage (18 to 127 kg) due to pigs previously weaned into a nursery unit vs those weaned directly into the grow-finish unit. In the grower-finisher stage there were significant main effects for sex: barrows had increased ADG and ADFI, but had a lower fat-free lean index compared to gilts. In trial 2 (Winter trial initiated on January 20, 1998) WF pigs had increased ($P \leq .06$) ADFI (9.9%) during the starter phase compared with NF pigs. No significant performance differences occurred in the grower-finisher stage for NF compared to WF pigs. Barrows had significant improvements (grower-finisher stage) in ADG and ADFI, but a significant reduction in G/F compared to gilts. These data suggest that NF pigs perform similarly to WF pigs in the grower-finisher stage.

Key Words: Pigs, Housing, Environment

31 Interaction of nursery and grow-finish space allocation on performance from weaning to slaughter.

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At weaning (5.4 kg), mixed sex crossbred pigs were assigned to nursery pens with space allocations of .16 (CN) or .23 (UN) m^2/pig. Nursery pen size was constant within station and space allocation was achieved by varying the number of pigs per pen. Final weight out of the nursery (22.4 vs 21.1 kg), ADG (.425 vs .400 kg/d) and ADF (.646 vs .602) were increased ($P<.005$) for the UN vs CN treatments. Intact pens were moved to grow-finish facilities. Within nursery treatments, grow-finish space allocations were .60 (CF) or .74 (UF) m^2/pig to slaughter at 109.6 kg. There was no interaction ($P>.15$) of nursery by grow-finish space allocation nor any effect of grow-finish space allocation on grow-finish ADG, ADF or gain:feed (G:F). Treatment means for CNCF, CNUF, UNCF and UNUF were: .822, .820, .829, and .834 kg/d ADG; 2.377, 2.403, 2.396 and 2.427 kg/d ADF; .345, .342, .346 and .344 kg/kg G:F. Likewise there was no interaction of nursery and grow-finish allocation on estimated carcass lean, there was an effect ($P=.052$) of grow-finish allocation with pigs given less space having higher predicted carcass lean (52.2% vs 51.7% for CF vs UF, respectively). There was no effect ($P>.15$) of space allocation on lean gain or lean gain efficiency during the grow-finish period. There was no nursery by grow-finish space allocation for interaction performance from weaning to slaughter. There was an increase ($P<.05$) in ADG (.718 vs .700 kg/d) and ADF (1.915 vs 1.867 kg/d) for UN vs CN on wean-finish performance. These results suggest there is limited, if any, interaction between space allocation decisions in nurseries and space allocation decisions in grow-finish facilities. These results suggest the two production phases are independent with regard to the effects of space allocation.

Key Words: Pigs, Space requirements

32 Indomethacin prevents sickness and hypothermia in early neonatal pigs injected with lipopolysaccharide (LPS).

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Loss of body temperature is a well-recognized contributing factor to morbidity and mortality in piglets. Using LPS as a model for infectious challenge, we recently reported a significant hypothermic response in early neonatal pigs (Matteri et al., Dom. Anim. Endocrinol. 15:397, 1998). Prostaglandins are known to be involved in the LPS-induced hypothermia that occurs in rodents housed at cool environmental temperatures. Accordingly, the objective of this study was to evaluate the effect of pretreatment with indomethacin (IND), a prostaglandin synthesis inhibitor, on sickness and hypothermic responses to LPS in one-day-old piglets. Ten mg IND/kg or vehicle (0.1 M Na_2 C0 $_3$) was administered i.p. 1 hr prior to i.p. injection of 150 ug LPS (0111:B4, Sigma Chem. Co.) or sterile saline. Forty-one piglets were utilized (LPS, n = 11; IND, n = 9; IND + LPS, n = 11; Control, n = 10). Piglets were injected with IND or vehicle while still with their sows. One hr following IND the animals were quickly moved to a pen contained in an 18°C environmental chamber and injected with LPS or saline (time 0). Rectal temperatures were obtained from 1 to 3 hr at 15 min intervals and signs of sickness (diarrhea, vomiting, not huddling) were monitored continuously. A significant incidence of vomiting was observed in the LPS group at .75 and 1 hr ($P < .01$). Diarrhea occurred in a significant number of the LPS piglets from .25 to 1.5 hr ($P < .05$). Huddling was reduced in the LPS piglets from .5 to 1.25 hr ($P < .05$). Injection of LPS induced a transient loss of body temperature between 1 and 2.75 hr ($P < .0001$). Body temperatures did not differ among Control, IND, and IND + LPS groups. There was no observable hypothermia or signs of sickness in LPS-injected animals pretreated with IND. Treatment with IND alone had no effect on any of the endpoints. Pretreatment with IND, likely through inhibition of prostaglandin synthesis, completely prevented the presently observed immunophysiological responses to LPS.

Key Words: Piglet, Body Temperature, Lipopolysaccharide

33 A comparison of peri- and post-parturient behavior in Yorkshire (Y) and Meishan (M) gilts.

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Piglet mortality continues to be a major problem in the swine industry, with 10.5% of live-born piglets dying before weaning. Of these deaths, piglet crushing accounts for most of the losses, and has increased from 40.4% in 1990 to 48.7% in 1995. Crushing may be due to poor maternal behaviors in our American production breeds. Meishan sows are characterized as having larger litters with higher survival rates than American breeds. Thus, this study was designed to quantify the peri- and post-parturient behavior between Y and M gilts. Six Y gilts and their litters (10.3 ± 1.7) and eight M gilts with litters (11.8 ± .86) were housed in .6 m by 2.1 m pens, in which they could turn around. Data were collected on sows using time-lapse photography (1 frame/ .4 s) for a 3-d duration at the initiation of farrowing. The frequency and duration of standing, head and body turns 10 s before lying, position changes while lying, and the amount of time it took the sow to complete lying down were recorded. The type of lying behavior was categorized as a body flop (an uncontrolled drop to the gilt's side), lean and lie, kneel and lie, sit and lie, or sternal lie. Farrowing duration, birth interval, crushing and birth weight were also recorded. Data were analyzed by 6-h periods using Wilcoxon-Mann-Whitney statistics. There was no difference between Y and M gilts in litter size, farrowing duration, crushing or birth interval ($P > .15$). Frequency (per period) and duration (s) of standing were greater ($P < .04$) in Y gilts (5.5 ± 2.5, 387.7 ± 27.9) than M gilts (.75 ± .31, 200.9 ± 46.5). The M gilts took less time ($P < .001$) to lie down (4.06 ± .48) than the Y gilts (7.90 ± .30). Meishan gilts tended to perform more head turns before lying down, but performed more position changes while lying than Y gilts ($P = .09$). Yorkshire gilts performed a body flop when lying more often than M gilts ($P < .05$). This study suggests that the lower incidence of crushing by Meishan dams may be due to those animals being less active, checking for piglets more often and lying down more quickly and carefully.

Key Words: Pigs, Maternal Behavior, Crushing

34 Tail-docking alters behavior but not acute phase proteins of young dairy calves. S.D. Eicher* and J.L. Morrow-Tesch, *USDA-ARS, West Lafayette, IN.*

Previously we have shown that the banding process of docking minimally affects mature cows' behavior and physiology, but cutting off the necrotic tail increased haptoglobin and the docked cows had more flies on rear legs and exhibited more fly avoidance behaviors. Because many producers dock young calves while they are in hutches where fly problems are more pronounced, we investigated changes in behavior and physiology of young calves following docking by banding. Twenty calves (3-5 wk of age) were assigned to a docked or control group. After applying a band to dock the tail, calves were tested every 15 min for sensitivity to heat below the band. Calf behavior was recorded for 24 h pre- and post-banding. After 3 wk, tails were removed and then one week later, fly counts and fly avoidance behaviors were observed. Tails were sensitive to heat for 60-120 min post-banding (mean 87 min). Banded calves were more active than control calves during the 2 h following banding. Percent of time spent lying was greater for control calves (6 vs 31, P<.005) and percent of time spent walking was greater for docked than control calves (20 vs 7, P<.005). More importantly, movements of the head to touch the tail were increased for banded calves (1 vs 8 movements per observation, P<.01). Rear leg fly counts were greater on banded calves in the afternoon (P=.06), but no differences in fly avoidance behaviors were evident at noon or in the afternoon. Only ear twitches were greater for the docked calves in the morning. The two acute phase proteins measured, haptoglobin and alpha$_1$-acid glycoprotein, were not different. This research shows that young calves' behavior was changed following tail banding and that docked calves have increased fly numbers on rear legs, but haptoglobin was unaffected.

Key Words: Tail-docking, Behavior, Calves

35 Feedlot performance and carcass characteristics of early weaned steers. J. M. Barker*, D. D. Buskirk, S. R. Rust, and M. E. Doumit, *Michigan State University, East Lansing, MI.*

Twenty-three Angus-sired steer calves from primiparous Angus crossbred heifers were used to determine the effects of early weaning on feedlot performance and carcass characteristics. Steers were assigned by birth date to one of two weaning treatments. Steers were weaned at an average of 100 d (EW) or 200 d (NW) of age. Following a 28 d adjustment period after weaning, steers were given ad libitum access to a high concentrate diet (90% dry whole shelled corn). Steers were harvested when 12th rib fat thickness averaged 1.1 cm within treatment as estimated by ultrasound. Carcass measurements were taken 48 h postmortem. After steaks were aged 14 d, tenderness was determined by Warner-Bratzler shear force and myofibril fragmentation index (MFI) was measured to determine the extent of proteolysis. The EW steers spent more days on feed than NW steers (253 d vs 209 d), yet there was no difference in DMI between treatments (P=.86). The EW steers had better feed efficiency through the feeding period compared to NW steers (.23 vs .20; P<.05). Carcass weights were lighter for EW steers relative to NW steers (271 vs 300 kg; P<.05), with two EW carcasses weighing less than 250 kg. There was no difference in yield grade between treatments (2.9 vs 2.8; P=.69), however, early weaning improved the percentage of carcasses grading Mid-Choice or greater (100 vs 64%; P<.05). Steaks from EW and NW steers had similar Warner-Bratzler shear force values (2.9 and 2.8 kg; P=.65) and MFI's (86.0 and 96.5; P=.19). Early weaning steers at 100 d of age resulted in lighter carcass weights and improved feed efficiency, marbling scores, and percentage of cattle grading Mid-Choice or higher.

Key Words: Early weaning, Cattle performance, Tenderness

36 Effects of pre-shipping vs arrival medication with tilmicosin phosphate and feeding chlortetracycline on health and performance of newly received beef cattle. G. C. Duff*, D. A. Walker, K. J. Malcolm-Callis, M. W. Wiseman, and D. M. Hallford, *Clayton Livestock Research Center, New Mexico State University, Clayton, NM USA.*

Our objective was to determine effects of pre-shipping (PRE) vs arrival (ARR) medication with tilmicosin phosphate (MIC; Exp. 1, 2, and 3) and feeding chlortetracycline (CTC; 22 mg/kg of BW from d 5 to 9; Exp. 2 and 3) on health and performance of beef calves received in the feedlot (Exp. 1 and 2) or on irrigated wheat pasture (Exp. 3). Ninety-six steers (Exp. 1), 240 (Exp. 2) and 108 (Exp. 3) steer and bull calves were used. For Exp. 1, treatments included no MIC (CON), PRE, and ARR. For Exp. 2 and 3, treatments were arranged in a 3 x 2 factorial. Treatments included CON, PRE, and ARR; either with CTC or without CTC. For Exp. 2, serum concentrations of IgG and alpha-1-acid glycoprotein (AGP) were determined on samples collected on d 0, 5, 10, and 28 and d 0, 5, and 10, respectively. No MIC x CTC interactions were observed. No differences were noted among MIC or CTC treatments in any of the experiments for ADG, daily DMI, or feed:gain ratio for the overall receiving periods. For Exp. 1, percentage of steers treated for bovine respiratory disease (BRD) was decreased (P < .05) for MIC-treated animals vs CON (71.9, 45.2, and 46.9 for CON, PRE, and ARR, respectively); and the week that calves were treated for BRD differed (P < .10) among treatments. For Exp. 2, calves treated for BRD was decreased (P < .01) for MIC-treated steers vs CON and decreased (P < .05) for ARR vs PRE (40.0, 18.7, and 7.5% for CON, PRE, and ARR, respectively). Percentage of calves treated for BRD was decreased for MIC-treated calves vs CON during Exp. 3. No differences among CTC treatments were observed for calves treated for BRD. Averaged across d, serum IgG was decreased (P < .05) for MIC-treated steers vs CON, with no differences noted among treatments for AGP. Results suggest that pre-shipping medication programs are no more effective than arrival medication programs using tilmicosin phosphate.

Key Words: Beef cattle, Disease, Antibiotics

37 Detection of *Mycoplasma bovis* in bulk milk samples submitted for somatic cell counting by nested polymerase chain reaction. C.C. Pinnow[1], J.A. Butler*[1], K.P. Sachse[2], H.H. Hotzel[2], L.L. Timms[1], and R.F. Rosenbusch[1], [1]*Iowa State University, Ames, Iowa,* [2]*Institute for Veterinary Medicine, Jena, Germany.*

Mastitis due to *Mycoplasma bovis* can be a problem for dairy farmers, and often there is a need to sample milk from every cow in the herd to isolate or remove subclinical carriers. Herd health programs in use at most U.S. dairy farms already involve the sampling of milk from every cow for somatic cell counting, but these milk samples are preservative-treated and therefore not amenable to culture for mycoplasmas. By using the highly sensitive and specific nested polymerase chain reaction (PCR) approach, these already available milk samples can be rapidly tested for the presence of *M. bovis* DNA. Therefore, this is a major advantage to veterinarians, since obtaining individual cow milk samples is an expensive and time consuming process, often resisted by farmers. For isolation of *M. bovis* DNA from milk, a procedure for the rapid extraction of DNA from fecal samples was modified. This involved the use of a cationic surfactant to eliminate those substances in milk which inhibit PCR. Mycoplasma-free, preservative-treated milk was inoculated with a known number of *M. bovis* cfu's. After purification of the milk, the final product was used as a template for the nested PCR reaction. This procedure resulted in a sensitivity of less than 5 cfu equivalents. A comparison of culture and the nested PCR reaction was performed with 53 untreated field samples submitted for *M. bovis* testing. The nested PCR diagnostic method demonstrated 100% verification of the 8 samples positive by culture and also amplified 23 others that were negative by culture. Thus, the nested PCR method has a finer sensitivity than culture and can be used on preservative-treated milk.

Key Words: *Mycoplasma bovis*, nested polymerase chain reaction

38 Use of estradiol to stimulate postnatal viability in piglets less than 1.5 kg at birth. B.A. DeMontigny*, R.M. Weigl, and J.E. Tilton, *North Dakota State University, Fargo, ND.*

Preweaning deaths of piglets represent a major loss to the swine industry,comprising as much as 20 percent in some herds. Our study was designed to test a potential method for overcoming a significant portion of that loss. Piglets that weighed less than 1.5 kg at birth were assigned to receive either 0.2 mg estradiol in 2.0 ml of sesame oil (N=124) or sesame oil alone (N=110) as soon as the litter birth process had been completed. All injections were administered intramuscularly in the neck region using a 20 gauge one-half inch hypodermic needle. The parameters evaluated were survival rates and growth rates to seven days and weaning. Analysis of variance and chi-square statistical procedures were applied to test these parameters. Survival rates of piglets weighing less than 1 kg were enhanced by the estradiol treatment (90.0% vs. 57.0%,

P≤ .02). Survival rates of piglets born with birth weights of 1.0-1.5 kg were not influenced (P≥ .10) by the estradiol treatment. Female piglets generally had greater survival rates than male piglets, especially at birth weights of less than 1.3 kg. Estradiol treatments did not alter growth performance (P ≥ .10) at seven days of age or at weaning (21 days). As litter size increases, the occurrence of piglets born at weights less than 1 kg increases. Use of estradiol treatments to stimulate survival and increase competitiveness at the udder facilitates economic gains in pork operations with minimal inputs of labor and materials.

Key Words: Piglets, Estradiol, Survival Rate

39 Effect of 21-day weaning weight, nursery feeding and management program and sex on pig performance to 56 days of age.

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Growth of piglets following weaning was evaluated utilizing a total of 160 piglets in a complete randomized block design arranged in a 2 x 2 x 2 factorial with the treatments being 1) weaning weight, [Heavy (H) vs. Light (L)], 2) nursery feeding and management program [Liquid Milk System (MS) vs. Conventional System (CS)], and 3) sex [Barrows (B) vs. Gilts (G)]. Piglets were weaned at 212 days of age, weighed and classified as either H or L and then placed into either the MS or CS nursery and penned in like-sex groups of four pigs. The study was broken into two periods; period 1 (21- 35 days of age) and period 2 (36 - 56 days of age). In period 1, MS piglets were placed into a nursery equipped with automated milk feeding equipment and given ad libitum access to a liquid milk diet for seven days and then a dry pelleted phase I diet for seven additional days, piglets on the CS were given ad libitum access to the dry phase I diet for the entire period. For period 2, all piglets were placed into the conventional nursery and fed a phase II and phase III diet for a further 14 and 7 days, respectively. There were no treatment interactions for any variables studied. H pigs were significantly heavier than L pigs at birth (1.7.03 vs. 1.4.05 kg, P<.001), weaning (5.5.04 vs. 3.9.07 kg, P<.001) and 56 d of age (20.7.33 vs. 17.2.52 kg, P<.001). For period 2, H pigs had higher ADFI (79820.6 vs. 70332.6 g, P<.01) and ADG (52011.9 vs. 45419.0 g, P<.01) than L pigs. Gain/feed was not affected by piglet weaning weight in period 2. Piglet weights were similar for both nursery treatments at weaning (4.7.05 kg, P>.10), but MS pigs were heavier at the end of period 1 (9.1.18 vs. 8.2.18 kg, P<.001) and 2 (19.4.39 vs. 18.4.39 kg, P<.05) compared to CS pigs. ADFI and ADG were not affected by nursery treatment, however, gain/feed tended to be higher (.66.012 vs. .64.012, P<.10) for MS pigs compared to CS pigs for nursery period 2. Sex did not impact the growth performance of pigs to 56 days of age. The H and L pigs on the MS compared to the CS program were heavier at 14-d post weaning and this advantage was maintained to 56 days of age (35-d post weaning).

Key Words: Weanling pigs, Performance, Management

40 Evaluation of genotype, therapeutic antibiotic and health management effects on swine lean growth rate.

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Two hundred eighty eight pigs from two genetic populations differing in percent lean were used to evaluate pig performance 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). Pigs were weighed every three weeks and serial real-time ultrasound measurements were taken on 2 pigs/pen. Between 51 days of age and slaughter, YL/Dur pigs had greater ADG (3.5%; P<.01) and ADFI (6%; P<.001), but the EUR pigs had higher G:F (.37 vs .36; P<.01). Genetic by environment interactions in ADG (P<.05) were; EUR pigs had greater ADG in the SEW (848 g/d) than in the CON (771 g/d), YL/Dur pigs had similar ADG in the SEW (848 g/d) and CON (821 g/d) environments. Pigs receiving the VAC treatment had greater ADG (P<.001) and ADFI (P<.001) than CT treated pigs. Environment by treatment interactions existed for ADG (P<.01); the VAC pigs had a greater increase in ADG in the CON (68 g/d) than the SEW (18 g/d). A genetic by environmental interaction for days to 113 kg existed (P<.01); the EUR pigs took one day less to market weight than the YL/Dur pigs in the SEW, but were 10 days slower in the CON. This research demonstrates that differences in environmental sensitivity exist between genotypes and the use of management techniques, vaccination and medication, can aid in maintaining performance in lower health status environments.

Key Words: Pigs, Environment, Genotype

41 Development of a swine forum by the swine production class and its efficacy in affecting opinions.

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In response to the controversy surrounding pork production, the Swine Production class developed a Swine Forum to provide an arena for a balanced discussion of the issues. The 58 students identified the 5 most controversial issues surrounding pork production in South Dakota, and were then divided into 7 groups. Five of the groups were responsible for identifying and arranging 2 speakers with opposing views for each of their specific topics (odor, environment, health of people and animals, business structure, and the anti-corporate farming amendment (Amendment E)), and the other two groups were responsible for publicity and facilities. During the Forum, speakers had 10 minutes to present their information, and after all were finished, a question and answer period was held. Each of the approximately 200 people attending was given notecards for questions and a survey. The front of the survey was to be completed before the Forum to establish a baseline of opinions, and the back of the survey with the same questions was completed after the Forum to measure any changes in opinion on the topics covered. Participants were given statements and on a 10 point scale, asked at what level did they agree or disagree with them. The survey also identified the audience by gender, occupation, ag background, and age. Ninety-eight of the surveys were properly completed, and the data were analyzed as repeated measures. Of the 11 statements made, peoples opinions changed on two of them. There was a better understanding of Amendment E (P<.03), and a tendency to have less confidence (P<.11) that facilities can be designed and operated to protect the environment. There were gender differences (P<.05) for support of all business structures, occupation differences (P<.05) for risks associated with large-scale livestock operations, and tendencies for age differences (P<.10) on business structure and risks of large-scale operations. The Swine Forum, developed and conducted by students, affected opinions on issues controversial to pork production in South Dakota.

Key Words: Swine, Students, Forum

42 Laboratory methods in animal reproduction.

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Strategies for innovations in laboratory exercises, 4 h weekly, focused on principles of animal reproduction, including endocrinology of growth and mammary function, are reviewed. Individual student is required to collect and evaluate boar and bull semen, and present written report of a selected special topic on livestock reproduction. The report may review contemporary literature or summarize results from a laboratory experiment (i.e., freezing bull or boar semen; fructolysis index of bull or ram semen; blood collections from cyclic pigs or cows for progesterone radioimmunoassay; monitor rat estrous cycles and pseudopregnancy by vaginal lavage; neurogenic control of oxytocin secretion by suckling induced lactation response in rats; hormone induced parturition in rats; relaxin induced interpubic ligament formation in immature mice; growth and tibia epiphyseal plate measurement in hypophysectomized immature rats given daily GH or PBS treatment compared with PBS treated intact controls; bovine embryo/fetal age and cotyledonary/caruncle development). All students review comparative anatomy (macro and micro) of male and female reproductive system in farm animals and the rat, histology of male and female gonadal and reproductive duct differentiation (pig and human), sagittal sections of central nervous system, histology of coronal sections of porcine pituitary gland, boar and bull semen dilution and artificial insemination,

porcine surgical and bovine non-surgical embryo recovery and transfer, endocrine aspects of growth and reproduction by GH, androgens, LH, FSH, PMSG, hCG, estrogens in immature male and female rats, horse and ram semen collection and insemination, estrous synchronization, superovulation, bovine freemartin, normal reproductive behaviors, rectal palpation of cattle for ovarian and uterine changes characterizing estrous cycles and detection of early pregnancy, electroejaculation of bull and ram; hormone/hormone receptor interaction for biological action, herd health for reproductive efficiency, hormone induction of parturition in cattle, sheep and swine, and postpartum fertility in cattle.

Key Words: Teaching, Innovations, Laboratory

43 The effect of steers grazing 1/2 vs 3/4 season native grass pastures.

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Mixed breed steers (256 kg) grazed burned native grass pastures (1990 to 1998). The steers were in a continuous grazing system and were allotted randomly to either 1/2 or 3/4 season pastures. The steers that grazed 1/2 season (1/2)(from April to July 15 - 81 d) were stocked at 1 steer to .81 hectares, while steers that grazed 3/4 season (3/4)(from April to August 15 - 112 d) were stocked at 1 steer to 1.21 hectares. The steers consumed a standard mineral mixture with no additional supplementation. The grass composition was measured at the start and end of the nine-year grazing period. The economics of steers grazing the two systems were determined by calf and feeder cattle prices at Dodge City adjusted to Southeast Kansas. The steers grazing 1/2 gained more per day (1.263 kg vs 1.127 kg, P<.01), but gained less (P<.01) per season (102.3 kg vs 126.2 kg). There was no change in percentage composition between systems for big bluestem, little bluestem, switchgrass, total perennial grass, or total perennial forbes. However, Indiangrass increased more (P<.05) during 1/2 vs 3/4 grazing. Percent basal coverage increased more (P<.05) in 1/2 compared to 3/4 grazing. The economical consideration of grazing systems depends on the viewpoint of the person. The 1/2 had a higher return per acre, but the 3/4 had a higher return per head. The landowner who also owns the cattle would prefer the 1/2 grazing; however, the cattle owner who rents the grass and hires the labor would prefer the 3/4 grazing because of fixed costs of cattle and the additional total gain from 3/4 grazing. In this study, grazing systems did not reduce grass composition during the nine-year period.

Key Words: Grass, Stocker, Grazing System

44 The effect of starting weight, body condition, and age on gain of cattle grazing native grass.

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In 29 trials (over 10 years), 6,614 head of cattle (heifers - 11 trials, 2,862 hd; steers - 18 trials, 3,752 hd) were used to determine the effect of starting weight on gain of steers and heifers grazing burned native grass pastures. The heifers grazed an average of 81 d (70 to 93) and steers an average of 86 d (75 to 99) from April to July. The cattle were stocked at one animal per .81 hectares. The cattle were sorted by starting weight into groups as follows: below 181.4 kg, 181.8 to 226.8 kg, 227.3 to 272.3 kg, 272.7 to 317.7 kg, and above 318.2 kg. In three other trials with yearling heifers (613 hd), the heifers were sorted by starting weight, as shown above, and body condition score from 1 to 5 (1 being the thinnest, and 5 being the fleshiest). A separate trial was conducted in which 158 yearling steers were compared to grazing 103 calves. The yearlings were spring born and wintered on wheat pasture; the calves were fall born. Heifers that weighed between 181.8 to 226.8 kg at the start of the grazing season had the best gain. They gained significantly more (P<.08) than heifers that weighed more than 272.7 kg. The steers with starting weights between 181.8 to 226.8 kg and 227.3 to 272.3 kg gained significantly more (P<.01) than other weight groups. Steers gained more than heifers (1.04 kg vs .86 kg/d, P<.0007). As heifers became fleshier, gain declined in all weight groups. Fall born steer calves (202 kg) gained less (1.11 kg vs 1.22 kg, P<.004), compared to spring-born yearling steers (265.7 kg). In these studies, the optimum weight for cattle to graze was 181.8 to 226.8 kg for heifers and 181.8 to 272 kg for steers. Yearling steers gained better than calves. Therefore, sex, age, and starting weight of cattle affects the gains while grazing burned native grass pastures. The optimum weight for best pasture gain may vary by forage type and quality, but it is clear that there is an ideal weight range for stocker cattle used for grazing.

Key Words: Stocker, Starting Weight, Grass

45 Practical lessons in feeding bison bulls for meat.

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Three on-farm bison feeding trials were conducted using a 4 x 4 Latin Square design with 80 d feeding periods and 20 bison bulls per cell. Objectives of the respective trials were to evaluate palatability of alternative feeds, compare effects of energy level and grain processing, and study feed delivery methods for bison bulls fed for meat. Effects of season were also evaluated. In trial 1, bison bulls (n=78, avg initial wt 213 kg) consumed equal (P>.10) amounts of concentrate diets (69% of DMI) formulated with wheat midds, wheat screenings, crambe meal or a proprietary commercial formulation. Grass hay was offered free choice to all bulls. Daily gains from screenings diets (.78 kg) were greater (P<.10) than crambe meal (.69 kg) with the other diets intermediate (.73 kg). DM intake as a percent of body wt was not affected by season (P>.10) but daily gains were reduced (P<.10) during winter (.17 kg) compared to the other three seasons (.74 kg). In trial 2, treatment diets were wheat screenings, rolled corn, rolled waxy corn, or whole waxy corn with grass hay offered free choice. Bison bulls (n=80, avg initial wt 273 kg) gained faster (P<.10) on the rolled corn diets (.75 kg), followed by the whole corn diet (.66 kg), and wheat screenings (.66 kg). DM intake was similar (P>.10) for all treatments (69% concentrate). Daily gains during the winter (.45 kg) were less (P<.10) than the other three seasons (.78 kg). In trial 3, four feed delivery systems were compared using 78 bison bulls (avg initial wt 296 kg). Concentrate (wheat screeings pellets) was fed in a self feeder; fenceline bunk; or programmable feeder (63% of DMI) with grass hay free choice. The fourth treatment was chopped hay and concentrate fed as a TMR in a fenceline bunk. Concentrate and dry matter intake was greater (P<.10) for the TMR diet. Hay intake was greater and concentrate less (P<.10) for the self feeder. No differences (P>.10) in gain or feed efficiency were observed. Performance of bison bulls can be influenced by diet or feed delivery system and are affected by season.

Key Words: Bison, Feeding, Season

46 Effect of pre-weaning and/or pre-vaccination on weight change during the weaning process.

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Sixty-four fall-born suckling calves (224 kg initial BW) were used in a study to evaluate the impact of pre-shipment vaccination and/or weaning on weight change of calves at different times during the weaning process. Calves grazed with their dams in eight groups on 8 different pastures of *Neotyphodium coenophialum*-infected fescue. Calves were allocated randomly to four treatments in a 2 x 2 factorial arrangement of a split-plot experiment to compare early (EW) with late weaning (LW) and pre-weaning (EV) with no pre-weaning vaccination (LV). Four calves within each group were vaccinated against IBR, BVD, PI_3, BRSV, five strains of *Leptospira sp.*, *H. somnus*, and *Pasturella haemolytica* on April 16 (d 0); four calves were not vaccinated. Four groups of calves were weaned in a 1-ha lot on April 30 and fed bermudagrass hay. At 0700 on May 14 (d 28), calves were gathered, weighed, transported approximately 16 km to an auction barn, and placed in 2 pens (5 x 10 m) without feed and water. Calves were weighed at 1930 then placed in 4 pens (5 x 10 m) with access to water only. Calves were returned to the research facility at 0830 on d 29, weighed, vaccinated against the previously-mentioned organisms, and placed in eight .4-ha lots. Calves were weighed on May 18 (d 32) and moved to pastures of rye and annual ryegrass. Weights were recorded on May 22 (d 36) and 28 (day 42) and June 4 and 5 (d 50). Weights tended (P < .10) to be less for EW-LV than for the other treatment groups on d 28, 32, 36, and 42. At the auction barn, EV calves weighed 5.9 kg more (P < .05) than LV. Weight gain from d 0 until d 50 was greater (P < .05) from LW compared with EW. Weight losses resulting from transportation to and from the auction barn did not differ (P > .10) among treatment combinations. Pre-weaning vaccination of calves may result in heavier calves at an auction barn,

but early weaning may reduce calf weight 3-wk following return from the auction barn.

Key Words: Vaccination, Weaning, Calves

47 Effects of gestation housing on reproductive performance of primiparous sows.

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The effects of swine gestation housing on reproductive performance of primiparous sows were evaluated at the Iowa State University Lauren Christian Swine Research and Demonstration Farm near Atlantic, Iowa. The gestation housing systems were: 1) individual gestation crates in a mechanically ventilated, partially slatted floor, manure flush building (CRATE); 2) group pens in a naturally ventilated, curtain-sided, partially slatted floor, no bedding, deep manure pit building (C); and 3) group pens in deep bedded, naturally ventilated hoop structures (H). Gilts were naturally mated in a centralized, slatted floor confinement breeding barn. Three to seven days after breeding, the gilts were randomly assigned to one of the gestation systems. The gilts were Yorkshire x Landrace or Hampshire x Yorkshire/Landrace in approximately a 1:1 ratio. Duroc terminal boars were mated to all gilts. The group-housed gilts were individually fed using either individual feeding stalls (FSTL) or electronic computerized feeders (EFDR). Boars were used daily to heat check. The percentage of gilts that were assumed bred that returned to estrus was 13.4%, 19.3%, 13.5%, 17.2%, and 12.7% of the total number of services for the system, CRATE (n = 276), C-FSTL (n = 150), C-EFDR (n = 141), H-EFDR (n = 122), and H-FSTL (n = 134), respectively. The average number of pigs born live per litter was 10.1, 9.6, 9.2, 9.3, and 9.4; the percentage of mummified pigs at birth was 1.2, 1.5, 2.0, 2.7, and 1.1; and the percentage of stillborn pigs was 8.0, 8.6, 9.0., 5.1, and 11.0 for the systems CRATE (n = 130), C-FSTL (n = 64), C-EFDR (n = 60), H-EFDR (n = 49), and H-FSTL (n = 68), respectively. No differences were found (P > .10). The sows farrowed May through September 1998 and are part of a long-term study comparing gestation systems. The reproductive performance of primiparous sows in confinement gestation crates, confinement pens, or deep-bedded hoop structures was similar.

Key Words: Gestation Housing, Reproductive Sow Performance, Hoop Structure

48 Weight gain of steers grazing cool-season perennial grasses in Oklahoma.

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Wheat pasture is an important forage resource for growing cattle in the southern Great Plains. However, cattle must be removed from wheat to be harvested for grain at the first hollow stem stage of maturity in late winter. Complementary, high-quality forage that could be grazed from the first hollow stem stage of maturity of hard red winter wheat (approximately March 7) until warm-season grasses begin to grow (May 15) would benefit management of this grazing program. The objective of this trial was to determine the suitability of cool-season perennial grasses for this purpose. Ninety crossbred steers (258 24 kg) and six pastures at the Wheat Pasture Research Unit near Marshall, OK were used in a 56-day trial (April 3 to May 29, 1998) to measure weight gain of steers grazing three cool-season perennial grasses. The grasses included 'Lincoln' smooth bromegrass (*Bromus inermis* Leyss), 'Manska' pubescent wheatgrass (*Thinopyrum intermedium* (Host)), and 'Paiute' orchardgrass (*Dactylis glomerata* L). Precipitation totals and long-term averages for the months of March, April, and May were 15.42, 8.23, and 7.29 cm; and 6.86, 6.60, and 12.45 cm, respectively. Growth of the grasses was not limited by precipitation. Thirty-seven kg/ha of actual N were applied on March 3. A set stocking rate of 5.29 steers/ha or 1365 kg initial live body weight/ha was used for all grasses. Data were analyzed using least squares procedures of SAS for a completely randomized design with pasture as the experimental unit. There were no differences (P =.42) in average daily gain (.99, 1.00, and .92 kg/d) or gain/ha (292, 297, and 271 kg/ha) for bromegrass, wheatgrass, and orchardgrass, respectively. Results indicate these grasses are highly productive, but that there may not be good synchrony between spring grazing of the grasses and pull-off dates at first hollow stem for cattle grazing early-maturing wheat varieties. The spring grazing period for the cool-season perennial grasses would certainly complement warm-season native range grasses.

Key Words: Growing cattle, Cool-Season perennial grasses

49 Selected fractionate analysis of extruded feed mixtures containing separated solids from liquid swine manure.

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Commingled liquid swine manure from a farrow to finish operation was separated into solid and liquid fractions with a Key Dollar^{TM} separator. Separated swine solids (SSS) were mixed with traditional feedstuffs on a wet weight basis and processed through a single screw dry extruder to determine SSS potential as a feedstuff for livestock. The mixtures with the most satisfactory physical properties, post extrusion, were 1) 50% SSS: 45% soybean hulls (SBH): 5% rolled corn (RC) and 2) 50% SSS: 45% whole soybeans (WSB): 5% rolled corn. Samples were analyzed for percent dry matter (DM), crude protein (CP), ether extract (EE) and total ash (ASH) by AOAC methods, and acid detergent fiber (ADF), cellulose (CELL), lignin (LIG), and acid insoluble ash (AIA) by the detergent method. On a percent basis, SSS contained: 42.46±6.57 DM, 8.80±2.33 CP, 4.20±1.28 EE, 25.14±2.20 ADF, 13.74±3.34 CELL, 10.90±2.35 LIG, 0.35±0.25 AIA, and 8.03±3.29 ASH. Selected element compositions were determined for SSS by atomic absorption spectroscopy and were found below maximum tolerable dietary concentrations for beef, swine and sheep. The element concentrations (PPM) for SSS were: 3.7±2.2 Al, 41.1±8.1 Ca, 0.6±0.3 Cu, 10.6±0.6 Fe, 16.0±2.1 Mg, 2.9±0.8 Zn, 7.2±3.2 P, 3.5±1.4 Co, 0.4±0.7 Cr, 0.9±0.8 Mn, 3.9±1.8 Ni, 44.9±8.8 K, and 18.2±3.8 Na. On a percent basis, the SSS:SBH:RC mixture contained: 75.10±1.14 DM, 10.34±2.49 CP, 1.82±0.48 EE, 41.9±1.47 ADF, 35.84±2.67 CELL, 5.90±1.21 LIG, 0.28±0.13 AIA, and 4.52±0.08 ASH. The SSS:WSB:RC mixture contained: 70.11±1.56 DM, 35.81±2.97 CP, 12.69±0.96 EE, 19.20±1.34 ADF, 7.18±0.26 CELL, 11.94±1.69 LIG, and 5.37±0.27 ASH. Following aseptic collection procedures of extruded feed mixtures total and fecal coliform, E. coli, and heterotrophic bacteria concentrations were below detection limits (< 20 CFU/g). Beef cows readily consumed 100% of the amount offered of both extruded mixtures. These data suggest that extruded feed mixtures containing SSS have potential use as a value added alternative feed for livestock.

Key Words: Extruded, Manure, Alternative feed

50 Comparison of selected fractionate analyses of two types of University food service waste streams regarding their use as a livestock feedstuff.

P. M. Walker, L. K. Karr*, and N. A. Pyatt, *Illinois State University, Normal, IL/USA*.

Twenty-nine samples were taken from each of two different types of food waste collected from the dining centers at Illinois State University to determine their potential as an alternative feedstuff. Cafeteria food waste was collected from traditional cafeteria style food service. In these dining centers, the student pays one predetermined fee for all the food items selected. A la carte food waste came from an itemized pricing food court service, which serves fast food products in which the student pays for each individual item chosen. Samples were analyzed for pH; percent dry matter (DM), ether extract (EE), crude protein (CP), and total ash (ASH) by AOAC methods; and analyzed for acid detergent fiber (ADF), cellulose (CELL), lignin (LIG), and acid insoluble ash (AIA) by the detergent method. Selected elemental composition in ppm was determined by atomic absorption spectroscopy.
Selected Fractional Analysis, %, ppm

Item	pH	DM	ADF	CELL	LIG	AIA	EE	CP	ASH
Cafeteria									
Mean	4.8*	42.51	15.88*	10.07*	5.71	.10*	14.58*	27.90*	4.60
SD	.7	5.13	3.27	3.79	2.01	.29	1.50	4.47	1.33
N	29	29	26	26	26	26	25	29	29
A la Carte									
Mean	5.5*	45.16	50.67*	41.08*	7.42	1.87*	9.27*	14.44*	5.33
SD	.7	7.71	7.68	8.49	3.32	3.07	2.61	3.02	5.47
N	29	29	29	29	29	29	29	29	29

Item	Al	Ca	Cu	Fe	Mg	Zn	P	Mn	Ni	K	Na
Cafeteria											
Mean	4.8	27.2	1.0	5.3	6.6	1.2	6.3	.4	2.8	23.5	26.0
SD	4.4	28.9	2.3	3.6	3.1	1.8	6.1	.5	4.1	19.3	21.0
N	29	26	29	29	29	29	29	29	29	29	27
A la Carte											
Mean	6.8	35.6	2.3	4.8	6.6	1.5	8.8	.8	1.7	15.5	30.0
SD	4.5	32.7	4.5	4.3	8.3	4.1	8.1	.7	1.9	11.6	25.0
N	29	29	29	29	29	29	29	29	29	29	29

These analyses showed that there was a significant difference between the composition of these food waste streams. The cafeteria style food waste was significantly higher in EE and CP and lower in ADF in relation to the a la carte food waste. Physical examination suggested that the a la carte food waste appeared to have less leftover food and a higher paper content than the cafeteria food waste. These analyses suggest cafeteria food waste has greater potential for use as a livestock feedstuff than a la carte food waste.

Key Words: Food waste, Alternative feedstuff

51 Effect of wool/polyester blankets on performance and gain of newborn dairy and beef calves.

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Two concurrent trials were conducted to evaluate the effects of wool-polyester blankets on the health and performance of dairy and beef calves during the winter months. Thirty-two dairy calves reared in hutches and 34 beef calves housed in drylot with barn access were included in factorial designs. At birth, alternate calves were assigned to one of two treatments (Trt): those receiving blankets (B) or the non-blanketed control (N). The dairy trial began December 12, 1997, and the beef trial on January 1, 1998. Both concluded April 14, 1998. Birth weights were recorded and all calves were weighed approximately every 28 days. Differences in ADG were compared for the entire trial as well as within each period. To account for physiological differences attributable to birth dates, a paired analysis was performed. Each calf from B was compared to a counterpart from N with a similar birth date in both breeds. Treatments were compared within similar chronological dates (Per) and similar physiological ages (Age). A paired t-test was used to analyze Trt, Trt × Per and Trt × Age effects. Average temperature was -4.2 C and -1.8 C for the beef and dairy trials, respectively. In both trials, ADG of B was higher than that of N (dairy, $P = .03$; beef, $P = .06$). Dairy calves from B had higher ADG than N during the first Per ($P = .008$) and first Age ($P = .002$). Blanketed beef calves also had higher ADG during the first Per ($P = .006$) and first Age ($P = .001$)than did N. No Trt × Per or Trt × Age effect was observed ($P > .12$). Wool-polyester blankets were effective in improving ADG of calves in the first three months of life during the winter months in North Dakota.

Item	B	N	SEM	n	*P*
Trial ADG, kg					
–Dairy	0.61	0.48	0.04	16	.03
–Beef	0.88	0.70	0.06	17	.06

Key Words: calves, environment, performance

52 Early weaned pig performance in hoop structures during early summer.

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Four groups of early weaned pigs (19 d old) weighing 5.4 kg were used in a 26-d trial to evaluate the performance of early weaned pigs in hoop structures and to compare them to pig performance in a confinement housing system. Three groups of pigs (n=552) were placed in three 9.1 x 18.3 m hoop structures with cornstalk bedding during May and June. The fourth group of pigs (n=159) was placed in six pens (4.0 x 4.1 m) of a mechanically ventilated modular confinement building. The confinement temperature was 29°C and on d 14 this was lowered 1°C every other day. The hoop pigs experienced temperatures from 6°C to 32°C for the 26-d trial. Three diets were fed in phase to all pigs. Pigs consumed 1.36 and 2.72 kg of diets 1 and 2, respectively. Intake of diet 3 was 6.35 and 5.94 kg for hoop and confinement pigs, respectively. Pigs were manually fed three times daily on mats for the first 8 d and then fed twice daily for the next 7 d. For the last 11 d of the trial the pigs were fed *ad libitum*. The pigs were weighed individually at the beginning, midway (14 d), and end (26 d) of the trial. Pig performance was acceptable for both housing systems throughout the trial. Average daily feed intake for the first 14 d was similar for hoop and confinement pigs because the pigs were limit fed ($P > .10$). Hoop pigs ate slightly more feed than the confinement pigs for d 15 to 26 (.587 vs .473 kg/d) ($P < .001$). Average daily gain for the 26-d trial was better for the hoop pigs (.258 vs .202 kg/d) ($P < .01$). The hoop pigs were 1.8 kg heavier at the end of the trial (12.2 vs 10.4 kg). The 0- to 14-d gain-to-feed ratio was slightly higher for hoop than confinement pigs (715 vs 516 g/kg feed) ($P < .06$). The 15- to 26-d and the overall 0- to 26-d gain-to-feed ratios were similar for the two systems. Overall (0 to 26 d) the hoop pigs ate more feed and grew faster but did not differ in feed efficiency than pigs in confinement. Early weaned pigs in hoops during summer performed similarly to pigs in confinement.

Key Words: Early Weaned Pigs, Hoop Structures, Growth

53 Effects of late summer protein or mineral supplementation on rate of gain for steers grazed on tall or midgrass prairie sites.

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Steers (n=225, 239 kg initial BW) were used to determine the effects of supplementation on gains of cattle grazed on tallgrass (TALL) or midgrass (MID) prairie. Cattle were assigned within a replicated 2 x 2 factorial experiment. Steers grazed 12 pastures with similar management and forage and water access from April through September either in southwestern (MID) or north-central (TALL) Oklahoma. Average forage quality for MID vs TALL during late summer over several years has been 13.6 vs 9.3% CP and 64.8 vs 61.5% TDN. Supplements contained monensin (150 mg/(steer*d)) and consisted of: 1) 30% CP (MP, 220 g DIP) fed at 1.1 kg/(steer*d), prorated for three feedings per week and 2) trace mineral salt (TMS) fed ad libitum. Cattle were randomly allotted to pastures in April and supplementation was initiated in June. Rate of gain prior to the initiation of supplementation was similar ($P > .91$) for MP and TMS fed cattle. Similar supplement intakes at both TALL and MID sites were noted within TMS and MP. Cattle fed MP tended ($P < .12$) to have greater ADG vs TMS fed steers (.90, .84 kg) for the season-long (April-Sept) grazing period. A trend ($P < .12$) for a site x diet interaction was noted for ADG during the supplementation period. At TALL sites, cattle fed MP had increased ($P < .01$) late season ADG vs steers fed TMS (1.1, .93 kg) while MP and TMS fed steers at MID sites had similar ($P > .37$) supplementation period ADG. All steers at TALL sites had greater ($P < .01$) late summer ADG than steers fed either MP or TMS at MID sites (.67, .62 kg). Supplement conversions for MP (kg added gain/kg supplement) were calculated using the TMS fed steers as a baseline. Cattle fed MP at TALL vs MID sites had improved G:F (.20, .05) and cost of added gain (1.12, 4.12$/added kg). In a year of favorable forage production, steers grazed on tallgrass prairie benefited from additional protein, while steers grazed on midgrass prairie did not show a rate of gain response from protein supplementation.

Key Words: Forage type , Protein supplementation, Monensin

54 Performance of lactating dairy cows in three different cooling systems.

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Ninety-six Holstein cows (initial days in milk (DIM) = 115) and 60 first calf heifers (initial DIM = 97) were used to evaluate the effectiveness of three cooling systems. The 10-week study was started June 10 and conducted on a commercial dairy near Palmer, KS. Thirty-two multiparous cows and twenty first-calf heifers were assigned to each of three treatments: 1) a single row of 0.91 m fans (5.2 m^3/sec per fan), spaced at 7.31 m intervals over the free stalls and over the feedline (FF), 2)

1.42 m ceiling fans (9.9 m^3/sec per fan), spaced at 7.31 m intervals over the free stalls (CF), and 3) poly-tube longitudinal cooling over the free stalls with four 0.91 m fans (5.2 m^3/sec per fan) (PT). Fans in each treatment ran continuously when the temperature exceeded 23.3°C. The same feedline sprinkler systems were used for each treatment. Sprinklers ran 3 min out of a 15 min cycle when the temperature exceeded 26.7°C, with a designed application of 3.03 L/m of feeding space per cycle. Milk production for FF (40.1 kg/d) was greater than for PT (37.6 kg/d) and CF (37.1 kg/d) (P<0.05). FF led to lower respiration rates (75.3 per min) than CF (83.5 per min) and PT (82.3 per min) (P<0.05). Average change in body condition score was greater for FF (+0.32) than for PT (+0.18) (P<0.05) with CF (+0.22) intermediate. Treatment differences in milk production by mature cows were numerically greater than for first calf heifers. Milk production for treatments FF, CF, and PT, respectively by mature cows was 42.3, 39.6, and 37.3 kg/d and by first calf heifers was 37.9, 35.6, and 36.8 kg/d. Dry matter intake tended to be greater for FF than CF and PT. There were no treatment differences in somatic cell count, % protein, or % fat. These results demonstrate that of the three cooling systems studied, FF was most effective at reducing heat stress, as indicated by increased milk production and reduced respiration rate.

Key Words: Heat Stress, Dairy Cattle, Milk Production

55 The effect of *Bacillus subtilis* C-3102 (Calsporin®) intake on growth performance, and micro-flora of pigs.

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Two hundred fifty-two crossbred pigs were allotted by weight to two treatments and placed randomly into 28 pens. The pen was the observational unit. The two treatments were 1) control diets and 2) control diets + .01% and .002% of *Bacillus subtilis* C-3102 powder (1x10^{10} CFU/g) in nursery and grow-finish diets, respectively. Pigs were weighed every 2 weeks for 42 days. At the end of the nursery stage, fresh feces were collected from two pigs randomly chosen in each pen of 24 pens. Micro-flora in feces were analyzed.

Growth performance	*Bacillus subtilis* C-3102	Control	SEM
ADG, g	486	481	46
ADFI, g	868	899	88
Feed:Gain*	1.79	1.87	.10

Bacteria counted[a]	*Bacillus subtilis* C-3102	Control
*Enterobacteriaceae spp.**	5.4 ± 1.0	6.2 ± .8
*Bacteroidaceae spp.***	4.9 ± .5	5.8 ± .9
*Lactobacillus spp.***	9.6 ± .2	9.1 ± .4
*Clostridium perfringens***	ND (0/12) [b]	2.3 ± .0 (3/12)
*Bifidobacterium spp.***	7.9 ± .5 (5/12)	ND (0/12)

[a] Mean(log CFU/g) SD. [b]Detected specimen no./specimen no. * P <.05, ** P <.01.

Feed conversion rate in pigs fed *B. subtilis* was improved (P<.05) during the first 42 days. At the end of the nursery stage, greater numbers (P<.01) of *Lactobacillus spp.* and *Bifidobacterium spp.* were found in feces from pigs fed *B. subtilis* than feces from the control. In contrast, fewer numbers of pathogenic bacteria such as *Enterobacteriaceae spp.*(P<.05), *Bacteroidaceae spp.* (P<.01), and *Clostridium perfringens* (P<.01) were found in feces from pigs fed *B. subtilis* than the control.

Key Words: *Bacillus subtilis*, Micro-flora

EXTENSION

56 Effect of milk replacer fat level (20% vs. 15%) on calf starter intake and calf performance during hot weather.

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Fifty-two female Holstein calves purchased from sale barns (average 39.5 kg BW) were utilized in a study to determine the effects of milk replacer (MR) fat level on calf starter intake and calf performance during summer months. Calves were allotted by weight to one of two treatments and fed a 20% protein MR with either 15% or 20% fat. Calves were weaned at 35 days and feed intake was recorded for 42 days. MR intake was held constant at 454 g/day for both groups. Calf starter (CS: 18% CP, 3% fat) was offered free choice. One calf in the 15% fat MR group died during week 3, while no calves died in the 20% fat MR group. Weight gains for the 2 groups at days 21 and 42 were not different, although the calves fed the 15% fat MR were numerically heavier at 42 days (61.0 vs. 59.7 kg). Overall CS intake was higher (p = .08) in the 15% fat MR group (35.2 vs. 31.9 kg). CS intake was similar in week 1. During week 2, calves fed 15% fat MR had a slightly higher CS intake (318 vs.255 g/day: p = .12). Significantly higher CS intakes in the 15% fat MR group were noted for week 3 (586 vs. 464 g/day: p = .03) and week 4 (873 vs. 723 g/day: p = .02). During week 5, CS intake in the 15% fat MR group was numerically higher (1500 vs. 1368 g/day: p = .11). CS intakes for week 6 were identical at 1691 g/day. Overall daily CS intake was higher for the 15% fat MR group (836 vs. 759 g/day: p = .08). Scour scores and number and cost of medical treatments were not different between the groups. Total feed cost for the 20% fat MR group was $27.13 while the cost of the 15% fat MR group was 27.45. Cost per kg of gain was $1.35 for the 20% fat MR group and 1.28 for the 15% fat MR group. Based on these data, it is suggested that reducing the MR fat level from 20% to 15% is an economically viable means of improving performance of calves reared in a warm environment.

Key Words: Milk Replacer, Calf Starter, Calves

57 Effects of protein content in milk replacers on growth, nutrient utilization, and body composition of Holstein calves.

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The objective of this experiment was to assess the effects of protein content in whey-protein-based milk replacers on growth of calves and to determine the amounts of protein, fat, ash, and energy that were deposited in the body. Forty male Holstein calves < 1 wk of age were purchased from a sale barn. Following a 2-wk adaptation period, calves were randomly assigned to an initial slaughter group or to one of four treatments (8 calves per treatment). Milk replacers were isocaloric and contained 16%, 18%, 22%, or 26% CP. Milk replacers were reconstituted to 12.5% solids and fed at 12% of body weight, adjusted weekly. Balances of nitrogen and energy were measured in a metabolism study during d 17-27. Calves were slaughtered on d 42; visceral tissues were removed and combined. Viscera and the empty body (with head, hide, hooves, and tail) were ground and analyzed. Growth and body composition data for the 42-d of experiment are in the following table (a,b,c P<0.05).

	%CP				
Variable	16%	18%	22%	26%	SEM
Body weight gain, kg	15.6^a	18.9^a	23.0^b	25.8^b	1.3
Empty body gain, kg	8.6^a	11.4^{ab}	15.0^{bc}	18.8^c	1.5
Empty body fat gain, kg	1.9	1.7	1.5	1.5	.24
Empty body protein gain, kg	1.9^a	2.7^b	3.5^c	4.1^c	.25
Empty body energy gain, Mcal	7.43^a	6.22^b	6.05^b	5.35^c	.21
Protein:fat gain	1.0^a	1.8^{ab}	3.2^{bc}	3.5^c	.56

Final empty body content of fat decreased as dietary protein increased (P<0.05), but protein content was unaffected (P>0.08). Nitrogen retention increased (P<0.05) as dietary protein percentage increased; metabolizability of energy did not differ. Protein gain increased as protein content of milk replacers increased to 22% when calves were fed at 12% of body weight.

Key Words: Calves, Milk Replacer, Protein

58 Effect of mechanical processing of alfalfa silage on lactation performance by dairy cows. A. G. Jirovec*, E. L. Miller, K. J. Shinners, and R. D. Shaver, *Univiersity of Wisconsin, Madison, WI.*

Sixteen (8 fitted with rumen cannulae) multiparous Holstein cows in mid lactation were in a replicated 4X4 Latin Square design with 21 day periods to evaulate the effect of mechanical processing of alfalfa silage on intake, digestion, and milk production. Main effects in the 2X2 factorial arrangement of treatments were silage processing method and dietary thiamin supplementation. Alfalfa silage harvested at the mid bloom stage of maturity and field wilted to 35% DM was either chopped at .93 cm theoretical length of cut (TLC; C) or chopped and rolled at 1.9 cm TLC with a 1 mm roll clearance (R). Cows were fed a TMR containing 60% alfalfa silage (DM basis) that was formulated to 18.5% CP using dry shelled corn and expeller extracted soybean meal. Average daily milk yield, fat%, and protein% for C and R were 40.7 kg/d, 3.66%, and 2.93% and 40.6 kg/d, 3.64%, and 2.81%, respectively, and were not affected by mechanical processing (P>.10). Rumination (423 vs 480 min/d) and total chewing (631 vs 687 minutes/d) activities were reduced (P<.001) for R. Ruminal pH measured in eight ruminally cannulated cows at 0, 4, 8, and 12 hours post-feeding was not affected by mechanical processing (P>.10), and reached nadir at 8 hours postfeeding at pH 6.27 for both C and R. Rolling alfalfa silage with an on-board crop processor did not affect lactation performance in this trial.

Key Words: Alfalfa silage, Processing, Dairy cows

59 Survey of feeding and management practices on six high producing Wisconsin dairy herds. J. L. Keuning*[1], S. L. Gunderson[1], and R. D. Shaver[2], [1]*University of Wisconsin-Extension, Madison, WI,* [2]*University of Wisconsin-Madison, Madison, WI.*

Six of the 13 dairy herds enrolled in the Ag Source DHI testing program that finished 1997 with RHA>13,650 kg per cow were randomly selected for a survey of their feeding and management practices. The initial survey was conducted during the spring of 1998. Herds were located in northwest (n=3), southwest (n=1), central (n=1), and northeast (n=1) WI. Herd size ranged from 52 to 300 lactating cows, and RHA for milk, fat, and protein ranged from 13,784 to 14,857 kg/d, 466 to 532 kg/d, and 435 to 469 kg/d, respectively. Four of the herds were milked 3X daily. All herds were fed a TMR; 4 herds fed only one ration to lactating cows. Five herds were housed in tie-stalls with the other herd using free-stalls. The tie-stall herds all used mattresses with either sawdust or chopped straw bedding while the free-stall herd used sand bedding. All herds were treated with BST; % of cows treated within a herd at any time ranged from 45% to 95% averaging 63%. An equal number of herds were fed 1X, 2X, and 3X daily. Feed push for lactating cows averaged 4.7X daily and ranged from 2X to 7X daily. Alfalfa silage and corn silage were components of lactating cow rations in 5 of the herds. Corn silage comprised 25% of the lacating cow forage program (DM basis), on average, ranging from 0 to 35%. Alfalfa silage RFV ranged from 127 to 158. Dry matter content of the alfalfa silage and corn silage ranged from 31.2% to 59.6% and 33.5% to 35.4%, respectively. Five herds were fed high-moisture corn as their primary grain source. All herds were fed whole cottonseed. All herds were fed a soy protein supplement. Five herds were fed meat meal and blood meal. Calculated average lactating cow TMR densities for CP%, UIP%, NDF%, ADF%, Fat%, Ca%, and P% were 19.4%, 6.9%, 27.5%, 19.0%, 6.0%, 1.07%, and .54% (DM basis), respectively. Dietary CP and P concentrations exceeded NRC guidelines in 5 of the 6 herds. Evaluation of the lactating cow diets using the CPM Model showed lysine to be in excess of requirements in relation to high dietary CP and suggested methionine as the limiting amino acid. Calculated average lactating cow supplemental Vitamins A, D, and E were 150,000 IU, 40,000 IU, and 850 IU, respectively. Total feed costs averaged $3.85 per cwt, ranging from $3.42 to $4.34 per cwt., respectively.

Key Words: Nutrition, Management, Dairy cows

60 Variation in mean particle length of processed corn silages on commercial Wisconsin dairies. R. L. Novak*, K. J. Shinners, and R. D. Shaver, *University of Wisconsin, Madison, WI.*

Eighty-four commercial Wisconsin dairies feeding corn silage processed through choppers fitted with an on-board roller mill were surveyed in Spring, 1998. Dairy producers were surveyed for corn silage production and harvest practices and herd performance. Mean particle length (MPL) was determined using an Oscillating Screen Particle Separator (OSPS; ANSI/ASAE S424, 1988) in triplicate on 85 processed corn silages from these dairies. Average silage DM content was 35.5% with a range of 25.5% to 57.3%. Silage MPL averaged 12.5 mm with a range of 6.5 mm to 19.8 mm and an SD of 2.5 mm. Percent particles retained on the top two screens (26.9 mm and 18.8 mm square hole diagonal) of the OSPS was 28.9% with a range of 4.4% to 58.8%. Percent particles retained on the bottom screen (1.65 mm square hole diagonal) and pan of the OSPS was 9.6% with a range of 1.7% to 30.4%. Packing densities were determined using coring method on horizontal silos from 38 of the dairies. Average packing density was 5.4 kg DM/cu. ft. with a range of 3.9 kg DM/cu. ft. to 8.3 kg DM/cu. ft. and an SD of .9 kg DM/cu. ft. Corresponding average DM content and MPL were 34.2% and 12.5 mm, respectively. Considerable variation exists in mean particle length of processed corn silage on commercial dairies.

Key Words: Corn silage, Processing, Particle Length

61 The dairy technician certification program. J. F. Keown* and R. J. Grant, *University of Nebraska-Lincoln, Lincoln, NE.*

The purpose of the Dairy Technician Certification Program is to train individuals to work on the large number of expanding dairy farms in Nebraska. As herds become larger and more specialized, and also as herds relocate to Nebraska from other states, the need for trained labor will grow. There is potential for trained dairy technicians to serve on all size dairies. We anticipate a need for 300 to 400 new dairy employees over the next five years to fill new positions in this expanding dairy industry. The Dairy Technician Certification Program is part of the existing Agribusiness Associate Degree Program. This program is jointly administered by Southeast Community College (SCC) in Beatrice, NE, and the University of Nebraska-Lincoln (UNL). SCC in Beatrice offers students courses that provide basic scientific background in order to work on more specialized modules that will be prepared by the Cooperative Extension Service at UNL. These dairy modules are incorporated into the basic courses taught at SCC. The Cooperative Extension Service also arranges a two-month internship for students to gain hands-on dairy experience. A Program Oversight Committee composed of dairy producers and dairy industry representatives continually provides input. The courses in this program focus on the areas of milking management, forages, feeding, health, breeding, and farm records.

Key Words: Certification, Internship, Agribusiness

62 Results of youth skill-a-thon competitions in Ohio. S.J. Moeller*, J.P. Black, D.M. Wulf, and S.L. Boyles, *The Ohio State University, Columbus, OH.*

In an effort to provide an educational forum for 4-H and FFA youth in Ohio, The Ohio State University Extension has developed and conducted knowledge assessment programs termed 'skill-a-thons' at the Ohio State Fair from 1995 to 1998. Participants in the program completed skill assessments in four topic areas each scored on a 25 point basis with a total score (TS) of 100 points possible. Topic areas included feed and animal records, quality assurance, breed identification, animal structure, external and internal anatomy and meat cut identification. From 1995 to 1998 (N=2228) youth between the ages of 9 and 18 representing three species: beef (N=471), sheep (N=764), and swine (N=993) have completed the program. Fixed effects of year and age were tested using analysis of variance. Results indicate that AGE and YR had significant effects (P< .001) on TS, with TS increasing from age 9 to 18 and from 1995 to 1998, respectively. The age by year interaction was not significant (P>.05). The average 9-year-old TS was 21 points lower than 18-year-old TS (56.6 vs 75.4). Scores from the 1997 and 1998 feed station indicated that 85 to 93% of the participants across species were able to correctly identify and answer questions related to information provided on a commercial feed tag. Large increases in the ability of youth to understand quality assurance programs were demonstrated in the sheep species, with the percentage of participants that correctly identified the proper injection site for medications increasing from 29.7% in 1996 to 75.2% in 1998. Injection site was correctly identified in swine (82%) and beef (91%) in 1998. Meat station results from 1998 in beef indicated 40.1% were able to correctly match the appropriate name with the cut of meat, 86.3% were able to match the cut with the appropriate

wholesale cut and 53.4% were able to correctly identify the location of the cut on the animal. These percentages in sheep were 45.5, 70.6 and 60.3, respectively and in swine were 70.6, 75.5 and 71.5, respectively. These results indicate that skill-a-thons are effective tools for teaching animal science principles and practices to youth.

Key Words: Youth, Education

63 Pork Central - a New Information Center for Nebraska Producers.

D.E. Reese*, L.L. Bitney, and A. Prosch, *University of Nebraska, Lincoln, NE USA*.

Pork producers are seeking more in-depth, operation-specific production and business management information that is easy and efficient to acquire. Funds from the Nebraska Pork Producers Association (NPPA) and the University were used to create Pork Central (PC), an information center accessible by a toll-free telephone line. A coordinator with a master's degree in business management and part-time secretary operate PC. A NPPA member serves on the steering committee for PC. The PC coordinator participates in monthly meetings of the 14-member swine extension team and solicits input from members to assist producers and conduct educational programs. The coordinator manages a home page and a listserv. A summary of PC's first two years of operation (1996-98), indicated that PC received 1,715 telephone calls from producers. Approximately 25% of the callers requested information on networking and contracting arrangements. Management, records and facility issues were discussed by 16, 13, and 13% of the callers, respectively. An impact study of PC was conducted in 1998. A survey was mailed to 604 randomly selected people who had contacted PC. Responses were received from 187 people (31% return rate). Most respondents (81%) were producers. About 95% of the respondents indicated that the concept of an information center, accessed by a toll-free telephone line, should be continued. Over 80% of the respondents gave PC an above average or higher rating. Sixty-six percent of the respondents indicated that PC was a better source of information than other sources they had used. Seventy-two percent of the respondents believed more research-based information was available to them since PC was established. Thirty-three percent of the respondents indicated that they made changes in methods of producing pork or in a business management strategy as a result of their contact with PC. Most producers (53%) said their operation's profitability stayed the same after contracting PC, but 18% said it increased. These results indicate that PC serves as a valuable information center for Nebraska pork producers.

Key Words: Pigs, Information

64 Pork producers evaluate pork quality.

R.O. Bates*[1], M. Ropp[1], B. Hines[1], and S. Hines[2], [1]*Michigan State University,* [2]*Michigan Pork Producers Association*.

Meat quality is an emerging issue within the swine industry. Meat quality is influenced by factors that are controlled by both producers and meat processors. However, there is not uniform understanding on how variation in meat quality can impact consumer satisfaction. A program was conducted in which pork producers and allied industry personnel completed a sensory evaluation of meat samples that differed in pork quality classification. Persons attending one of 4 spring meetings in 1998 evaluated 5 meat samples. There were 154 persons that completed the sensory evaluation. Four samples were from center cut loin chops while the fifth was turkey breast. Meat used was from local grocery stores. Samples were either RFN (red, firm, nonexudative), DFD (dark, firm and dry) or PSE (pale, soft and exudative) cooked to approximately 71.1 ^{o} C, as was turkey breast (T). The fifth sample was RFN cooked to exceed 82.2 ^{o} C (RFNO). Participants scored the samples 1 to 10 (1-poorest; 10 -best) for tenderness, juiciness and pork flavor as well as indicated if the sample was either an acceptable or unacceptable pork eating experience. Participants indicated that DFD, RFN and T were similar for tenderness and tended (P=0.14) to be better than PSE and RFNO. For juiciness, RFN scored highest followed by DFD, PSE, T and RFNO. There was a meeting by sample type interaction for flavor. In two of the four meetings, RFNO and T scored highest for pork flavor, while at the other two meetings, RFNO and T were either similar to or lower than DFD, RFN, and PSE for pork flavor. There was also a meeting by sample type interaction for percent unacceptable. In one meeting, 5% percent of participants found T unacceptable, while the other samples were classified as 12 to 32% unacceptable. In the other three meetings, PSE, T and RFNO were more unacceptable than RFN and DFD. Pork producers and allied industry personnel did not consistently evaluate eating quality as would be suggested by meat quality classification standards.

Key Words: pig, meat quality, sensory evaluation

65 Wean-to-finish swine production results in leaner pigs at market.

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Evaluating new technologies under field conditions is difficult. As part of our extension program, we have used compositional growth curves of statistically valid samplings of pigs within production systems to compare technologies. For example, growth rates, fat depth, and longissimus muscle area (LMA) were compared in a wean-to-finish (WF) and nursery-finisher (NF) production system (2 barrow and 2 gilt groups/system). Pigs were fed similar diets with lysine content adjusted to gender and decreasing with BW. All pigs (PIC) originated from a single sow farm and averaged 15.3 $\pm$ .8 d at weaning. Pigs in the WF groups were weaned into fully slatted curtain-sided finishers and remained there until market. The NF groups were weaned into nurseries and then moved to finishers at 62 d of age. At 73 d of age, 40 pigs were randomly selected within each 1,200-head group and individually weighed and scanned to obtain 10^{th} rib fat depth and LMA every 21 d until market. A system $\times$ age interaction (P<.07) occurred for ADG. The WF pigs had higher ADG at 73 d of age than NF pigs (.63 vs .55 kg). The NF pigs had higher ADG for all subsequent ages. While not significant, WF pigs had a BW advantage at all ages that ranged from 2.3 kg at 73 d to 4.1 kg at 94 d of age. At 94 d of age, WF pigs tended to have greater (P<.06) fat depth (.8 vs .7 $\pm$ .02 cm) and larger (P<.01) LMA (20.9 vs. 16.2 $\pm$ .2cm^2). At 195 d of age, WF pigs had similar fat depths (2.0 $\pm$ .1 cm), larger (P<.01) LMA (49.2 vs 43.8 $\pm$ .8 cm^2), and greater (P<.04) fat free lean percentage (52.7 vs 51.1 $\pm$ .3) than NF pigs. These results indicate that the faster growth of WF pigs before 73 d of age resulted in larger LMA with little additional fat. The larger LMA was maintained through market at 195 d of age. Faster growth of NF pigs after 94 d of age resulted in greater fat deposition during this period. This extension effort demonstrated that a WF system improved early finisher growth, resulting in leaner, more muscular pigs.

Key Words: Pig, Wean to Finish, Growth and Carcass

66 Economic analysis of commercial swine breeding herd replacement rates.

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The objectives of this study were to: 1. develop a computerized method of determining the parity when breeding herd females reach a positive net present value in commercial swine operations; and 2. calculate breakeven parities based on historical cost, price, and production data. Swine record keeping entities have reported breeding herd female replacement rates approaching 50% in commercial swine operations, since 1995. Reported average parity of sows that have farrowed is 3.3 and average parity of culled sows is 3.5. This data shows that many breeding females never reach the fourth or fifth mature equivalent parities. Swine producers need a method to evaluate the parity in which a sow becomes profitable on a herd-specific basis. Capital budgeting techniques are used to determine the parity at which a positive net present value occurs for replacement gilts. Producers that provide operation specific cost of replacement females, production information, feed costs, fixed asset equity level, discount rate, variable costs, market price of pigs sold, and salvage value of cull females can calculate the number of parities sows must remain in the herd to be profitable investments. Sensitivity analysis is used to examine the impact of variation in the cost of replacement females, number of pigs sold per litter, and price of pigs sold on the number of parities required to achieve positive net present values. Internal rates of return are calculated so producers can compare the returns of investing in the swine herd to alternative investments with similar levels of risk. The parity at which positive net present value is reached was estimated for typical commercial herds using historical data. Using five-year average feed costs and market hog price, sows reach a positive net present value at parity 3 in a farrow-to-wean operation (F-W) and parity 2 in a farrow-to-finish operation (F-F). Internal rate of return was approximately 2.5 times higher for F-F herds compared to F-W operations.

Key Words: Replacement Rate, Productivity, Net Present Value

67 New methods for estimating the energy value of corn silage. W. P. Weiss*, *Ohio State University, Wooster*.

Estimating the energy value of corn silage is difficult because it contains several different components (stalks, leaves, cobs, and grain) and the particle size of the components is not uniform. The major source of variation in the digestible energy content of corn silage is the digestibility of the carbohydrate fraction (NDF and starch). In vitro or in situ techniques or equations based on fiber components (e.g., NDF and lignin) are fairly accurate at estimating the digestibility of NDF. These methods are not very accurate at estimating the digestibility of starch in corn silage. The digestibility of finely ground corn grain usually exceeds 95% but whole corn grain may be less than 80% digestible when fed to lactating dairy cows. Corn silage contains a diverse matric of corn grain particles ranging from whole kernels to very small particles. Quantification of the distribution of corn grain particles (i.e. starch) should allow improved estimates of the digestibility of starch in corn silage. The recommended approach based on current information is to estimate fiber energy using equations or in vitro/in situ data, estimate protein and fat energy using standard equations, estimate starch digestibility based on maturity (e.g., digestibility of starch in corn silage harvested at 1/2 milk line = 98%; black line = 88%) and sum the values. More accurate results may eventually be obtained by measuring the distribution of starch-containing particles and by adjusting for rates of NDF digestion. Currently available data are inadequate to accurately use this information to estimate energy values of corn silage.

Key Words: Corn silage, Energy

68 Practical Use of Energy Values in Ration Formulation. S. M. Abrams*, *Nutrition Professionals, Inc.*.

Energy values of forages are typically estimated from their fiber content. Discrepancies between these estimates and actual energy values are due to many factors, and nutritionists commonly make adjustments for these discrepancies. Modifications in either the energy values of feedstuffs or in the energy density of rations are made based on physical characteristics (moisture content, particle size, heat-damage), environmental effects (annual and seasonal), animal performance (milk production, milk butterfat, herd health), and management (feeding practices, housing, genetics). In general, adjustments are based on an imprecise understanding of these relationships. Variation in fiber content from published values for grains and byproduct feeds is also used to adjust energy levels, although there is little experimental evidence to support this practice. Nutritionists are often the focus of sometimes competing demands for increased milk production, reduced reproductive failure, and lower incidence of health problems that may be attributable to ration energy and fiber density. Improvement in the characterization of both the energy content and effective fiber of feedstuffs would help meet the goals of high milk production, reproductive efficiency, and increased herd health.

Key Words: Ration Formulation, NEL, Fiber

69 Energy prediction from a feed testing lab perspective. P.K. Sirois*, *DHI Forage Lab, Ithaca, NY/USA*.

Routine feed and forage analyses have provided a wealth of data about the components of major nutritional significance. However, energy, the first limiting nutrient has been the least well determined. Direct determination requires housing animals in specialized chambers, is time consuming, costly and impractical. Relationships between measurable components and digestibility have been used to predict energy. Acid detergent fiber and its negative correlation with digestibility is most commonly used. Limitations with this approach are that the negative impact of lignin is not directly accounted for nor is the positive impact of fat. Additionally, multiple equations available for specific feedstuffs leads to a lack of uniformity and confusion at the producer level. The summative approach developed by Weiss utilizes a single multiple equation to predict the energy values of forages, grains and byproducts. Incorporating lignin and fat into the equation helps overcome the limitations of solely using ADF. As byproducts continue to play an increasingly important role in dairy rations, the use of this equation has been a great asset. Advancing energy prediction to the next level involves some form of direct biological measurement. A batch in vitro analysis technique developed by ANKOM Technologies was employed to measure NDF digestibility. Samples were sealed in individual filter bags and incubated with rumen fluid from high producing lactating dairy cows and buffer for 30 hours. The residues were extracted in neutral detergent solution leaving the undigested fibrous residue and a measure of in vitro true digestibility (IVTD). The undigested fibrous residue was used to calculate digestible NDF and substituted in the summative equation for energy prediction. Results varied, but greater success was achieved with corn silage over other forage types. Work needs to continue in this area to reach agreements on buffers and particle size to produce more uniform numbers across the industry. The existence of proprietary and regional equations makes it difficult to reach a national consensus for predicting energy. As computers account for the majority of livestock rations developed today, energy prediction could easily be handled by ration software eliminating the need for labs to generate values.

Key Words: Energy prediction, In vitro true digestiblity, Summative equation

GROWTH, DEVELOPMENT, MUSCLE BIOLOGY AND MEAT SCIENCE

70 Antimicrobial-induced growth: a possible mechanism. M. R. Hathaway*, *University of MN*.

Antimicrobial supplementation has been shown to increase average daily gain in weanling swine. However, it has not been clear how antimicrobials are able to affect growth. One hypothesis is that changes in the microflora population results in either increased production of positive growth factors and/or decreased production of negative growth factors. Recently we have shown that when pigs are weaned, their serum insulin-like growth factor-I (IGF-I) concentrations decrease rapidly. However, the magnitude of the decrease is less ($P < .02$) for antimicrobial supplemented pigs than for control pigs. The antimicrobial-induced difference in serum IGF-I concentrations is maintained for 5 weeks ($P < .001$). Serum IGF-I concentrations are known to be very sensitive to the plane of nutrition. Additionally, feeding antimicrobials typically enhances voluntary feed intake. However, we have demonstrated that the increase in serum IGF-I concentration was not due to differences in feed intake. IGF-I complexes with binding proteins (BP) in biological fluids. These BP are known to modify IGF-I's activity. We have shown that antimicrobial supplementation increases IGFBP-3 concentrations ($P < .001$). There is also a decrease in as yet, an unidentified serum borne growth inhibitor/toxin when antimicrobials are fed to young swine. These data support the theory that antimicrobial stimulated growth may be due to alterations of the growth factor milieu

Key Words: antimicrobials, growth, pigs

71 Feed efficiency, ADG and carcass parameters of pigs implanted with trenbolone acetate and estradiol. T.J. Safranski*[1], W.G. Zollers[2], J.A. Carroll[3], R.L. Matteri[3], and D.C. Kenison[2], [1]*University of Missouri, Columbia,* [2]*Ivy Laboratories, Inc., Overland Park, KS,* [3]*ARS-USDA, Columbia, MO*.

Anabolic implants are an integral part of beef production. This study was to test the use of similar implants in growing pigs. Fifty-four crossbred barrows were blocked by weight at 53d and randomly assigned within block to treatment. Treatments consisted of implanting one of three compounds in the middle third of the ear at 56d. Implants were either a sham implant (control), 120 mg trenbolone acetate (TBA)/24 mg estradiol (E2)(TBA/E2,5:1) or 120 mg TBA/12 mg E2 (TBA/E2,10:1). At 56d all pigs were penned in groups of three by weight within treatment. Feed disappearance and ADG were measured weekly. Feed efficiency was calculated as the ratio of pen weight gain to pen feed disappearance (G:F). Ultrasound evaluations of backfat thickness (BF) and loin muscle area (LMA) were determined every other week from when the heaviest pig reached 65 kg. For all analyses pen was the experimental unit. One pig from TBA/E2,5:1 became ill and was euthanized, and that pen not included in analyses. There were no significant differences among treatments for ADG or LMA. After a significant starting weight x treatment interaction was found for BF, pairwise comparisons were made by quartile; Controls were fatter than TBA/E2,10:1 for the first quartile ($P=0.027$). Least-squares means and standard errors for G:F from 56d to slaughter at 118kg were 0.333.010, 0.361.010 and 0.357.010

for controls, TBA/E2,10:1 and TBA/E2,5:1, respectively. Covariance analysis of this trait revealed no significant treatment effect (P=0.1239). Similarly, pairwise comparisons showed tendencies for treatment differences which were not significant (P=0.059 and P=0.113 for control vs TBA/E2,10:1 and control vs TBA/E2,5:1, respectively). When control was compared to the mean of the other two treatments combined a difference was detected in G:F (P=0.048; approximately 8% improvement). Use of TBA/E2 may prove to be a valuable tool to enhance efficiency of swine production.

Key Words: steroid, implant, pig

72 Steroidal enhancement of growth related endocrine mechanisms in the neonatal pig. J. A. Carroll*[1], R. L. Matteri[1], T. J. Safranski[2], D. C. Kenison[3], and W. G. Zollers[3], [1]*Animal Physiology Research Unit, ARS-USDA,* [2]*Animal Sciences, University of Missouri, Columbia, MO,* [3]*Ivy Laboratories, Inc., Overland Park, KS.*

Anabolic steroids can be successfully utilized to enhance growth performance in growing/finishing cattle. Limited information exists on the use of anabolic steroids to enhance growth performance in swine. We hypothesized that neonatal treatment with anabolic steroids may alter or preset the somatotrophic axis which could enhance growth performance later in life. Therefore, we evaluated the growth related endocrine effects of 2 ratios of trenbolone acetate (TBA) and estradiol (E2) (5:1 and 10:1, respectively) in barrows beginning at 3d of age. At 1d of age, 30 piglets were assigned to 1 of 3 treatment groups (n=10 piglets/group): 1) Sham-implanted controls, 2) 5:1 TBA/E2 (40 mg TBA and 8 mg E2) and 3) 10:1 TBA/E2 (40 mg TBA and 4 mg E2). Piglets were exposed to the normal managerial practices of ear notching, tail docking, eye teeth clipping, iron injections, and castration by 3d of age. At 3d of age, piglets were implanted in the middle 1/3 of the dorsal region of the ear with their respective treatments. Blood samples and body weights were collected at 2d intervals between 3d and 6wk to evaluate treatment effects on weight gain and plasma concentration of growth hormone (GH), IGF-1 and IGF-2. Piglets were weaned at 2wk of age and offered a standard starting ration ad libitum in individual pens for monitoring of feed intake. At 6wk of age, pigs were sacrificed for tissue collection to evaluate treatment effects on the somatotrophic axis. Using birth weight as a covariate, steroid treatment tended (P=0.06) to enhance body weight. Feed intake was not different among treatment groups. Serum GH (P=0.002), but not IGF-1 (P=0.155), was increased by steroid treatment. Pituitary content of mRNAs for GH-releasing hormone receptor and GH did not differ among treatment groups. Results indicated that 10:1 TBA:E2 has the most potential for effectively increasing growth performance in swine.

Key Words: Pigs , Steroids, Growth

73 Cloning and biological activity of porcine orexin. C. J. Dyer*[1], K. J. Touchette[2], J. A. Carroll[1], G. L. Allee[2], and R. L. Matteri[1], [1]*Animal Physiology Research Unit, ARS-USDA,* [2]*Animal Sciences, University of Missouri, Columbia, MO.*

Early growth is an important determinant of gain and efficiency in growing pigs. A major limiting factor of piglet growth is feed intake. Orexins, newly discovered neuropeptides, may be important regulators of appetite. The orexin gene, which encodes orexin-A and B, was recently identified in rodents and man. The objectives of this study were to clone the cDNA for porcine orexin, utilize the cDNA sequence information to produce synthetic hormone, and evaluate the effect of orexin administration on feed intake in weanling pigs. Oligonucleotide primers were designed for RNA-PCR production of porcine orexin cDNA. The PCR products were cloned into the pGEM-T vector (Promega Corp., Madison, WI). The cloned cDNA (GenBank AF075241) was found to be 88.5% homologous to the human orexin sequence. Predicted translation of porcine orexin cDNA revealed orexin-A and B amino acid sequences that were 100% and 96% homologous to the known human peptides, respectively. Porcine orexin-B was synthesized according to the predicted sequence. Twenty-six cross-bred piglets were utilized in 3 replicates (n=8-10/replicate). Piglets were weaned between 2-3 wk of age. One wk after weaning, equal numbers of animals received i.m. injections of orexin-B (3 mg /kg body weight) or vehicle (sterile water) in each replicate. Feed intake was monitored from 24 to 24 hr relative to injection (time 0). The effects of orexin treatment and experimental replicate were evaluated by analysis of variance, using prior 24 h feed intake as a covariate. The orexin-injected pigs ingested an additional meal at 12 h when compared with the control animals ($P = .018$). Cumulative feed intake was increased by orexin-B administration from 12 to 24 hr post-injection ($P \leq .05$). Total feed intake at 24 hr was improved by 18% in orexin-treated pigs ($P = .05$). The ability to stimulate appetite during critical periods of early growth, particularly following weaning, could result in significant improvements in swine production efficiency.

Key Words: Piglet, Appetite, Orexin

74 Effect of triiodothyronine (T3) on heat production of MH and ML mice. M. G. Knobbe*[1], M. K. Nielsen[1], and J. L. Miner[1], [1]*University of Nebraska.*

More efficient growth of animals may be obtained by better understanding the processes that govern maintenance energy requirements. Use of energy for maintenance results in heat production. Two lines of mice developed by selection at the University of Nebraska (high = MH and low = ML) differ by 45% in heat production. Triiodothyronine (T3) increases oxidative metabolism in mice. The MH and ML mice have similar serum concentrations of free and bound thyroid hormones. The objective of this study was to determine whether sensitivity to T3 contributed to the differences in heat production between the two lines. We hypothesized that the MH mice have a greater sensitivity to T3 than the ML line. To test this hypothesis, mice were injected i.p. with one of four doses of T3 (n = 8 mice per dose·line). Heat production was measured by direct calorimetry for 15 h beginning 30 min postinjection. Data were analyzed using Proc Mixed of SAS. The MH mice produced more heat than the ML mice (153 vs 99 $kcal \cdot kg^{-.75} \cdot d^{-1}$, SE = 3.2; $P < .01$). Mice treated with 0, 10, 100 and 1000 $\mu g \cdot kg^{-1}$ BW doses of T3 produced 117, 110, 140 and 139 $kcal \cdot kg^{.75} \cdot day^{-1}$ (SE = 4.3; $P < .01$), respectively. No significant dose by line interaction was detected. However, the two larger doses did cause a greater heat production than the two smaller doses ($P < .01$). The MH mice were not more sensitive to T3 than the ML mice. We conclude that the difference in heat production between the MH and ML mice is not due to differing thyroid hormone sensitivity or serum concentration.

Key Words: Mice, Thyroid, Maintenance energy

75 Acylation stimulating protein and fatty acid esterification in the pig. C. L. Ramsel*[1], S. K. Jacobi[1], K. Cianflone[2], and J. L. Miner[1], [1]*University of Nebraska,* [2]*McGill University.*

Human acylation stimulating protein (hASP) increases fatty acid esterification in cultured human adipocytes. Objectives of this study were to determine whether hASP stimulates esterification in cultured porcine adipose tissue and whether amount of feed intake affects responsiveness of adipose tissue to hASP. Eight crossbred barrows (90 kg initial BW) were used in two trials. All pigs had unrestricted access to feed in the first trial. The second trial was a crossover design in which half of the pigs were restricted to 50% of NE_m requirement in each of the two 3-wk periods. Subcutaneous adipose tissue was obtained using a 1.6-cm diameter borer, placed in M199 media containing 4 mM glucose, cut into 15-mg explants (n = 4/treatment), and incubated for 2 h in 250 μL M199 media, hASP (0, .1, 1, and 10 μM), 2 mM oleate labeled with .5 μCi/mL ^{3}H, 1% BSA, and 0 or 10 nM insulin. After incubation, the media were removed and .31 M trichloroacetic acid was added to stop metabolism. Explants were washed with .9% NaCl, weighed, and extracted in 2:1 (v/v) chloroform:methanol. After washing with .38 M $NaHCO_3$, extracts were dried, resuspended in hexane, and radioactivity was quantified with a beta-counter. Without added insulin, oleate esterification in Trial 1 was 1.39, 1.44, 1.60, and 1.67 nmol for 0, .1, 1, and 10 μM hASP (SE = .097), respectively, and with 10 nM added insulin, lipid synthesis was 1.49, 1.72, 1.49, and 1.45 nmol, for the respective hASP concentrations. There was no insulin ($P > .5$) or hASP ($P = .13$) effect, but an insulin by hASP interaction ($P < .06$) was observed. In Trial 2, oleate esterification was .97, .94, 1.07, and 1.05 nmol for 0, .1, 1, and 10 μM hASP (SE = .054), respectively. No interactions between hASP, insulin, and feed restriction occurred ($P > .5$), but an effect of hASP was detected ($P < .10$), and feed restriction reduced esterification by 25% ($P < .01$). Human ASP thus seems capable of promoting fat synthesis in porcine adipose tissue, but this activity is less than that observed with human adipocytes. The Nebraska Pork Producers Association supported this research.

Key Words: Pig, Acylation Stimulating Protein, Lipid

76 Feeding status and the reponsiveness of bovine adipose tissue to human acylation stimulating protein (hASP).

S. K. Jacobi*[1], K. Cianflone[2], and J. L. Miner[1], [1] *University of Nebraska,* [2] *McGill University.*

Human ASP stimulates triacylglycerol synthesis in human adipocytes and bovine adipose explants. Our objective was to determine whether feeding status affects the responsiveness of bovine adipose tissue to hASP. Nine, 9-mo-old steers were housed individually for two periods of 3 wk each. During the first period, four of the nine steers were fed to 50% of NE_m requirement and the other five consumed the same diet ad libitum. After the first period, steers were allowed ad libitum access to feed for 2 wk then were assigned the opposite ration for the second period. Steers gained 40.5 kg BW when intake was ad libitum but lost 30.2 kg BW when intake was restricted (SE = 7.84; P < .01). After each period, subcutaneous adipose tissue was sectioned into 20-mg explants and incubated for 3 h in M199, 1% BSA, 2.5 mM ^{14}C-acetate, and .75 mM ^{3}H-oleate. Incubation media were collected and frozen at -20^{o}C. Media were assayed for NEFA concentrations to determine the effect of treatments on lipolysis. Explants were extracted in an organic solvent, washed with 1 M KCl:.15 N HCl solution and .38 M $NaHCO_3$ solution. Extracts were dried, reconstituted in hexane, and lipid was quantified by a β-counter. Four explants/steer·period were used to test effects of insulin (0 and 1 nM) and hASP (0, .01, .1, and 1 μM). Insulin did not influence incorporation of acetate or oleate into lipid. Acetate incorporation was 2.98, 3.09, 3.13, and 3.29 nmol/mg (SE = .384; P < .32); and oleate incorporation was 1.04, 1.07, 1.06, and 1.26 nmol/mg (SE = .066; P < .01) for 0, .01, .1, and 1 μM hASP, respectively. Feed restriction reduced (P < .01) acetate incorporation from 5.95 to .29 nmol/mg, and oleate incorporation from 1.37 to .84 nmol/mg. No interactions between feeding status, insulin, or hASP were detected. There was no difference in NEFA concentration between treatments. Feed restriction increased NEFA concentration in media to 254.34 μEq/L from 228.40 μEq/L in unrestricted steers (SE = 4.10; P < .01). In conclusion, the ability of hASP to promote fatty acid esterification is not influenced by feed restriction.

Key Words: Bovine, Adipose, Acylation stimulating protein

77 Adipose and skeletal muscle expression of genes related to lipid metabolism in finishing pigs deprived of feed.

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The objective of this study was to evaluate the expression of lipoprotein lipase (LPL), hormone-sensitive lipase (HSL) and mitochondrial uncoupling protein 3 (UCP3) in adipose tissue and(or) skeletal muscle of pigs in response to a 96-h period of feed deprivation. Thirty two barrows (87 kg 5%) were divided into 2 treatment groups, ad libitum intake vs. feed deprivation (FD). All pigs had free access to water. At 96 h, the pigs were slaughtered and longissimus and semitendinosus (ST, red and white components separated) muscle and inner layer subcutaneous adipose tissue samples collected for total RNA extraction. Sample RNA concentrations were determined fluorometrically using RiboGreen^{TM}. The abundance of LPL, HSL and UCP3 mRNA was quantified by respective ribonuclease protection assays developed in our laboratory. Feed deprivation caused a reduction (66%, P < 0.013) in LPL mRNA in adipose tissue. Likewise, LPL expression was decreased (P < 0.001) by FD in all skeletal muscle tissues; however, the magnitude of decrease in red ST (32%) was half that in white ST (62%) or longissimus muscle (68%). Red ST muscle also had approximately double (P < 0.001) the LPL mRNA as did either the white ST or the longissimus muscle, irrespective of intake. Longissimus muscle UCP3 mRNA was increased dramatically (237%, P < 0.001) by FD. As regards HSL, mRNA abundance in adipose tissue was increased by FD (46%, P < 0.04). These data indicate that LPL expression is responsive to FD in the pig in both adipose and skeletal muscle tissue. Furthermore, LPL mRNA in muscle containing predominantly red (more oxidative) muscle fibers seems considerably less responsive to FD and is more abundant than that in muscle containing predominantly white muscle fibers. The FD-induced increase in UCP3 is likely in keeping with a shift to lipids as a metabolic fuel. Finally, we provide evidence that HSL is regulated in part at the level of gene transcription in pigs deprived of feed long term.

Key Words: Lipoprotein Lipase, Hormone-sensitive Lipase, Uncoupling Protein 3

78 Influence of swine dietary supplementation of modified tall oil and vitamin E on longissimus muscle quality characteristics and display color stability.

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Seventy-two pork loins were used to determine the influence of diet supplementation of modified tall oil (MTO) and vitamin E on longissimus muscle (LM) quality. In a 2 x 3 factorial design, barrows (PIC) were blocked by initial BW (45.5 kg) and ancestry and randomly allotted to diet additions of no MTO, no vitamin E (NMNE); no MTO, 22 IU/kg vitamin E (NMLE); no MTO, 110 IU/kg (NMHE); .5% MTO, no vitamin E (MNE); .5% MTO, 22 IU/kg vitamin E (MLE); and .5% MTO, 110 IU/kg vitamin E (MHE). Pigs were fed to an average BW of 114.6 kg. Boneless loins were vacuum packaged at 24 h postmortem and cut into 2.54 cm chops at 7 d postmortem. Visual display color was evaluated by a 9-member panel on 0, 1, 2, 4, 6, and 8 d of display. At 2 d, LM chops from MHE fed pigs had (P<.05) lower (less deterioration) scores than NMHE and MNE chops. At 4 d, LM chops from MHE, MLE, and NMNE had (P<.05) lower scores than MNE chops. At 6 d, LM chops from MHE had (P<.05) lower scores than MNE, NMLE, and NMHE chops; and MLE and NMNE chops had (P<.05) lower scores than MNE chops. At 8 d, MHE chops had (P<.05) lower scores than all other treatments; and NMHE and MLE chops had (P<.05) lower scores than MNE chops. Instrumental Hunter L*, a*, and b*, and ratios of reflectance at %R630/%R580 and %R610/%R580 supported visual data suggesting a delay in color deterioration for MHE chops. At 0 d, LM chops from pigs fed NMHE, MLE, and MHE had (P<.05) lower thiobarbituric acid-reacting substance (TBARS) values than NMLE and MNE chops. At 4 d, LM chops from pigs fed high levels of vitamin E had (P<.05) lower TBARS values than chops from pigs fed no vitamin E and the MHE chops had the lowest numerical values. No differences (P>.05) were detected for Warner-Bratzler shear force and sensory panel evaluations. Feeding MTO in combination with high levels of vitamin E extended display life without affecting palatability.

Key Words: Pork, Modified tall oil, Longissimus muscle

79 Carcass and live value of cull beef cows.

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Mature beef cows (n = 111) were slaughtered to determine the influence of body condition scores (BCS) on carcass and live animal value. All cows were weighed and assigned BCS, based on a 9-point scale, 24 h before slaughter. By-product weights were recorded during slaughter, and, after a 48-h chill period, the right side of each carcass was fabricated into boneless subprimal cuts, minor cuts, lean trim, fat, and bone. Cuts were progressively trimmed to 6.4 and 0.0 mm of external and visible seam fat, and weights were recorded at all stages of fabrication. Gross value was the sum of the carcass value and the offal value, and net value was calculated by subtracting a slaughter fee ($28.00/animal) and a processing fee ($7.75/45.45 kg hot carcass wt) from the gross value. Offal value decreased linearly (P < .001) as BCS increased from 2 to 8. Among U. S. Cutter carcasses, BCS-6 cows had higher (P < .05) carcass values than BCS-2 and 5 cows. Cutter-grade carcasses from BCS-2 cows had the lowest (P < .05) and carcasses from BCS-4 and 6 cows had the highest (P < .05) gross and net values at both fat-trim levels. Cows assigned a BCS of 2 had higher (P < .05) live values than cows assigned a BCS of 5 when carcasses received a quality grade of U. S. Cutter. Within the U. S. Utility grade, BCS-8 cows had lower (P < .05) carcass values than cows assigned a BCS of 3 through 7. Although gross and net values of BCS-7 and 8 cows were higher (P < .05) than BCS-3, 4, and 5 cows within the Utility grade, BCS had no effect (P > .05) on live value. Across the Utility/Cutter mix, gross and net value increased linearly (P < .001) as BCS increased from 2 to 8. When subprimal cuts were trimmed to 6.4 mm of fat, live value also increased linearly (P < .001) from 2 to 8, with BCS-2 cows having the lowest (P < .05) and BCS-7 cows having the highest (P < .05) live values. Although no differences (P > .05) were noted between BCS when cuts were trimmed free of visible fat, the same linear (P = .02) trend was found where live value increased from a low of $42.10/45.45 kg at BCS of 2 to a high of $46.10/45.45 kg at a BCS of 7.

Key Words: Beef Cows, Value, Body Condition

80 Estimation of pork longissimus dorsi intramuscular fat.

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Chemical intramuscular fat (IMF) content of different regions of the longissimus dorsi (LD) were compared to the chemical IMF content of the entire LD of 40 pork loins (20/rep). Boneless loins were selected at a commercial processing plant based upon visual indicators of IMF to represent a wide variation of IMF content. Five sampling locations were used to estimate the IMF content of the LD. Sampling locations included were 6th/7th rib (A); last rib (B); last lumbar (C); pooled, weighted sample from locations A, B and C (ABC); and LD from the 6th/7th rib to the last rib (D). Sample D and the remaining LD were homogenized using a Fatosa Silent Cutter (5 rev at 1524 rpm). Samples of the LD from each sampling location were submitted for proximate analyses (CEM FAS-9001 Fat Extraction System). The mean IMF content of the entire LD was 3.77% (range: 1.79 - 7.41%). Sampling locations A, B, C, ABC and D had mean IMF contents of 3.05%, 1.91%, 3.94%, 2.70% and 3.26%, respectively. Spearman rank correlations indicated the IMF content of all sampling locations were highly related (P<.0001) to the IMF content of the entire LD (range of r = 0.77129 - 0.86924). In conclusion, all sampling locations provided desirable estimates (P<.0001) of the relative ranking of the IMF quantity within the LD. However, the absolute values for IMF content are dependent upon the sampling location. Therefore, for IMF content conclusions to be meaningful, care must be taken to obtain samples from the same anatomical location within a research trial, and when comparing the results of different studies, the sampling location must be noted.

Key Words: Pork, Longissimus dorsi, Intramuscular fat

81 The relationship between tenderness of longissimus and tenderness of other pork muscles.

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The objectives of this experiment were to determine 1) the relationship between tenderness of the longissimus and tenderness of other muscles in the pork carcass, and 2) how factors affecting pork tenderness vary among muscles. Twenty-three white composite barrows were slaughtered and carcasses (70 kg) chilled at 0°C for 24 h. At 1 d postmortem, the longissimus lumborum (LD), biceps femoris (BF), semimembranosus (SM), semitendinosus (ST), and triceps brachii, long head (TB) were dissected from one side of each carcass and frozen. Trained sensory panelists evaluated tenderness and connective tissue amount (8 = extremely tender and none, 1 = extremely tough and abundant) on grilled (70°C) chops. Raw chops were used for total collagen, sarcomere length (SL), and the extent of proteolysis with Western blotting of desmin. Due to long sarcomeres, ST and TB were tender despite high collagen content and low proteolysis. Due to shorter sarcomeres, LD was less tender than ST and TB, despite less collagen and greater proteolysis. Due to lower proteolysis, SM was less tender than LD, but more tender than BF due to lower collagen. The simple correlations between LD tenderness and the tenderness of other muscles were .54 (SM), .36 (ST), .36 (TB), and .18 (BF). Total collagen, sarcomere length, and proteolysis accounted for 55% of the variation in tenderness rating among all samples. These data indicate pork muscles vary widely in tenderness of grilled chops, provide a basis for variation in pork tenderness among muscles, and should contribute to efforts to improve the quality and value of underutilized pork cuts.

Muscle	Tenderness	Connective tissue	Collagen, mg/g	SL, μm	Desmin, % degraded
ST	7.2^{a}	7.6^{a}	5.3^{c}	2.5^{a}	$.3^{c}$
TB	7.1^{a}	7.5^{a}	6.0^{b}	2.4^{a}	-4.8^{c}
LD	6.4^{b}	7.2^{b}	4.1^{d}	1.8^{bc}	39.0^{a}
SM	5.7^{c}	6.7^{c}	4.5^{d}	1.8^{b}	24.4^{b}
BF	4.0^{d}	5.4^{d}	7.1^{a}	1.7^{c}	19.9^{b}

^{abcd}P < .05.

Key Words: Muscle, Pork, Tenderness

82 Improving shear force protocols for evaluation of pork longissimus tenderness.

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The present experiments were conducted to determine if improved beef longissimus shear force methodology could be used to assess pork longissimus tenderness. Specifically, two experiments were conducted to determine the effect of belt grill (BG) cookery on Warner-Bratzler shear force (WBSF) and to estimate the repeatability of pork longissimus slice shear force (SSF). In each experiment, the longissimus was removed from the left side of each carcass (Exp. 1, n = 25; Exp. 2, n = 23) at 1 d postmortem and immediately frozen to maximize variation in tenderness. Repeatability of shear force was estimated as the proportion of the total variance attributable to the variance among carcasses. In Exp. 1, chops were cooked with either open-hearth broilers (OH) or BG and WBSF was measured. Percentage of cooking loss was lower (P < .001) and less variable for chops cooked with a BG (23.1 ± .4 vs 28.2 ± .6). Estimates of the repeatability of WBSF were similar for chops cooked with OH (.61) and BG (.59). Although significant (P < .01), differences in WBSF (4.3 vs 4.0) between cooking methods accounted for less than 5% of the total variation in WBSF. In Exp. 2, four chops were obtained from the center of each loin and cooked with a BG. Slice shear force was measured for each chop. The four chops from each loin were divided into two replicates consisting of two chops per replicate. Slice shear force values were averaged for the two observations within each replicate and the average shear force value was the experimental unit. Under this protocol, the repeatability of pork longissimus SSF was .72. This value is within the range (.53 to .86) of our published estimates of the repeatability of beef longissimus WBSF, but lower than estimates of the repeatability (.91) of beef longissimus SSF. Use of BG cookery and SSF could facilitate the collection of accurate pork longissimus tenderness data. Time and labor savings associated with BG cookery and the SSF technique should help to reduce research costs.

Key Words: Longissimus, Pork, Tenderness

83 Growth and health of Holstein calves fed milk replacers supplemented with antibiotics or Enteroguard®.

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To control infection by enteric pathogens in preweaned calves, antibiotics, oligosaccharides, or probiotics are often included in milk replacers. Forty-five Holstein calves were used to compare the effects of milk replacers containing either antibiotics (oxytetracycline at 138 mg/kg and neomycin at 276 mg/kg, MRA, n = 22) or a blend of fructooligosaccharides, allicin, and gut-active microbes (Enteroguard®, MRE, n = 23) on growth and health. Milk replacers were fed at 0.23 kg twice daily. All calves received 2.84 L of colostrum within 2 h after birth and 12 h later. Mean immunoglobulin content of the colostrum as determined by specific gravity was 55 mg/ml and was not different ($P = 0.86$) between treatments. Starter grain mix was fed for ad libitum consumption from 21 to 35 d of age. There were no differences between starter intakes (mean = 0.22 kg/d, $P = 0.29$) or mean body weight gain (0.17 vs. 0.14 kg/d for MRA and MRE, respectively, $P = 0.47$). Gain of calves fed MRA tended to be less than that of calves fed MRE during wk 2 (0.07 vs. 0.09 kg/d) and greater during wk 5 (0.62 vs. 0.51 kg/d, $P = 0.09$ for treatment × wk). Total gain for calves fed MRE was not different compared with gain for calves fed MRA ($P = 0.53$). Likewise, feed efficiencies (gain / DMI) were not different ($P = 0.80$); but feed efficiency tended to be lower for calves fed MRA during wk 2 than for calves fed MRE and greater during wk 5 ($P = 0.06$ for treatment × wk). Severity of scours as measured by fecal scores was not different between MRA and MRE (1.8 vs. 1.9, $P = 0.92$). Serum proteins, an indirect measure of immunoglobulins, were similar for MRA and MRE (5.4 vs. 5.3 mg/dl, $P = 0.21$). Overall performance, as measured by weight gain, feed efficiency, and health of calves fed milk replacer containing Enterogaurd® was equal to that of calves fed milk replacer containing antibiotics.

Key Words: milk replacer, antibiotics, calves

84 Influence of amino acid content of grower and finisher diets on quality characteristics of pork from Duroc pigs selected for lean growth effiency. S. M. Lonergan*[2], E. Huff-Lonergan[2], L. I. Chiba[1], L.T. Frobish[1], S. B. Jungst[1], and D. L. Kuhlers[1], [1]*Auburn University,* [2]*Iowa State University.*

Indirect selection for lean growth efficiency has generated a line of Duroc pigs (S) that is leaner than a randomly selected control line (C). An investigation designed to determine effects of selection and dietary lysine levels during the grower (20-50 kg) and finishing (50-112 kg) phases on fresh pork quality was conducted. Barrows (n=32) and gilts (n=32) were pen fed in pairs by treatment combination of selection line (C or S) grower diet (.421 or .762 lysine:DE, g/MJ),and finisher diet (.421 or .656 lysine:DE, g/MJ). Carcass composition data and quality attributes of longissimus dorsi (LD) semimembranosus (SM), semitendinosus (ST) and biceps femoris (BF) were documented. Carcasses from S line had less backfat and higher percent muscle than C line carcasses. Neither diet nor selection affected LD subjective color or marbling scores. Hunter L values were higher in S line BF and SM chops and Hunter a values were higher in S line ST, LD and BF chops when compared to C line chops. Selection for lean growth resulted in lower pH in SM and LD muscles at 45 minutes, but not 24 h postmortem. LD chops from S line pigs had lower subjective firmness scores, higher percent moisture and protein lost as purge, and tended (P<.10) to have higher Warner-Bratzler shear values (WBS) than LD chops from C line. BF chops from S line had greater drip loss than C line. Napole yields in SM, BF, and LD were not affected by line or diet. Within S line LD, the high lysine finishing diet group had higher percent moisture lost as drip than the low lysine diet. The high lysine grower diet resulted in higher LD WBS than the low lysine grower diet within S line pigs. The S lean growth efficiency line of pigs produced poorer quality pork regardless of dietary treatment. Line by diet interactions indicate that pork quality traits may be influenced by production practices in specific genetic lines of pigs.

Key Words: Pork, Meat Quality, Lean growth efficiency

85 Dietary Modifications using Vitamin D3 to Improve Beef Tenderness. J. L. Montgomery*, M. A. Carr, C. R. Kerth, G. G. Hilton, L. L. Behrends, E. R. Behrends, and M. F. Miller, *Texas Tech University, Lubbock Texas.*

A total of 167 feedlot steers were weighed and placed in pens with other steers of similar weight. A total of 42 pens of 4 steers each were blocked into 7 categories according to similar average weight. Six vitamin D3 treatments (28 head/treatment) of no supplemental vitamin D3, million, 1 million, 2.5 million, 5 million, and 7.5 million IU/steer/d were randomly applied to each of the 7 categories. Treatments were supplemented for 8 consecutive days starting at 10 d prior to slaughter. 2.5, 5, and 7.5 million treatments reduced feed intake averages per steer (P < .05) at the end of the feeding trial. Control carcasses tended (P = .10) to have higher temperatures 3 h postmortem and had the highest (P < .05) temperatures, 15.6C higher vs. vitamin D treatments at 24 h postmortem. Control carcasses had higher (P < .05) Minolta b* values. Treatments had no effect on carcass quality factors. Therefore, vitamin D treatments do not negatively effect quality factors. Thus, any improvements which vitamin D supplementation can make to meat tenderness can be gained without negatively effecting carcass traits. Individual USDA yield factors were not significantly changed between vitamin D treatments, although overall USDA Yield Grades for 5 and 7.5 million treatments were reduced (P < .05). Vitamin D3 treatments significantly reduced shear force of inside round steaks at d 7 and 10. Vitamin D3 treatments of million, 1 million, and 5 million IU/ d reduced shear force of round steaks on d 7 (P < .05). All vitamin D3 treatments reduced the shear force of round steaks at d 10 (P < .05). Vitamin D treatments reduced shear force variation of longissimus steaks and tended to reduce shear forces (P = .0758) of million and 7.5 million treated cattle at 7-d postmortem. Vitamin D3 treatments of million and 2.5 million reduced (P < 05) WBS of 7-d longissimus steaks for Hereford steers. Vitamin D treatments of million, 1 million, 5 and 7.5 million treatments reduced (P < .05) WBS of inside round steaks of Continental-steers at 7-d postmortem and all vitamin D treatments reduced WBS at 10-d postmortem. Thus, vitamin D3 treatments will effectively improve tenderness if cattle tend to be tough and have no impact on cattle that produce tender beef.

Key Words: Beef, Tenderness, Vitamin D

86 Relationship of muscle fiber orientation during Hydrodyne treatment to tenderness, aging, and proteolysis of beef. B. M. O'Rourke[1], C. R. Calkins*[1], R. T. Rosario[1], J. S. Eastridge[2], M. B. Solomon[2], and J. B. Long[3], [1]*University of Nebraska, Lincoln, NE,* [2]*USDA, ARS, BARC, MSRL, Beltsville, MD,* [3]*Hydrodyne, Inc., San Juan, PR.*

This study was conducted to determine the influence of muscle fiber orientation during treatment on the extent of tenderization from the Hydrodyne process. The Hydrodyne process involves creation of a shock wave within a water-filled tank which enhances meat tenderness through the resulting microstructural damage in the vacuum-packaged meat. Paired semitendinosus muscles from 10 USDA Select beef carcasses were used. One side of each pair was held as a control and the opposite side was treated with Hydrodyne (350 g explosive, 46 cm from the meat) 5 d post mortem. The treated side was cut in half and assigned either horizontal or vertical positioning in the 1060 L Hydrodyne tank. Samples for shear force determination and electrophoretic analysis were removed from controls at d 5 and d 15, horizontal samples at d 5 and d 15, and vertically oriented beef at d 5 post mortem. Steaks were broiled to 70 C. Control, d 5 samples (6.22 kg) were significantly (P < .05) tougher than control, d 15 (4.38 kg) and Hydrodyne-treated samples (horizontal d 5, 4.74 kg; d 15 4.57 kg; and vertical d 5, 5.22 kg). No significant differences were found between vertical semitendinosus muscles whether they were sampled proximal to or distal from the tank wall. When the d 5 vertical and horizontal orientations were compared without inclusion of the controls in the analysis, vertical samples were significantly (P < .05) less tender (.48 kg) than were samples with a horizontal orientation. Electrophoretic gels showed limited proteolytic differences among samples due to the Hydrodyne treatment. Muscle fiber orientation is important during Hydrodyne treatment, suggesting cuts must be placed in a specific orientation within the Hydrodyne unit for optimal effectiveness in tenderization.

Key Words: Beef, Tenderness, Aging

87 Dietary supplementation of creatine monohydrate in swine finishing diets improves fresh pork quality. E. P. Berg*, J. D. Spencer, and G. L. Allee, *University of Missouri-Columbia.*

Creatine monohydrate (CMH) was fed during the final stage of growth to determine its effects on fresh pork quality. Twenty-four Duroc-sired market hogs (107 kg) were individually penned and fed a traditional finishing diet. Treatments consisted of a control diet (C) tested against two durations of CMH supplemented diets (25g CMH/pig/day) fed for 5 (T1) or 10 (T2) days prior to slaughter. Eight replicates were used per treatment. Pigs were slaughtered on day 11 of treatment (118 kg). Postmortem pH was measured in the loin (10th rib) and ham semimembranosus (SM) at 45 min (PH1) and 24 hs (PH2). At 24hs, Hunter L-values were taken at the 10th rib and the ham face (gluteus medius). At 48hs drip loss (DRIP) was determined from the loin (8th rib) and SM. Percentage of moisture, crude fat, and crude protein were determined for loin (9th rib) and SM. Treatment 2 SM had a higher PH1 (P<.06) and PH2 (P<.02) than C. A declining trend was shown with length of CMH supplementation for ham L-values and DRIP. Treatment 2 SM had the highest proportion of moisture and lowest CP:moisture ratio suggesting greater myofiber hydration. No statistical differences were detected across treatments for loin PH1, PH2, or CP:moisture, however, a quadratic trend was observed for DRIP. Loins from T1 had significantly more chemical fat than C (T2 was intermediate) suggesting optimal CMH saturation may allow more i.m. fat deposition. Standard deviations of ham L-value means for T1 and T2 were 26 and 48% lower than C, while loin L-value SD for T1 and T2 were 51 and 64% lower than C. These results suggest that CMH supplementation buffers early and ultimate pH decline in the SM, reduces 48h moisture loss, and provides for more uniform fresh pork color.

	C	T1	T2	SEM	P-value Linear	Quad
Ham PH1	6.11	6.32	6.49	0.13	0.06	NS
Ham PH2	5.57	5.56	5.78	0.06	0.02	0.12
Ham L-value	44.2	42.9	42.1	1.31	0.26	NS
Ham DRIP	3.80	3.28	2.47	0.72	0.18	NS
Loin DRIP	6.04	4.30	5.20	0.73	0.40	0.14
Ham CP:Moisture	35.1	34.5	33.9	0.67	0.19	NS
Loin CF	2.77	4.40	3.55	0.54	0.29	0.06

Key Words: Pork, Quality, Creatine

88 Color Stability and Tenderness Properties of Beef from Vitamin E Fed Cattle. S.E. Harris[1], E. Huff-Lonergan*[2], and S.M. Lonergan[2], [1]*Auburn University,* [2]*Iowa State University.*

The objectives of this study were to determine if vitamin E supplementation inhibits discoloration in beef injected with calcium chloride and to determine if supplementation affectes the tenderness properties of calcium chloride injected beef. Twelve market heifers were fed a standard finishing diet with minimal levels of vitamin E (C group). Another twelve market heifers were fed the C diet with 1000 IU of DL-α-tocopherol/head/day for the last 125 days on feed (E group). Animals were slaughtered after 125 d on experimental diets and upon reaching an ultrasound backfat thickness of 10 mm. Longissimus dorsi were removed from all carcasses at 24 hours postmortem. Half of the muscles from each treatment group (C and E) were immediately pumped to 10% over the original weight with 250 mM $CaCl_2$ (Ca treatment). Remaining muscles (C and E) were pumped to 10% over the original weight with water (W treatment). All muscles were vacuum packaged overnight. Steaks (2.54-cm) were overwrapped with O_2-permeable film and stored at 8C for 7 d postinjection (PI). Hunter L, a, b values were obtained each day of storage. Trained panelists evaluated color on days 1, 4, and 7 PI. TBA values were measured on days 1 and 7 PI. Warner-Bratzler (W-B) shear force values and trained sensory panel evaluations of tenderness and flavor at 1, 3, and 7 d PI were obtained. Immunoblotting techniques were used to monitor the 30 kDa degradation product of troponin-T at 1, 3, and 7 d PI. At 4 d PI E/Ca steaks were the least discolored (P<.05). E/Ca steak TBA values were not significantly different from C/W steaks at 7 d PI, while C/Ca steaks had greater (P<.05) TBA values after 7 d PI compared to all other groups. Ca treatment resulted in higher off-flavor scores (P<.05). E/Ca samples had the most rapid tenderization and proteolysis. W-B values were lower in E/Ca samples than in E/W samples at 1, 3, and 7 d PI (P<.05). No difference in tenderness was noted between C/Ca and C/W samples. Injection of $CaCl_2$ may result in more rapid and immediate tenderization if beef from animals supplemented with vitamin E is used.

Key Words: beef tenderness, Vitamin E, beef color

89 Comparison of the meat quality traits of the porcine longissimus dorsi and gluteus medius muscles. L. A. Kinman*[1], R. C. Johnson[2], P. K. Camfield[1], C. P. Allison[2], and J. E. Cannon[2], [1]*Oklahoma Panhandle State University, Goodwell, OK,* [2]*DEKALB Swine Breeders, Inc., DeKalb, IL.*

Longissimus dorsi (LD) and gluteus medius (GM) muscles from the right side of 80 pigs (2 reps, 40/rep) of diverse genetic backgrounds were used to compare the meat quality traits of color, water holding capacity and tenderness of the two muscles. Color (L*, a*, b*) of both the LD and GM was measured on day 2 and 7 postmortem with a HunterLab MiniScan XE (D65/10°). Purge loss was determined by difference following vacuum packaged, refrigerated storage from day 2 to day 7. Following cooking in a CTX G-26 Conveyor Oven (17 min at 482°C), cooking loss was also obtained by difference. Warner-Bratzler (WB) shear force values were obtained from three cores (13 mm diameter) from two chops from the LD (six cores total) and four cores from the GM of each pig. LD and GM mean pH values at 22 hr postmortem (5.73 vs 5.89) were different (P<.01). On both day 2 and day 7, L* values for the LD were higher (P<.01) than GM L* values (Day 2: 50.7 vs 45.3, Day 7: 49.0 vx 43.9). Purge loss of the GM (2.59%) was greater (P<.01) than LD purge loss (1.14%). GM cooking loss was also greater (P<.01) than LD cooking loss (31.9% vs 26.0%). WB shear force values were less (P<.01) for the LD (2.6 kg) than the GM (3.1 kg). Rank correlations for color on day 2 and 7 (P<.0001), purge (P<.0003), cooking loss (P<.02), and WB shear (P>.05) were .54, .42, .39, .26, and -.04, respectively. The results of this study indicated the relationship between color and water holding capacity measurements of purge and cooking loss of the LD and GM were intermediate. However, WB shear values of the two muscles were not related.

Key Words: Pork, Meat quality

90 The effect of dietary vitamin C on meat quality of pork. B. T. Kremer*, T. S. Stahly, and R. C. Ewan, *Iowa State University, Ames.*

Fourteen sets of three barrows, from a high lean halothane-free genetic strain, weighing 29.7 ± 3.6 kg were used to determine the effects of dietary vitamin C on pork quality. Vitamin C can be metabolized to oxalic acid which in turn has been shown to inhibit glycolysis and improve pork quality. Pigs were offered a basal diet (15 g/kg BW) containing 0, 783, or 2348 ppm vitamin C for 4 h prior to stunning. Pigs were transported 5 km to the ISU Meat Lab and killed within 60 min of arrival. Pigs were stunned with 270 V for 5 s and exsanguinated. Longissimus muscle pH and temperature were determined at 22, 45, 90, and 180 min postmortem. At 180 min postmortem, the carcass was chilled at 0°C. At 24 h postmortem, chops (2.5 cm) were taken from the longissimus and semimembranosus for measurement of water loss (WL) and Hunter color scores on d 0, 3, 6, 9, and 12 of retail storage (7.2°C). Pigs consumed 325, 371, and 300 g of feed (P < .02), respectively, resulting in intakes of 0, 290, and 715 mg of vitamin C. Dietary vitamin C increased (P < .05) muscle pH (6.06 vs 6.14, 6.18) pooled across time postmortem. Dietary vitamin C also lowered (P < .07) percentage WL (5.99 vs 5.78, 5.21%) pooled across storage days. Dietary vitamin C lowered (P < .01) Hunter L* values (47.9 vs 45.7, 47.5) but raised (P < .02) Hunter a* color values (8.9 vs 10.0, 9.2), but the magnitude of response was minimized as storage time increased. Muscle pH and water loss were similar between the 738 and 2348 ppm feeding levels. Short-term feeding of vitamin C was effective in reducing the water loss and improving the color scores of pork.

Key Words: Pigs, Pork quality, Vitamin C

91 Effects of CLA supplementation on pork quality characteristics in crossbred growing-finishing barrows. B.R. Wiegand*, F.C. Parrish, Jr., and J.C. Sparks, *Iowa State University Ames, IA.*

Pork quality characteristics including color, marbling, firmness, water holding capacity (WHC), pH and lipid oxidation were measured on pork loins from crossbred barrows supplemented with 0.75% of conjugated linoleic acid (CLA) in the diet. Ninety-two crossbred barrows were assigned by litter, to four treatment groups with five replications per treatment. Treatments were defined as the body weight of pigs when they were placed on CLA and included a control(T1), 90 kg (T2), 65 kg (T3) and 40 kg (T4). Pigs averaged 115 kg at slaughter. Whole bone-in loins were removed from the left side of the carcass at 24 hr postmortem. Subjective color, marbling and firmness were evaluated with a five-point scale at 72 hr postmortem. Lipid oxidation, pH and WHC characteristics were evaluated at 1, 14 and 28 d of shelf storage. A linear relationship was observed for subjective marbling (p<.03) and subjective firmness (p<.07) with increases in both characteristics with increasing time on a CLA diet. Differences in subjective marbling scores were supported by similar differences in ether extractable fat, where T4 chops had more (p<.02) fat than T1 chops. CLA fat tended to be firmer than control fat. This was supported by a high correlation (0.93) between subjective marbling and firmness scores. T4 chops exhibited less lipid oxidation (p<.05) compared with T1 at 1 d of shelf storage. Additionally, T4 chops tended to exhibit higher Hunter a* values which corresponds to a redder product. Also, T4 chops exhibited higher Hunter b* values (p<.03), indicating a more yellow color than T1 chops. Measures of pH, WHC, subjective color and lipid oxidation at 14 and 28 d were not significantly affected by CLA supplementation. Supplementation with CLA in the growing-finishing diet could potentially improve certain measures of pork quality including subjective marbling, subjective firmness and Hunter red values. These improvements could result in a pork loin product with greater consumer acceptability.

Key Words: swine, conjugated linoleic acid, pork quality

92 Effects of CLA supplementation on ham quality characteristics of crossbred growing-finishing barrows. S.T. Larsen*, B.R. Wiegand, F.C. Parrish, Jr., and J.C. Sparks, *Iowa State University, Ames, IA*.

Pork quality characteristics of fresh and processed semimembranosis muscles were measured subjectively and objectively from barrows supplemented with 0.75% of conjugated linoleic acid (CLA)in the diet. Ninety-two crossbred barrows were assigned by litter to five treatment groups with five replications per treatment. Treatments were defined as the body weight when barrows were placed on CLA and included a control (T1), 90kg (T2), 65kg (T3)and 40kg (T4). Barrows averaged 115kg at slaughter. Whole bone-in hams were removed from the left side of the carcass at 24hr postmortem. Subjective color, marbling and firmness of the semimembranosis muscle at 48hr postmortem were evaluated by using a five-point scale. Also, color of semimembranosis muscles was measured using the L*, a* and b* Hunter scale. At 24hr postmortem, pH was determined. For fresh hams, a linear relationship was observed for redder subjective color ($p<.02$), increased marbling ($p<.03$) and greater uniformity ($p<.009$) with increasing time on CLA. Additionally, CLA hams tended to have higher Hunter L* values compared to control hams. Values for pH, Hunter a* and b* in fresh hams, were not significantly affected by CLA supplementation. In addition, the semimembranosis muscle was removed from 25 hams, twelve controls (T1) and thirteen CLA (T4) and each pumped to 25% of its green weight. Cured hams were evaluated for sensory attributes using a ten point scale to determine texture, flavor, saltiness and overall acceptability. Additionally, color of cured hams was measured using the L*, a* and b* Hunter scale, and tenderness was determined by using the Warner-Bratzler Shear technique. Results for sensory attributes, Hunter values and tenderness characteristics were not significantly affected by supplementation of CLA in the finishing diet.

Key Words: swine, conjugated linoleic acid, ham quality

93 Effects of CLA supplementation on quality and sensory characteristics of pork. R.L. Thiel-Cooper*, B.R. Weigand, F.C. Parrish, Jr., and J.A. Love, *Iowa State University, Ames, IA*.

Dietary conjugated linoleic acid (CLA) has been shown to improve pork carcass composition by decreasing fat and increasing muscle deposition. Two experiments were conducted to determine the effects of feeding CLA on specific quality and sensory characteristics of pork. Forty crossbred barrows (26 kg) were randomly assigned by litter to five treatment groups with eight litter replications per treatment. Treatments were defined by diet and included a control, .12, .25, .50, or 1.0% CLA by weight of the diet. Pigs were harvested at 116 kg. Study 1 (S1) ws designed to investigate dietary CLA (0, .12, .25, .50, 1.0%) impacts on loin quality traits one day postmortem. Study 2 (S2) compared dietary CLA (0, 1.0%) on color and sensory characteristics of loin chops aged 7, 14, 28, and 56 days postmortem. S2 chops were held at 2°C under vacuum and were frozen on designated days. In S1, no differences were found for day one postmortem pH, water-holding capacity (Carver press method) and Warner-Bratzler shear between CLA and control loin chops. Hunter a values for S1 chops showed a linear increase ($p<.01$) with increasing amounts of CLA in the diet. Subjective color, firmness and marbling scores at the 10th-11th rib interface were not different between CLA treated loin chops and controls. A trained sensory panel for S1 determined that initial juiciness was the only sensory characteristic in which controls were different ($p<.04$) compared to all other treatment groups. No differences were observed in Hunter L, a, and b balues for S2 at any day (7, 14, 28, or 56) postmortem. Trained sensory panel results for S2 loin chops found no differences between treatments for initial juiciness, sustained juiciness, initial tenderness and overall tenderness, however linear improvements were noted for each of these characteristics through day 28 postmortem. The ability of CLA to improve Hunter a values could potentially provide fresh loin chops with additional consumer appeal. CLA does not seem to have any detrimental effect on fresh pork quality.

Key Words: pork, conjugated linoleic acid, meat quality

94 Effects of vascular infusion of cattle after exsanguination with a solution of saccharides, sodium chloride, and phosphates, with or without vitamin C, on carcass and meat palatability traits. E.J. Yancey*[1], T.E. Dobbels[1], M.E. Dikeman[1], and E. Katsanidis[2], [1]*Kansas State University, Manhattan,* [2]*University of Minnesota, St. Paul*.

Two groups of 18 grain-finished, Charolais steers were utilized in this study. Nine from one group of 18 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; MPSC, Inc., Eden Prairie, MN). The remaining nine steers served as non-infused controls (Con). An additional 18 steers were infused with either the MPSC solution (n=9) or the MPSC solution + 500ppm vitamin C (MPSC+C)(n=9). Steers infused with the standard MPSC solution had a 2.9% higher mean dressing percentage ($P<.05$) than Con steers. Vascular infusion had no effect ($P>.05$) on USDA yield or quality grades, percentages of purge loss from vacuum packaged muscles, or Warner-Bratzler shear force values of the Longissimus lumborum and Semitendinosus muscles. Results from a Descriptive Flavor Profile Sensory Panel for both freshly cooked and warmed-over Longissimus and Semitendinosus muscles and ground beef showed that several statistically significant differences in flavor profile characteristics resulted from MPSC infusion, but these differences were somewhat inconsistent and likely too small to be of practical importance. Flavor profile characteristics that were variable and inconsistent were soapy/chemical, cardboard flavor, bloody/serumy, and oxidized/painty. Our results show that vascular infusion with the standard MPSC solution or MPSC+C should increase carcass weights, have minimal effects on USDA yield and quality grade traits, and cause some inconsistent effects on the flavor profile characteristics of cooked beef.

Key Words: Beef, Vascular Infusion, Palatability

95 Effects of vascular infusion of cattle after exsanguination with a solution of saccharides, sodium chloride, and phosphates, or with calcium chloride on carcass traits and meat palatability. M.E. Dikeman*, T.E. Dobbels, J.J. Schoenbeck, and M.C. Hunt, *Kansas State University, Manhattan, Kansas*.

Grain-finished Hereford x Angus steers (n=36) were used to evaluate the effects of vascular infusion on carcass traits and meat palatability. Twenty-four steers were infused via the carotid artery immediately after exsanguination at 10% of live weight with either a solution containing 98.52% water, .97% saccharides, .23% NaCl, and .28% phosphates (MPSC standard solution, MPSC, Inc., Eden Prairie, MN)(n=12); or with .3M CaCl2 (n=12). Twelve steers served as non-infused controls (Con). After infusion, steers were dressed and chilled conventionally. Steers infused with CaCl2 displayed extensive muscle contraction at the time of chilling. This resulted in undesirable hemorrhaging and fluid accumulation between muscles at the time of fabrication. Mean dressing percentage was increased ($P<.05$) 4% by infusing the MPSC solution and 2.3% by the CaCl2 solution. In addition, hearts and livers were heavier for steers infused with the MPSC solution. At 24h postmortem, lean was firmer and finer textured ($P<.05$) for Con carcasses than those infused with either solution. Infusion had no effect ($P>.05$) on USDA yield and quality grade traits. Percentages of purge were 1.2 and 1.6% lower ($P<.05$) for the Quadriceps muscle of MPSC-infused carcasses after 14d aging than for Con and CaCl2 -infused carcasses, respectively, but purge was not different in four other muscles. Longissimus muscles from CaCl2 -infused carcasses had higher Warner-Bratzler shear values and lower sensory panel tenderness and juiciness scores than those from MPSC-infused or Con carcasses ($P<.05$). Flavor profiles of both freshly cooked and warmed-over Longissimus and Semitendinosus muscles and ground beef from CaCl2 -infused carcasses were undesirably different ($P<.05$) than those from Con and MPSC-infused carcasses. Longissimus muscles from MPSC-infused carcasses were not different($P>.05$) in shear force or palatability from those of Con. Vascular infusion at 10% of live weight with the MPSC solution should increase dressing percentage and have minimal effects on meat palatability of grain-fed steers, whereas infusion with .3M CaCl2 should increase dressing percentage, but cause undesirable intermuscular fluid accumulation, toughness, and undesirable flavor.

Key Words: Beef, Vascular Infusion, Palatability

96 Ultrasound assessment of marbling score in steers and bulls. R. Rekaya*[1], J. R. Brethour[2], S. C. Arp[1], and D. M. Schaefer[1], [1]*University of Wisconsin, Madison, WI,* [2]*Kansas State University, Hays, KS.*

Ultrasound assessment is a non-invasive method of marbling score estimation. The CPEC system was developed with Aloka 210 equipment. Due to the unavailability of this equipment, the objective was to substitute Aloka 500 equipment and evaluate the accuracy of this system for marbling score prediction.
Images of finished Holstein steers and bulls were collected via a 15 cm, 3.5 MHz transducer positioned sagittally over the 12th and 13th ribs. The marbling score assigned by a USDA meat grader to the ribeye which had been insonified was recorded for each carcass. A 0.5 cm surface slice collected from the insonified ribeye was dissected to yield longissimus in which ether-extractable lipid percentage (EE) was determined. EE was converted to marbling score (EEM) using the Savell equation. Data from 219 steers and bulls were clustered into four quality grade subgroups (Prime, Choice, Select, Standard) based on EEM. From each subclass, 2/3 of the animals were chosen randomly to be used in the training data set and the other 1/3 for the validation set. The program was used also on a test set of 88 Holstein steers.
The correlation of USDA or CPEC-predicted marbling score to EEM was 0.86 and 0.17, respectively. The CPEC system was modified by inclusion of parameters arising from the Fourier transform and subsequent determination of weighting coefficients by neural networks. Variables added to the CPEC program were the first and second moments of pixel intensities in the region of interest and the mean and standard deviation of pixel values after Fourier transformation as well as the power spectrum. A multilayer perceptrons trained by back propagation was used to compute the new weights for prediction of EE. A two-layer networks with 7 input nodes, one hidden layer with 10 nodes and EE as the real output was implemented. The correlation between marbling score predicted by the revised CPEC program and EEM was improved to 0.67. The combination of Fourier transform variables with run length and gray level variables in the CPEC program resulted in marked improvement in the accuracy of EEM prediction when an Aloka 500 was employed.

Key Words: marbling, ultrasound, beef

97 Serum concentrations of IGF-I and relative amounts of IGF binding proteins (IGFBPs) in growing boars, barrows and gilts. J.A. Clapper* and T.M. Clark, *South Dakota State University.*

To determine if serum concentrations of IGF-I and relative amounts of serum IGFBPs differ in pigs from 70 to 140 d of age, boars (n=11), barrows (n=11), and gilts (n=12) of similar age 67.6 .7 d and weight 31.2 .4 kg were housed in pens of 3 or 4 and given ad libitum access to a 17 % CP corn-soy diet and water. Pigs were weighed, and blood samples collected on the first day of the experiment (d 1), then at biweekly intervals. Serum concentrations of IGF-I were determined by RIA and relative amounts of IGFBPs were determined by ligand blot analysis. Feed/gain (F/G) ratios were calculated biweekly starting at d 29. F/G ratios were similar (P>.05) between barrows (3.1 .2) and gilts (3.5 .2) throughout the experiment and were greater (P<.05) than in boars (2.5 .2). Mean serum concentrations of IGF-I were similar (P>.05) among pigs on d 1. By d 14 and continuing throughout the remainder of the experiment, mean serum concentrations of IGF-I were greater (P<.05) in boars (214.5 13.1 ng/ml) than in barrows (141.4 9.4 ng/ml) or gilts (152.6 5.1 ng/ml). Ligand blot analysis detected 46 and 41 kDa forms of IGFBP-3, a 34 kDa form of IGFBP-2, and 28 and 24 kDa forms of IGFBP-4. Relative amounts of 46 kDa IGFBP-3 and 28 kDa IGFBP-4 were similar (P>.05) among pigs on d 1, however, boars and barrows had greater (P<.05) relative amounts of 23 kDa IGFBP-4 and 41 kDa IGFBP-3 than gilts. Relative amounts of IGFBP-2 were greater (P<.01) in barrows than in gilts or boars on d 1. From d 14 through the end of the experiment relative amounts of both forms of IGFBP-3 and the 28 kDa IGFBP-4 were greater (P<.05) in boars than in gilts or barrows. Relative amounts of IGFBP-2 were greater (P<.05) in barrows than in gilts or boars at d 21 but by d 72 relative amounts were greater (P<.05) in boars and barrows than in gilts. Changes in serum concentrations of IGF-I and relative amounts of IGFBPs may contribute to differences observed in growth characteristics of boars, barrows and gilts.

Key Words: IGF-I, binding proteins, boars

98 The Effects of Caesarian Birth on Immune Function in Two Week Old Pigs. M. E. Zannelli*[1], J. A. Carroll[2], R. L. Matteri[2], L. J. Luchene [1], and L. A. Beausang[1], [1]*Endogen, Inc, Woburn, MA,* [2]*Animal Physiology Research Unit, ARS-USDA, Columbia, MO.*

Each year a large percentage of new born pigs succumb to disease due to stress and diminished immune function in the first 15d of life. Preweaning mortality is prevalent within the first 10-15d of life and represents a significant agricultural loss. The present study was designed to assess what effects, if any, the natural birth process has on the immune function of the neonatal pig. Pigs were delivered by natural birth (N; n=23) or Caesarian birth (C; n=22), non-surgically jugular cannulated at 13d then challenged with LPS (150ug/kg) on day 14. Serum concentrations of IFNg were assessed by utilizing a porcine specific IFNg ELISA following serial blood collection. Basal serum concentrations of IFNg at birth (n=45) were lower (P=0.0208) in the C group as compared to the N group (0.65 +/- 0.53 and 106.1 +/- 45.8 pg/ml, respectively). At 14d, basal serum concentrations of IFNg were lower (P=0.0153) in the C group (471.7 +/- 126.0 pg/ml) as compared to the N group (723.0 +/- 134.9 pg/ml) and both had increased dramatically (P<0.0001) from birth (52.17 +/- 22.7 pg/ml) to two weeks of age (584.07 +/- 88.8 pg/ml). Serum concentrations of IFNg increased between 90 and 120 minutes post-LPS challenge in both birth types and continued to increase over the course of the study. There was no effect (P=0.371) of birth type on serum concentrations of IFNg for the LPS challenged pigs (1613.2 +/- 581.0 and 1033.8 +/- 221.0 pg/ml for the C and N groups, respectively). LPS challenge increased (P=0.0509) serum concentration of IFNg in both birth types compared to saline controls (1323.5 +/- 330.8 and 630.5 +/- 144.6 pg/ml, respectively). Our results indicate that the periparturient events associated with the natural birth process are involved with the postnatal development and function of the immune system in the pig.

Key Words: swine, IFNg, immune system

99 Interactions of Specific Domains of Muscle Talin with Actin Filaments. H.-S. Lee*, J.S. Schmidt, and R.M. Robson, *Iowa State University, Ames.*

Talin, a 272 kDa cytoskeletal protein present in cell-matrix type adherens junctions and thought to help link actin filaments to the cell membrane, contains three actin-binding sites (Hemmings et al., 1996, J. Cell. Sci. 109: 2715-2726), but the nature of their individual interactions with actin is not clear. We have shown that highly purified native talin crosslinks actin filaments in a pH- and ionic strength-dependent manner. The objectives of this study were to determine the abilities of (1) the large calpain-generated 190 kDa C-terminal fragment of talin, which contains two of the three actin-binding sites, and (2) the three individual actin-binding sites of talin fused to GST, to interact with actin as measured by cosedimentation, low shear viscometry and electron microscopy. Each of talin's individual actin-binding sites exhibited a significant pH dependence in its ability to interact with actin. The isolated 190 kDa fragment cosedimented with F-actin with maximal binding at a pH of 6.0, which was lower than required for intact talin. Low shear viscometry studies also demonstrated that the 190 kDa talin fragment significantly increased viscosity of F-actin solutions, but not as effectively as intact talin under identical ionic conditions. Intact talin and the 190 kDa talin fragment crosslinked actin filaments into both networks and bundles, but intact talin was a more effective crosslinker than the 190 kDa fragment when examined under identical ionic conditions. In summary, (1) each of talin's actin-binding sites is highly sensitive to ionic conditions in its ability to interact with actin, (2) the decreased ability of the 190 kDa calpain-generated talin fragment, in comparison to intact talin, may indicate a role for the calpain system in the cytoskeletal remodeling of adherens junctions that occurs coincident with muscle cell development, and (3) the presence of three actin-binding sites in talin may permit the dynamic sensitivity required in attachment of actin filaments to the muscle cell sarcolemma. (Supported in part by USDA-NRICGP 96-35206-3744).

Key Words: Talin, Muscle Cell Cytoskeleton, Actin Attachment Sites

100 Effect of the RN gene, feed withdrawal and lysine deficient diet on fresh longissimus quality. B.S. Bidner*, M. Ellis, D.P. Witte, M. England, D. Campion, and F.K. McKeith, *University of Illinois, Urbana*.

Feed withdrawal and a lysine deficient diet were evaluated on different RN genotypes to determine the effect on fresh longissimus quality. Sixty-four gilts from a commercial hybrid line were allocated to feed withdrawal and deitary treatments based on live weight and glycolytic potential (GP) using live-animal biopsy. Diets containing 4.8 (deficient) or 6.4 g/kg lysine were fed for the last six weeks prior to slaughter. Pigs were fasted 12 or 36 hr prior to slaughter and were not commingled until loading. Mean biopsy GP values were 215±17.5 and 314±23.2 μ mole/g for pigs classified as rn^+rn^+ and RN^-rn^+, respectively. Feed withdrawal for 36 hr did not affect the fresh muscle characteristics of the *longissimus thoracis* (LT) for either genotype. The RN^-rn^+ genotype had a had a lower ultimate pH of the LT (P<.001). The RN^-rn^+ pork had a higher Japanese color score (P<.001), a lower Hunter L$*$ (P<.0001), and a higher Hunter a$*$ (P<.0001). The lysine deficient diet increased intramuscular fat content of the LT by 24 % but reduced average daily gain (P<.01), feed effiency (P<.001), and total carcass % lean. These data suggest that *longissimus* quality was not affected by a 36 hr feed withdrawal and the lysine deficient diet increased % intramuscular fat.

Key Words: Meat Quality, Feed Withdrawal, Lysine Deficient Diet

101 Effect of the RN gene and feed withdrawal prior to slaughter on fresh longissimus quality and sensory characteristics. B.S. Bidner*, M. Ellis, K.D. Miller, M. Hemann, D. Campion, and F.K. McKeith, *University of Illinois, Urbana*.

This study was conducted to evaluate the effect of feed withdrawal on meat quality characteristics of RN^-rn^+ (carrier) and rn^+rn^+ (normal) pigs. Seventy-two pigs from a commercial hybrid line were allocated based upon live weight and RN genotype to feed withdrawal periods of 12, 36, or 60 hr prior to slaughter. The 36 and 60 hr treatments were removed from their rearing groups and commingled with other pigs in a holding pen at the start of feed withdrawal. The 12 hr treatment remained in their rearing group until they were loaded for transport to slaughter at a commercial facility. RN gene status was determined using glycolytic potential (GP) preformed on *longissimus lumborum* (LL) samples obtained using live-animal biopsy. Mean GP values were 176±26.0 and 304±34.6 μ mole/g for pigs classified as rn^+rn^+ and RN^-rn^+, respectively. Feed withdrawal did not influence any meat quality characteristics of the RN^-rn^+ genotype. The 60 and 36 hr feed withdrawal treatments resulted in a higher ultimate pH of the *longissimus thoracis* (LT) than the 12hr treatment in the rn^+rn^+ genotype. Hunter L$*$ of the LT decreased from 55.5±1.8 at 12 hr to 51.8±3.8 after 60 hr off feed in the rn^+rn^+ genotype (P<.05). Subjective color and firmness were not affected by feed withdrawal for either genotype. The RN^-rn^+ genotype had a higher % drip loss of the LT (P<.0001), a higher % purge and cooking loss in the LL (P<.01). LT from RN^-rn^+ animals contanied a higher % moisture (P<.05) and a lower % protein (P<.0001). A 13 cm LL section was aged 7 d, frozen, cut into 2.5 cm thick chops, cooked to 70° C internal temperature and served to a trained 6 member taste panel. RN^-rn^+ pork rated higher for tenderness and juiciness (P<.05). These results suggest that feed withdrawal can improve the meat quality of the rn^+rn^+ genotype without affecting sensory characteristics.

Key Words: RN Gene, Meat Quality, Feed Withdrawal

102 Yield and value of beef by-products from cull beef cows is affected by body condition scores. J. K. Apple*, J. C. Davis, J. D. Stephenson, and C. B. Boger, *University of Arkansas, Fayetteville*.

Mature beef cows (n = 122) representing British and Continental genotypes were slaughtered to measure the effect of body condition scores (BCS) on by-product yields and value. All cows were weighed and assigned BCS, based on a 9-point scale, 24 h before slaughter. By-product yields were calculated as a percentage of the animal's live weight and as a percentage of the animal's shrunk (4.0 %) live weight. Cows assigned a BCS of 2 had the lightest (P < .05), while cows given a BCS of 7 or 8 had the heaviest (P < .05), live weights and total offal weights. Weight of the hide, liver, oxtail, large intestines, and mesenteric fat increased linearly (P < .001) as BCS increased from 2 to 8. Cows with a BCS of 2 had a higher (P < .05) percentage of their live weight as hide, skull, oxlips, tripe, honeycomb tripe, heart, feet and hooves, and lungs than BCS-4 or higher cows. The hide, cheek meat, gullet, liver, oxtail, large intestines, and mesenteric fat from BCS-8 cows had the greatest (P < .05) value. Total by-product value increased linearly (P < .001) from a low of 79.55 for BCS-2 cows to a high of 111.10 for BCS-8 cows. Drop credit, however, was highest (P < .05) for BCS-2 cows and lowest (P < .05) for BCS-6 and BCS-8 cows. By-products from cows in thin condition were of less total value than those from cows in relatively heavy condition, with moderately-conditioned cows being intermediate in value. Thus, BCS appear to be good indicators of both by-product yields and value.

Key Words: Beef Cows, By-Products, Body Condition

103 Influence of body condition scores on carcass characteristics and subprimal yields from cull beef cows. J. K. Apple*, J. C. Davis, J. D. Stephenson, J. E. Hankins, J. R. Davis, S. L. Beaty, C. S. Boger, and C. B. Boger, *University of Arkansas, Fayetteville*.

Mature beef cows (n = 111) were used to measure the effect of body condition scores (BCS) on carcass characteristics and subprimal yields. All cows were weighed and assigned BCS, based on a 9-point scale, 24 h before slaughter. After a 48-h chilling period, carcass data were collected on left sides of each carcass. The right side was processed into boneless subprimal cuts, minor cuts, lean trim, fat, and bone. Cuts were progressively trimmed to 6.4 and 0.0 mm of external and visible seam fat, and yields were calculated as a percentage of the chilled side weight. Live wt, hot and chilled carcass wt, dressing percent, fat thickness, longissimus muscle area, internal fat percent, muscle:bone ratio, numerical yield grade, and quality grade increased linearly (P < .01) as BCS increased from 2 to 8. Cows assigned a BCS of 5 had higher (P < .05) shoulder clod yields than BCS-2, 3, 6, 7, or 8 cows. Carcasses from BCS-2 cows had lower (P < .05) strip loin yields than all other cows. Cows assigned a BCS of 2, 3, 4, and 5 had higher (P < .05) top sirloin butt yields than BCS-6, 7, or 8 cows. Tenderloin yields were greatest (P < .05) for BCS-2 cows, while carcasses from BCS-8 cows had the lowest (P < .05) tenderloin yields. Knuckle yields increased linearly (P < .001) as BCS increased from 2 to 8. Total lean product yield at 6.4 mm of fat was quadratically (P < .001) related to BCS, with BCS-3, 4, 5, and 6 cows having greater (P < .05) yields than cows assigned a BCS of 2, 7, or 8. When lean product was trimmed to 0.0 mm of fat, total lean yields increased from 60.8% for BCS-2 cows to a high of 61.69% for BCS-5 cows, then declined to 58.66, 54.14, and 49.41% for BCS-6, 7, and 8 cows, respectively. Total trimmable fat yields increased (P < .001) and total bone yields decreased (P < .001) linearly as BCS increased from 2 to 8. Both cow producers and packers may benefit most by marketing BCS-6 cows, which had the highest yields of lean product with acceptable carcass quality.

Key Words: Beef Cows, Carcass Composition, Body Condition

104 The effects of swine dietary supplementation of modified tall oil, chromium nicotinate, and L-carnitine on longissimus muscle quality characteristics and display color stability. A. T. Waylan*[1], P. R. O'Quinn[1], J. A. Unruh[1], R. D. Goodband[1], J. L. Nelssen[1], J. C. Woodworth[1], M. D. Tokach[1], and K. Q. Owen[2], [1]*Kansas State University, Manhattan,* [2]*Lonza Inc., Fair Lawn, NJ*.

Eighty pork loins were used to determine the effects of diet supplementation of modified tall oil (MTO), chromium nicotinate (CrNic), and L-carnitine on longissimus muscle (LM) quality. Gilts (PIC) were blocked by initial BW (45 kg) and ancestry and assigned to one of eight treatments in a 2 x 2 x 2 factorial design with main effects of MTO (0 or .5%), CrNic (0 or 50 ppb), and L-carnitine (0 or 50 ppm). Boneless loins were vacuum packaged at 24 h postmortem and cut into 2.54 cm chops at 7 d postmortem. Visual display color was evaluated by an 8-member panel on 0, 1, 3, 5, and 7 d of display. In addition, instrumental L*, a*, b*, ratio of reflectance %R630/%R580, and saturation index values were determined. Separate display chops were evaluated for thiobarbituric acid-reacting substance (TBARS) on 0 and 4 d. Additional chops were used for Warner-Bratzler shear force (WBS). No differences (P>.05)

were detected for visual color. In a CrNic x L-carnitine interaction at 0 d, chops from pigs fed a combination of no CrNic and L-carnitine (50 ppm) had (P<.05) lower L* values than chops from pigs fed a combination of CrNic (50 ppb) and L-carnitine. At 1 and 7 d, chops from pigs fed CrNic had lower (P<.05) saturation index values than chops from pigs fed no CrNic. At 3 and 5 d, LM chops from pigs fed MTO had (P<.05) higher b* and saturation index values than chops from pigs fed no MTO. No differences (P>.05) were detected for TBARS and WBS evaluations. Dietary supplementation of MTO, CrNic, and L-carnitine had minimal effect on LM quality characteristics and color stability.

Key Words: Modified tall oil, Chromium nicotinate, L-carnitine

105 Predicting component pieces of pork carcasses is improved by differential analysis of the industrial electromagnetic scan curve. Berg, E. P., Ellersieck, M. R., Asfaw, A., and Linville, M.*, *University of Missouri-Columbia*.

The objective of this study was to test and validate existing electromagnetic (EM) scan equations for an existing industrial operation. Fifty-four whole, pre-rigor, eviscerated carcasses (avg 75 kg) were selected representing carcasses marketed to Sioux-Preme Packers Inc., Sioux Center, IA. Carcasses (spanning 41 65% carcass lean) were electromagnetically (EM) scanned before entering the chill cooler. Selected carcasses were fabricated into primal cuts and individually dissected into subcutaneous fat, seam fat, lean, and bone. Weights were recorded for total dissected carcass (TOTLN), ham (HAM), loin (LOIN), and entire square cut shoulder (SHL) lean. Differential points (D) were determined as the numeric difference between EM phase index points located along the EM scan curve. Areas (A) under the EM curve were also obtained and used as independent variables for the prediction of carcass and component lean tissue. Previous analysis eliminated the lowest 10% of the EM scan curve to eliminate EM noise at the point of entry. This analysis examined the entire EM scan curve. Total area under the EM scan curve explained 93.5% of the variation in TOTLN. An equation using peak EM absorption and 3 additional A variables accounted for 94.3% of TOTLN variation (RMSE=1.35Kg). Equations were developed for HAM, LOIN, and SHL accounted for 84.3, 84.4, and 88.8% of the sample variation, respectively (RMSE=0.77,0.80, and 0.51kg, respectively). Differential analysis of the entire EM scan curve improved R-square statistics from existing equations for TOTLN by 4.3 %; HAM by 1.1%; SHL by 3.9%; and improved RMSE for TOTLN by 0.24kg.

Key Words: Pork, Electromagnetic scanning, Composition

NONRUMINANT NUTRITION

106 Effect of amino acid intake during gestation on sow body weight changes and litter size. D.R. Ball*, J.F. Patience, and R.T. Zijlstra, *Prairie Swine Centre Inc., Saskatoon, Canada*.

Nutrient intake during gestation will have an impact on gestation parameters and subsequent lactation performance. The objective of this experiment was to determine the impact of feeding two levels of amino acids in gestation [below or above NRC, 1998)] on sow body weight changes in gestation and lactation and on litter size. At mating, 258 sows were randomly assigned within parities (PR) 1, 2 or 3+ to a gestation diet (GD) containing either 0.37 (LL) or 0.49% (HL) apparent ileal digestible lysine and 3100 kcal DE/kg; other indispensable amino acids were adjusted to lysine. Feed allowance in gestation was determined factorially using estimated DE requirements for maintenance, maternal gain and conceptus growth. Lactation diet was provided ad libitum. Gestation weight gain (GWG) from d 0 to 110 was affected by PR (63.0, 59.9 and 38.5 kg for PR1, 2 and 3+, respectively; $P < 0.05$) but not ($P > 0.10$) by GD. The GD x PR interaction was not significant ($P > 0.10$). Sow lactation weight change from d 0 to 19 was affected by PR (1.3, 3.5 and 5.0 kg for P1, 2 and 3+, respectively; $P < 0.01$) and GWG ($P < 0.01$), but not by GD (4.4 vs. 5.3 kg for LL and HL, respectively; $P > 0.10$). Lactation feed intake was affected by PR (6.3, 7.4 and 7.4 kg/day for PR1, 2 and 3+, respectively; $P < 0.01$). Total piglets born was affected by PR (9.4, 11.2 and 13.4, for PR1, 2 and 3+, respectively; $P < 0.01$) and by GWG; GD x PR and GWG x PR approached significance ($P < 0.10$). Total piglets born alive (mean = 11.4) was affected by GWG and by GWG x PR ($P < 0.05$); PR approached significance ($P < 0.10$). Total litter weight born alive was affected by PR (13.5, 17.4 and 18.6 kg for PR1, 2 and 3+, respectively; $P < 0.01$) and GWG ($P < 0.05$); GD x PR approached significance ($P < 0.10$). These results confirm the effect of parity on sow body weight changes and litter size, and highlight the effects of gestation weight gain on lactation weight changes. The amino acid levels in the two gestation diets had no effect on sow body weight changes or litter size.

Key Words: Sow, Amino Acids, Gestation

107 Impact of dietary lysine intake during lactation on follicular development and oocyte maturation in primiparous sows. H. Yang*[1], G. R. Foxcroft[2], J. E. Pettigrew[3], L. J. Johnston[1], G. C. Shurson[1], A. N. Costa[4], and L. J. Zak[2], [1]*University of Minnesota, St. Paul,* [2]*University of Alberta, Edmonton, Canada,* [3]*Pettigrew Consulting International, Louisiana, MO,* [4]*Universidade Federal Rural de Pernambuco, Recife, Brazil*.

Primiparous lactating sows (n = 36) were used to evaluate the effects of dietary lysine intake on follicular development and oocyte maturation. Sows were assigned randomly to one of three diets containing .4% (L), 1.0% (Normal) or 1.6% (H) total lysine from intact protein, and nursed 10 piglets during an 18-d lactation. All diets contained 2.1 Mcal NE/kg and exceeded NRC (1988) requirements for all other nutrients. Actual lysine intakes were 16, 36 and 56 g/d for sows consuming L, Normal and H, respectively. Sows were slaughtered during proestrus after weaning. The largest 15 preovulatory follicles per sow were classified by size (large: > 7.0 mm; medium: 5.5 to 7.0 mm; small: < 5.5 mm), and their follicular fluid (FF) was harvested for analysis. Compared to sows fed Normal or H, sows fed L tended to have lower uterine weight, FF volume, and FF estradiol content ($P < .15$), but similar ovary weight and FF IGF-1 concentration. Sows fed L had a lower percentage (33 vs 50 or 58%; $P < .01$) of large follicles, but a higher percentage (62 vs 44 or 39%; $P < .01$) of medium follicles compared to sows fed Normal or H. Standardized pools of oocytes from prepubertal gilts were incubated for 44 h with FF recovered from experimental sows. Fewer oocyte nuclei matured to metaphase II of meiosis when cultured with FF recovered from sows fed L than from sows fed Normal or H ($P < .01$). No differences ($P > .15$) were noted for any response criteria between sows fed Normal and H. Our results suggest that low lysine intake in primiparous lactating sows impaired follicular development and reduced the ability of the follicle to support oocyte maturation, whereas high lysine intake had no positive or negative effects compared to normal lysine intake.

Key Words: Lysine, Follicle, Primiparous Sow

108 Valine addition to a practical lactation diet did not improve sow performance. R. D. Boyd*[1], M. E. Johnston[1], J. L. Usry[2], and K. J. Touchette[3], [1]*PIC USA, Franklin, KY,* [2]*Heartland Lysine, Chicago, IL,* [3]*University of Missouri, Colunbia, MO*.

The value of adding crystalline valine to a practical corn-soy diet for lactating sows was studied using 235 PIC commercial sows. Females were allocated to 4 dietary treatments by parity (1-4). Diets consisted of corn, soybean meal, 12% wheat midds and each contained .05% of synthetic lysine. Diets were formulated to contain .95% total lysine with the control diet having a total valine:lysine ratio of .90; test diets had ratios of 1.05, 1.20 and 1.20. Semi-essential arginine was added to the latter diet to achieve a ratio of 1.35 total arginine:lysine (similar to mammary uptake). The control diet had a ratio of 1.20 arginine:lysine. Relative concentrations of other amino acids exceeded NRC (1998) levels. Diets were fed from d 112 of pregnancy through a 19 d lactation. Litter size was standardized 24 h post-farrow (10.7±.2 pigs) and diets were fed ad libitum. Synthetic valine addition did not decrease sow weight or loin depth loss ($P > .10$). Sows lost 7.17 to 9.52 kg BW, 1.6 to 2.3 mm BF and 1.7 to 2.0 mm loin depth, with no differences observed between treatments ($P > .10$). Number of pigs weaned ranged from 10.0 to 10.3 ($P > .10$) and litter growth rate was 2250, 2150, 2190 and 2150 g/d for control and respective diet groups ($P > .10$). Average feed intake (corrected for a minimum 6% waste) was greater than expected and ranged from 7.16-7.22±.15 kg/d ($P > .10$). Calculated dietary lysine intake (67.3 to 67.9 g/d) vs lysine need suggests that the requirement slightly exceeded intake, which was critical to the test. A separate analysis of

parity 1 females x diet (14-15/diet and 178±4.7 kg post-farrow BW) was consistent with results for parity 2-4 females. This study failed to show an advantage in formulating a practical corn-soy diet to a valine:lysine ratio greater than .90:1.0.

Key Words: Sows, Lactation, Valine

109 Quantitation of body endogenous amino acid contribution in the lactating sow.

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Sixteen sows (Landrace x Yorkshire; parity 2 or 3; BW at postfarrowing = 219.0 ± 25.5 kg) were used to quantify endogenous amino acid contribution from body protein degradation (EAA) during lactation by plasma arterio-venous (A-V) differences of free plasma amino acids (AA) across the mammary gland. Each sow nursing 11 pigs was provided ad libitum access to 1 of 4 diets (4 sows/diet). All diets were isocaloric (3.4 Mcal ME/kg) with similar AA ratios, but contained different CP levels (7.8, 13.0, 18.2, and 23.5%). Sows were fitted with carotid arterial and main mammary venous catheters on d 4 or 5 of lactation. On d 10, 14, 18, and 22 of lactation, arterial and venous blood were collected simultaneously every 30 min for 6 h. Milk yield on d 11 and 21 was estimated by D_2O dilution method. During a 21-day lactation period, daily sow body weight loss, milk production, and litter weight gain were 1.18 ± .56 kg, 11.48 ± 2.19 kg, and 2.15 ± .34 kg, respectively. The relationship between log AA A-V difference and daily AA intake was linear and quadratic ($P < .05$). The best fitting regression model was $Y = aX^2 + bX + c$, with Y being the predicted log AA A-V difference, X the daily AA intake (g/d), and a, b and c the parameter estimates. When daily AA intake = 0, plasma AA A-V difference (t) = reverse log intercept c. When t is multiplied by mammary plasma flow rate, the product, i.e., AA uptake by the mammary glands, represents the difference between EAA and obligatory AA need for extra-mammary tissues. Daily mammary plasma flow rate was evaluated at 6440 L/d using the Fick principle where daily uptake of plasma lysine by the mammary glands was assumed equal to daily output of lysine in milk. During the 21-day lactation period, sow's body endogenous contribution of arginine, lysine, methionine, phenylalanine, threonine, and valine were 3.40, 11.13, 2.18, 5.79, 5.77, and 4.80 g/kg BW loss, respectively.

Key Words: Porcine mammary gland, Arterio-venous difference, Endogenous amino acid

110 Effects of litter size on nutrient mobilization in lactating sows.

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Twenty-eight primiparous sows were used to quantify the effect of litter size on mobilization of nutrients from different organs during lactation. Litter size was set from six to 12 pigs immediately after birth with four sows allotted to each litter size. Sows were provided a maximum of 13.6 Mcal ME and 46.3 g lysine per day during lactation. Sows were slaughtered on d 21 of lactation. Liver, gastrointestinal tract (GIT, composed of the empty stomach, empty small and large intestines, cecum and rectum), reproductive tract, and the other organs were separated from the carcass. The gastrointestinal tract was manually stripped of contents and flushed with water to remove digesta. The hot carcass was split longitudinally at the midline. Individual organs and carcass were weighed and ground for chemical analysis. Dry matter, protein, fat, amino acid, and ash contents were measured. Regression equations (variable = slope × litter size + intercept) were obtained. Changing litter size from six to 12 pigs resulted in 14.5, 3.5, 0.86 kg greater loss of carcass weight, carcass protein, carcass ash, respectively of sows on d 21 of lactation. The protein content of liver and GIT in sows decreased by 74 g and 4.1 kg as litter size increased from six to 12. There was no clear pattern in reproductive tract and the other organs. Sows with larger litter size clearly mobilized more protein from body, liver, and GIT, while fat changes did not show a clear pattern. Protein or amino acid requirements in lactating sows should consider number of pigs nursed during lactation. These data provide a basis for estimating nutrient supply available for milk production and mammary gland growth.

	Carcass wt (kg)	Carcass protein (kg)	Carcass ash (kg)	Liver protein (g)	GIT protein (kg)
Slope	-2.424	-0.584	-0.144	-12.386	-0.678
Probability	0.0482	0.0121	0.0164	0.0607	0.0368
Intercept	148.49	27.01	5.18	572.38	23.38
Probability	0.0001	0.0001	0.0001	0.0001	0.0001
R-square	0.57	0.75	0.72	0.54	0.62

Key Words: Sow, Nutrient mobilization, Litter size

111 Effects of litter size on mammary gland and litter growth in lactating sows.

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Twenty-eight primiparous sows which farrowed at least eight live piglets were used to determine the effect of litter size on mammary gland growth during lactation. Litter size was set to six, seven, eight, nine, 10, 11, or 12 pigs immediately after birth by cross-fostering. Four sows were allotted to each litter size group. Sows were allowed to consume a maximum of 13.6 Mcal ME and 46.3 g lysine per day during lactation. Sows were slaughtered on d 21 of lactation. Mammary glands were collected at slaughter and trimmed of skin and the extraneous fat pad. Each gland was separated, weighed, and ground for chemical analysis. Dry matter content, dry-fat-free-tissue content (DFFT), protein content, amino acid composition, ash content, and DNA content were measured. Only glands known to have been suckled were included in the data set. Regression equations (variable = slope × litter size + intercept) were obtained. Total mammary wet and dry weight, DFFT, protein, DNA, fat, and ash amount in total suckled mammary gland were increased as litter size increased. Changing litter size from six to 12 pigs resulted in 2098, 432, 253, 227, 4.4, 178, and 20 g increases in the amounts of total mammary wet weight, dry weight, DFFT, protein, fat, and ash, respectively on day 21 of lactation. Litter weight gain (LWG) was about 18.1 kg greater in sows with 12 pigs compared to sows with 6 pigs. These data support a hypothesis that mammary gland growth during lactation varies according to litter size. Thus, sows with a larger litter size should require more nutrients to support mammary tissue expansion.

	Wet wt (g)	Dry wt (g)	DFFT (g)	Protein (g)	Fat (g)	DNA (mg)	LWG (g)
Slope	349.6	71.9	42.2	37.8	29.7	725.4	3022.8
Probability	0.0012	0.0003	0.0016	0.0016	0.0008	0.0049	0.0011
Intercept	1147.2	255.5	153.1	132.8	102.4	2180.4	835.4
Probability	0.0658	0.0187	0.0584	0.0650	0.0448	0.1779	0.8487
R-square	0.90	0.94	0.89	0.88	0.91	0.82	0.90

Key Words: Sow, Mammary gland, Litter size

112 Added dietary fat improved growth performance and feed efficiency in grow-finish pigs under commercial conditions.

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A total of 480 pigs (PIC), housed in a fully-slatted commercial research barn, were used to evaluate the effects of feeding added dietary fat (0, 2, 4, or 6% choice white grease) to corn-soybean meal-based diets. Pigs (initial BW = 36 kg) were randomly allotted to 24 pens (20 pigs/pen and 3 pens of barrows and 3 pens of gilts per fat level). Diets were fed in three phases with lysine:calorie ratio decreasing with each phase (3.67, 2.67, and 1.97 g lysine/Mcal ME, respectively). Diets were switched when the average BW for all pens within gender reached 59 and 93 kg. Diets did not contain any synthetic amino acids. From 36 to 59 kg, ADG and G/F improved linearly ($P < .05$; .81, .83, .86, .89 ± .01 kg and .44, .46, .47, .50 ± .01, respectively) with no effect on ADFI as fat level increased from 0 to 6%. From 59 to 93 kg, the response in ADG was not as great (linear, $P < .13$); however, the response in G/F (linear, $P < .05$) was similar to 36 to 59 kg (.33, .34, .36, .37 ± .01, respectively). From 93 to 120 kg, ADFI decreased and G/F increased linearly ($P < .05$; 2.56, 2.47, 2.49, 2.34 ± .06 kg and .27, .28, .30, .31 ± .005, respectively) with no effect on ADG as fat was added to the diet. For the cumulative study, increasing added fat increased ADG and G/F linearly ($P < .05$) with a trend for lower ADFI ($P < .13$). Therefore, the magnitude of response to added fat remained constant throughout the study

for G/F, but decreased for ADG as pigs became heavier. Lean percentage and premium per pig decreased linearly (P < .05) with increasing dietary fat. However, when adjusted to the same market weight, there were no differences in any of the carcass or sale price parameters, indicating the importance of the adjustment to examine the true treatment effects. Under these experimental conditions, up to 6% fat can be added to corn-soybean meal based-diets for grow-finish pigs without negatively influencing standard carcass parameters or premiums received.

Key Words: Pigs, Finishing, Dietary Fat

113 Nutritional modification of late finishing swine diets in a controlled heat stress environment.

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Nutritional modifications were made to finishing swine diets to determine the effect on growth recovery and body composition of maternal line barrows (PIC C-22) subjected to a controlled environmental heat stress (HS). A total of 60 pigs (81-91 kg) that were within 7 d of age, and 5 mm backfat were selected. Twelve pigs were used for initial body composition. Forty-eight pigs were randomly assigned to treatments (trts) and individual pens in four environmental chambers containing 12 pens/room. One chamber was set to a thermoneutral temperature and contained 12 pigs fed a control diet (TN-C). The other 3 chambers (HS, 35°C) each contained 4 dietary trts: (1) control diet, (2) diet with added fat to reduce heat increment, (3) diet with added fat and amino acids (AA) to the same true digestible lysine:ME ratio as the control, (4) as trt 3 plus AA to fully compensate for the expected decrease in ADFI with HS and fat addition. Pigs were killed at 116 kg BW for determination of body composition. Pigs fed the TN-C displayed a higher ADFI (P<.05) than HS. For ADG, pigs fed diets 1 and 2 grew slower than pigs fed the TN-C (P<.05). Pigs fed diet 1 grew slower than all other HS treatments (P<.05). Pigs fed diets 3 and 4 showed improved feed efficiency (G:F) over pigs fed the TN-C and diet 1 (P<.05). Treatment 1 had a lower G:F than all other HS trts (P<.05). Pigs fed diet 3 had an improved carcass fat:protein ratio and accretion rate (g/day) compared to HS trts with added fat and AA. These results suggest that lowering the dietary heat increment during HS improves G:F by allowing pigs to grow faster. It also suggests that for maximum performance under HS, the lysine level of the diet should be balanced to the ME concentration of the diet.

Environment Diet	TN Control	HS 1	HS 2	HS 3	HS 4	SEM	P value
ADG (kg)	1.21	.86	1.05	1.14	1.14	.05	.02
G:F	.30	.28	.34	.38	.37	.02	.04
Fat:protein	1.77	1.67	1.85	1.75	1.91	.07	.20
CarcPro (g/d)	146	140	130	141	131	9.8	.78
CarcFat (g/d)	397	323	396	355	428	24.4	.06

Key Words: Growing Pigs, Heat Stress, Body Composition

114 Effects of genotype and dietary fat on pork quality and carcass composition.

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A study of pork quality and carcass composition of two genotypes that have different rates of fat and lean growth was conducted. Gilts (n = 120) were randomly assigned to a 2 × 5 factorial arrangement of genotype and diet. Pigs were selected at 45 kg live weight and fed conventional corn-soybean meal diets with or without 5% added fat until slaughter at 115 kg live weight. The dietary treatments included no fat supplement (**NF**), high quality poultry fat (**HQ**; low in polyunsaturated and free fatty acids), and low quality poultry fat (**LQ**; high in polyunsaturated and free fatty acids). Two additional dietary treatments were identical to HQ and LQ except that poultry fat was replaced with 5% beef tallow at 80 kg live weight (**HQT** and **LQT**, respectively). Diets were formulated to have equivalent lysine:calorie ratios and offered on an *ad libitum* basis. High-lean genotype gilts had larger loin eye areas (46.45 vs 42.52 ± .71 cm ^{2}, P ≤ .01), less 10^{th} rib backfat (1.42 vs 2.16 ± .08 cm, P ≤ .01), thinner bellies (4.24 vs 4.65 ± .08 cm, P ≤ .01), less drip loss (3.90 vs 5.69 ± .40%, P ≤ .01), lower belly firmness scores (1 = very soft; 3 = very firm; 2.56 vs 2.83 ± .09, P ≤ .05) than average-lean gilts. Genotype did not affect loin color scores or 45-minute pH. Dietary fat had a significant effect on marbling scores (NF: 1.68, HQ: 1.66, LQ: 1.42, HQT: 1.83, LQT: 1.50 ± .10, P ≤ .05). The dietary treatments did not affect loin firmness, backfat thickness, belly thickness, belly firmness, 45-minute pH, drip loss or loin eye area. In conclusion, feeding poultry fat, with or without finishing with beef tallow, appears to have minimal impact on pork quality, and does not affect carcass composition.

Key Words: Pigs, Pork Quality, Dietary Fat

115 Hydrogenated dietary fat improves pork quality of pigs from two lean genotypes.

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Pork quality is influenced by nutrition, genetics, management, and pork-processing procedures. Lean genotype pigs fed diets high in unsaturated fat may result in thinner, lower quality bellies with a soft fat composition. Therefore, we investigated the effects of supplementing 5% choice white grease that had been chemically hydrogenated to iodine values (IV) of 80, 60, 40, or 20. Diets were fed to barrows and gilts (n=240) from one of two genotypes (designated A and B) in a 4 x 2 x 2 factorial design. Pigs were blocked by initial weight (76.5 kg) and fed dietary treatments for 52 days. Genotype A had a greater feed conversion ratio (F/G=2.94 vs 2.82 .04; $P < .05$), backfat depth (26.2 vs 23.9 .5 mm; $P < .01$), and loin depth (58.9 vs 55.1 .8 mm; $P < .01$) compared to genotype B. Decreasing IV of fat fed to pigs increased belly thickness linearly on both dorsal and ventral sides ($P < .01$) and linearly decreased belly length on ham ($P < .05$) and shoulder ($P < .01$) ends. Increased belly thickness was associated with a progressive decrease in belly IV from 77.1 to 70.3 .6 (linear and quadratic effect; $P < .05$), and a decrease (linear and quadratic effect; $P < .01$) in C18:2 concentration in belly fat (20.5, 17.7, 16.7, 16.2 .3 %) as diet IV declined from 80 to 20 IV, respectively. The belly mono/polyunsaturated fat ratio increased 30% as diet IV declined from 80 to 20 (linear and quadratic effect; $P < .01$). Further, there was a linear increase ($P < .05$) in saturated fatty acids (C14 - 18) as fat IV level declined. Increasing linear and quadratic ($P < .01$) effects were detected in the level of C18:1*trans* as IV value decreased from 80 to 20. IV had no effect on fat digestibility, ADFI, or F/G ($P > .1$). Pork belly quality was improved as defined by reduced IV, C18:2 content, increased saturated fatty acid content, increased thickness and decreased length. Results indicate that reduction of dietary fat IV by chemical hydrogenation has the desirable effect of improving pork quality and does not alter growth performance.

Key Words: Pigs, Dietary Fat, Pork Quality

116 The effects of modified tall oil and vitamin E on growth performance and carcass characteristics of finishing pigs.

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Seventy-two crossbred barrows (initially 45.5 kg BW) were used to investigate the effects of modified tall oil (MTO) and increasing vitamin E on growth performance and carcass characteristics of finishing pigs. Pigs were blocked by initial weight and ancestry and randomly allotted to one of the six dietary treatments which were arranged as a 2 x 3 factorial with main effects of MTO (0 or .5% of the diet) and added vitamin E (0, 22, or 110 IU/kg of diet). The vitamin premix did not contain any alpha-tocopherol. The corn-soybean meal diets were fed in meal form in two phases: 45.5 to 81.6 (1.00% lysine) and 81.6 to 114.6 (.75% lysine) kg BW. Diets did not contain added fat. From 45.5 to 81.6 kg, pigs fed MTO had increased ADG (P = .03) and G/F (P = .09) regardless of added vitamin E when compared to pigs not fed MTO; otherwise dietary treatment did not affect (P > .15) growth performance. Pigs fed MTO had reduced average backfat (P = .004) regardless of vitamin E level. Interactions of MTO and vitamin E (P ≤ .07) were observed for marbling, firmness, and drip loss percentage of the longissimus muscle. Increasing vitamin E in diets containing MTO resulted in firmer longissimus muscle that had more marbling and reduced drip loss. Conversely, increasing vitamin E in diets not containing MTO resulted in higher drip loss and longissimus muscle that were less firm and had less marbling. Dietary combinations had no effect (P > .10) on visual color of the longissimus muscle 24-h postmortem. Pigs fed MTO had firmer bellies (P ≤ .04) initially, and after one and five minutes when centrally

suspended from a horizontal bar with the skin laid dorsally in orientation. Bellies from pigs fed MTO were about 13% firmer overall than those from pigs not fed MTO regardless of vitamin E level. These data support evidence of MTO as a potential growth promoter and carcass modifier for finishing swine.

Key Words: Modified tall oil, Growth, Carcass characteristics

117 Effects of conjugated linoleic acid (CLA) on growth and composition of lean gilts.

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Conjugated linoleic acid (CLA) is known to function as an anticarcinogen, an antiatherogen and an insulin sensitizor in laboratory animals. If it can be demonstrated that CLA has similar effects on human health, then the accumulation of CLA in pork products may enhance their nutritional value, thereby creating value-added, heart-healthy pork products. A study of the effects of CLA and feed intake on the growth and composition of lean gilts was conducted. From 75 to 120 kg liveweight, thirty gilts were fed one of three dietary treatments (1% CLA *ad libitum* (**CLA**), 1% sunflower oil *ad libitum* (**SFO**), or 1% sunflower oil restricted to the feed intake of the CLA-fed pigs (**RSFO**)). All diets were corn-soybean meal based (.85% LYS) and contained no additional fats. Gilts fed SFO demonstrated higher ADG (.98 vs .88 or .80 $\pm$ .03 kg/day, P $\leq$ .01) than did CLA and RSFO gilts, respectively. Dietary treatment did not affect ultimate pH or subjective quality evaluations of the loin. Gilts fed CLA tended to have less backfat and drip loss, but these results were not statistically significant. Subjective evaluations of belly firmness (1 = very soft; 3 = very firm) were higher for CLA-fed gilts (2.91 vs 2.43 or 2.07 $\pm$ .13, P $\leq$ .01) than gilts fed SFO or RSFO, respectively. Belly fat of gilts fed CLA contained more saturated fatty acids (44.45 vs 37.50 or 36.60 $\pm$ .46%, P $\leq$ .001), less unsaturated fatty acids (54.78 vs 61.75 or 62.47 $\pm$ .46%, P $\leq$ .001) and a lower ratio of polyunsaturated:saturated fatty acids (.25 vs .39 or .35 $\pm$ .02, P $\leq$ .001) than SFO or RSFO gilts, respectively. Gilts fed CLA accumulated more CLA in the loin (.55 vs .09 or .09 $\pm$ .03%, P $\leq$ .001), belly fat (1.56 vs .13 or .13 $\pm$ .15%, P $\leq$ .001) and liver (1.69 vs .27 or .26 $\pm$ .08%, P $\leq$ .001) than did gilts fed SFO or RSFO, respectively. In conclusion, CLA-fed gilts accumulated more saturated and less unsaturated fatty acids, resulting in an increase in belly firmness and an improved fatty acid composition of pork products.

Key Words: Pigs, CLA, Pork Quality

118 Effects of diet manipulation on growth performance, carcass characteristics, and meat quality of intact male pigs.

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Ten barrows and 70 boars (average initial BW of 51 kg) were used in a 70-d growth assay to determine the effects of diet manipulation on growth performance, carcass characteristics, and meat quality. There were two pigs per pen and five pens per treatment. The pigs were fed the same diets (1.3% lysine, .75% Ca, and .65% P for 51 to 77 kg BW and 1.1% lysine, .65% Ca, and .55% P for 77 to 102 kg BW) initially. Then, for 102 to 125 kg BW, the barrows and boar control pigs were changed to a basal diet with 15% CP, 1.1% lysine, .55% Ca, and .45% P. For the other treatments, dietary pH (decrease by adding 1.6% citric acid and increased by adding 2% sodium bicarbonate), crude protein concentration (increased to 17% by removing crystalline amino acids and decreased to 12% by adding more of them), and antimicrobial concentrations (decreased by removing tylosin and increased by adding copper sulfate and tylosin) were altered. Growth performance and carcass data were collected and boar odor was determined by streaking a small sample of fat across a hot plate. A trained sensory panel then assigned a score of 1 to 5 (1 = no odor; 2 = very slight; 3 = slight; 4 = moderate; and 5 = strong boar odor). Overall (from 51 to 125 kg BW), boars were more efficient (P < .002) and consumed less feed (P < .009) than barrows. Also, barrows tended to be fatter than boars (P < .06) with lower scores for boar odor (P < .002). From 102 to 125 kg BW, boars fed the low pH treatment consumed less feed (P < .04) than boars fed the high pH diet, but ADG and G/F were not affected (P > .15). There were no differences for growth performance or carcass characteristics with manipulation of CP concentration in the diet (P > .11), but increasing antimicrobial concentration tended to improve G/F (P < .07). However, in the final analysis, changes in pH, CP, and antimicrobial concentrations in the diet did not affect (P > .24) presence or strength of odor in boar tissue when cooked.

Key Words: Boars, Taint, Pig

119 Effects of betaine and space allocation on growth performance, plasma urea concentration, and carcass characteristics of growing and finishing barrows.

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The objective of this experiment was to examine the effects of betaine on growth performance, carcass characteristics, and plasma urea concentration of pigs with reduced feed intake. One hundred twenty crossbred barrows (initial BW = 46 kg) were blocked by weight and randomly allotted to one of four treatments. Treatments were arranged in a 2 $\times$ 2 factorial with betaine (0 or .125%) and space (.6 or 1.2 m^2/pig) as the main effects. Corn-soybean meal diets were fed in three phases: 46 to 59 (.88% total lysine), 59 to 86 (.73% total lysine), and 86 to 119 (.60% total lysine) kg of BW. Pigs were slaughtered when final BW was approximately 119 kg. Low space allocation (crowding) decreased overall ADG (P < .001) and ADFI (P < .01), but did not affect (P > .10) ADG/ADFI. Betaine did not affect (P > .10) overall ADG, ADFI, or ADG/ADFI. Plasma urea concentration was not affected (P > .10) by diet or space. Ham weight, longissimus muscle weight, and total primal cut weight were not affected (P > .10) by diet or space. However, shoulder weight was greater (P < .05) in the betaine group and tended to be lower (P < .10) in crowded pigs. Crowding decreased (P < .01) fat-free lean gain; however, betaine improved (space $\times$ diet interaction, P = .05) fat-free lean gain in crowded pigs. The data indicate that crowding reduced growth performance and protein accretion. Betaine partially ameliorated the decreased protein accretion observed in crowded pigs.

Key Words: Betaine, Pigs, Space

120 Effect of dietary energy source and free choice feeding on performance of high lean pigs.

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Eighteen sets of three littermate barrows, penned individually, were used to evaluate the effects of dietary energy sources in corn on the growth and body composition of high lean pigs fed from 55 to 110 kg. Pigs in each of 9 replications were self-fed a basal corn-soybean meal diet which contained either a normal corn (NC), or a composite corn (CC) in which 80% of the fiber (NDF) in corn was replaced with isocaloric (gross energy) amounts of either corn starch or oil, or were given free choice (FC) access to the NC and the respective CC diet. The amount and source of each dietary nutrient per unit of corn gross energy remained constant among diets. Over the duration of the study, pigs fed the low fiber CC diets had greater (P < .01) gain:feed ratios than pigs fed NC diets (.371 vs .314), and the magnitude of improvement was greater (P < .01) when corn oil versus starch replaced the corn fiber on an isocaloric basis. Feeding the CC diets did not alter efficiency of ME utilization (.098 vs .096 kg gain/Mcal) or daily BW (.802 vs .842 kg) and muscle gains (.340 vs .331 kg) compared with NC. At 110 kg BW, real-time ultrasound measurements of backfat (2.35 vs 2.47 cm), loin muscle area (40.6 vs 39.7 cm2), and estimated muscle mass (45.1 vs 44.5 kg) were similar between CC and NC groups. Pigs given FC access to the respective CC and NC diets consumed a higher proportion of the CC diet with added oil (67 vs 33%) but not with added starch (46 vs 54%). Gain:feed was improved (P < .01) in FC vs NC (.345 vs .314) groups, but gain:ME, BW and muscle gains, and body composition were not altered. Responses of pigs during each 8-kg increment of BW gain also were evaluated. Minimizing corn fiber content lowered BW gain and efficiency of ME utilization during the initial increment of growth, but resulted in improved BW gain, gain:feed, and gain:ME ratios during subsequent stages of growth. Growth responses of high lean pigs per kg of corn were improved by minimizing the fiber content of corn, but the responses of pigs per Mcal of ME were not altered by corn energy source.

Key Words: Pigs, Energy Source, Muscle Growth

121 Corn energy values for growing pigs. I. B. Kim*[1], G. L. Allee[1], T. S. Sauber[2], and R. F. Sanders[2], [1]*University of Missouri-Columbia, MO,* [2]*Optimum Quality Grains, LLC, Des Moines, IA*.

Corn is the major energy source used in most swine diets. Due to the high level of inclusion, variation in energy content has a marked economic impact. The objectives of this study were to evaluate the energy value of 18 samples of commercial normal corn (NC) and three samples of high-oil corn (HOC). These corn samples were from multiple genetic lines, grown in different locations during 1995-1997. Therefore, this study does not allow separation of genetic and environmental effects on available energy. Crossbred barrows (19.4±2.8 kg) were placed in metabolism crates allowing for sample collection. Litter was used as a blocking factor in assigning pigs to treatments. There were 8 or 10 replications of each treatment. Pigs were fed the experimental diets twice per day (0630 and 1830, about 6.6% of BW) and supplied water ad libitum during each experimental period. The experimental diet was composed 97.2% of each corn grain and 2.8% of a mineral-vitamin premix. The experimental periods consisted of 5 d of diet adaptation and 5 d of sample collection. Total fecal, refusal feed, and urine samples were collected for energy determination. All results are reported on a DM basis. In normal corn lines (n=18), GE values varied by 4.2% (avg 4,465±15 cal/g, range 4,575-4,388), DE by 4.9% (3,891±11 cal/g, 3,976-3,784), and ME by 5.2% (3,806±11 cal/g, 3,893-3,694). In HOC lines (n=3), GE varied by 4.0% (avg 4,714±38 cal/g, range 4,819-4,631), DE by 1.3% (4,069±28 cal/g, 4,102-4,048), and ME by 1.0% (3,970±27 cal/g, 3,994-3,954). For the comparison of two corn types, HOC had higher GE, CP (10.74±.32 vs 8.38±.13%), crude fat (7.55±.31 vs 3.85±.13%), lysine (.31±.01 vs .26±.004%), and methionine (.24±.01 vs .18±.005%) contents than NC (P<.01). Average DE and ME values for the three HOC samples were greater than the average of the 18 NC samples (P<.01). However, the magnitude of this difference depends on the value used for the normal corn. These results suggest that there is about a 5% (±100 cal/g) variation in ME values between corn samples.

Key Words: Swine, Energy, Corn

122 Measurements to predict swine digestible energy content of barley. R.T. Zijlstra*[1], T.A. Scott[2], M.J. Edney[3], M.L. Swift[4], and J.F. Patience[1], [1]*Prairie Swine Centre Inc., Saskatoon,* [2]*Pacific Agri-Food Research Centre, Agassiz,* [3]*Canadian Grain Commission, Winnipeg,* [4]*AgroPacific Industries, Chilliwack, Canada*.

A range of measurements ((1) physical, (2) chemical, (3) apparent metabolizable energy (AME), and (4) near infra-red spectroscopy (NIRS)) was explored to predict digestible energy (DE) content of barley for pigs. The focus was DE, because with least-cost diet formulation the greatest cost pressure is against supply of available energy. Forty barley samples were analyzed for swine DE in 2 trials. Trial 1 included 20 samples without damaged kernels, whereas trial 2 included off-grade (sprouted, frost-damaged) samples. Overall, DE ranged from 2686 to 3163 kcal/kg (90% DM). (1) Density ranged from 47.9 to 71.5 kg/hL and was not correlated to DE ($R^2 = 0.14$), indicating that physical measurements can not predict DE accurately. (2) Acid detergent fiber (ADF) concentration was the best single predictor for DE in trial 1 (DE=3526 - 92.8 x ADF (90% DM); $R^2 = 0.85$; $P < 0.01$), indicating that chemical parameters can predict DE accurately. (3) Barley samples were analyzed by a modified AME-bioassay in broiler chicks, in diets with and without supplemental enzymes. Without enzymes, AME and DE were not correlated ($R^2 = 0.18$), but correlation improved greatly by enzyme addition ($R^2 = 0.56$). (4) Ground and whole kernel barley samples were analyzed by NIRS (400-2500 nm, 2 nm intervals). A good calibration was developed using 27 ground samples ($R^2 = 0.96$; SE of prediction (SEP) = 30.47) to predict DE in 12 other ground samples ($R^2 = 0.98$; SEP = 24.0), similar to a calibration with whole kernel samples ($R^2 = 0.94$; SE of cross validation (SECV) = 86.8 kcal/kg). Together, results indicate that barley DE can be predicted accurately by NIRS; however, a larger sample set is required to increase robustness of calibration. Supported in part by the Alberta Barley Commission, the Western Grains Research Foundation, and an AAFC Matching Grant.

Key Words: Barley, Digestible Energy, NIRS

123 Effect of enzyme supplementation to wheat-canola meal diets on performance and energy digestibility in grower pigs. R.T. Zijlstra* and J.F. Patience, *Prairie Swine Centre Inc., Saskatoon, Canada*.

Nutritional value of canola meal for grower pigs is limited by fibrous components (including non-starch polysaccharides; NSP) and perhaps protein components. The objective was to evaluate effects of supplementation of diets (27 % canola meal, 63% wheat) with NSP-degrading enzymes (B-glucanase and xylanase mix) or a protease. Enzyme supplementation (control, carbohydrase (CHO), protease (PRO), and CHO+PRO) and canola meal samples A and B were tested in a 4 x 2 factorial arrangement in 5 randomized complete blocks in diets limiting in either DE (3180 kcal/kg; Exp. 1 and 3) or digestible lysine (0.65 g/kg; Exp. 2). In Exp. 1 and 2, 9-wk-old pigs (PIC, N=72) were housed individually and, after a 7 d acclimation, allowed free access to 1 of 8 diets for 28 d. In Exp. 3, 9-wk-old barrows (PIC, N=40) were housed for 4 wk in metabolism crates to collect feces in two collection periods. In Exp. 1, average daily feed intake (ADFI) was 11% higher ($P < 0.05$) from d 1 to 28 for pigs fed A versus B control diet, with a corresponding 11% increase ($P < 0.10$) in average daily gain (ADG), indicating that large differences exist in nutritional value among canola meal samples. Supplementation of CHO increased ($P < 0.10$) ADFI 11% (d 14 to 28) and ADG 15% (d 1 to 14) in A diets. Supplementation of PRO increased ($P < 0.10$) ADFI 10% in A diets, but reduced ($P < 0.10$) ADFI 10% and ADG 9% in B diets. In Exp. 2., ADFI and ADG did not differ ($P > 0.10$) among the low-lysine diets. In Exp. 3., apparent fecal energy digestibility ranged from 79.8 to 80.4% among diets and was not affected ($P > 0.10$) by supplementation. In summary, CHO and PRO supplementation increased performance of pigs fed A diets; PRO supplementation reduced performance of pigs fed B diets; supplementation did not affect energy digestibility. Supported by the Canola Council of Canada, Finnfeeds International, Saskatchewan Canola Development Commission, and the Program for Export Market Development.

Key Words: Canola Meal, Nutritional Value, Enzyme Supplementation

124 Effects of xylanase addition to pelleted and expanded-pelleted, wheat-based diets for finishing pigs. J. S. Park*, J. D. Hancock, R. H. Hines, K. C. Behnke, G. A. Kennedy, C. A. Maloney, J. M. DeRouchey, H. Cao, and N. Amornthewaphat, *Kansas State University, Manhattan*.

Eighty crossbred gilts (average initial BW of 54.1 kg) were used in a 56-d growth assay to determine the effects of xylanase addition to wheat-based diets for finishing pigs. There were two pigs per pen and five pens per treatment. The diets were formulated to .9% lysine, .65% Ca, and .55% P for d 0 to 33 and .7% lysine, .55% Ca, and .45% P for d 33 to 56 of the experiment. The wheat was ground (in a hammermill having a screen with 3.2 mm openings) to a geometric mean particle size of 612 mm. Treatments were mash, standard-pellets (steam conditioned to 78C before pelleting), and expanded pellets (conditioned to 80C and expanded at 12 kg / cm^2 cone pressure before pelleting) without or with xylanase (derived from *Tricherma longibrachiatium*, fermented reesi bacteria). The enzyme was applied to supply 4,000 xylanase unit per kg of diet. There were no interactions ($P > .24$) among diet form and enzyme addition for ADG, ADFI, or gain/feed. Also, there were no overall differences ($P > .59$) in ADG, ADFI, or gain/feed among pigs fed mash or pellets. Adding enzyme to the mash diet improved ($P < .03$) overall gain/feed by 5.4% (approaching the same numerical response as observed for pellets). Digestibility of DM also was improved ($P < .05$) by enzyme supplementation of mash diets. Enzyme supplementation did not affect stomach ulceration score ($P > .22$). Pelleting tended to improve digestibility of DM (mash vs pellets, $P < .11$). Compared to standard pellets, expanded pellets had no effect on overall ADG or ADFI ($P > .67$), but tended ($P < .16$) to increase overall gain/feed. Pelleting tended to increase score for ulceration of the stomach ($P < .06$). In conclusion, enzyme supplementation and pelleting were beneficial, but not additive

Key Words: Xylanase, Wheat, Pigs

125 Effects of feeder design and pellet quality on growth performance, nutrient digestibility, carcass characteristics, and water usage in finishing pigs. N. Amornthewaphat*, J. D Hancock, K. C. Behnke, R. H. Hines, G. A. Kenney, H. Cao, J. S. Park, C. S. Moloney, D. W. Dean, J. M. DeRouchey, and D. J. Lee, *Kansas State University, Manhattan*.

A total of 384 pigs (avg initial BW of 41.8 kg) were used to determine the effects of feeder design and pellet quality on growth performance, nutrient digestibility, carcass characteristics, stomach morphology, and water usage. Treatments were meal, screened pellets, and pellets with 25% and 50% fines offered through a conventional two-hole dry feeder (Smidley, Style B 1/2, No. 2) or a single-hole, wet-dry (w/d) feeder (Crystal Spring, F-5000). The diets were formulated to .95% and .80% lysine for 41.8 to 91.4 and 91.4 to 117.2 kg BW, respectively. Pigs fed with wet-dry feeders had 2.4% greater ($P < .02$) ADG and used 26% less ($P < .001$) water than those fed with the conventional feeders. Pigs fed through wet-dry feeders tended to have greater last rib backfat thickness (BF), but only when the diet was fed in meal form (conventional vs wet/dry x meal vs pellets, $P < .002$). This seemed to be related to the greater feed intake for pigs fed from the wet-dry feeders. In the conventional dry feeders pigs fed screened pellets had 7% greater ADG and gain/feed compared to pigs fed the meal diet. However, benefits of pelleting were lost when the feed was offered through wet-dry feeders. The incidence and severity of stomach lesion (scoring scale of 0 = normal to 3 = severe) was less when pigs were fed a meal diet compared to pellets ($P < .001$). There was decreased ADG (conventional vs wet/dry x fines linear, $P < .04$) and digestibility of DM (conventional vs wet/dry x fines quadratic, $P < .05$) and severity of stomach lesion (fines linear, $P < .04$) as percentage fines was increased. In conclusion, feeder design, and pellet quality had effects on growth performance of finishing pigs

	Meal		0%		25%		50%		
	Dry	w/d	Dry	w/d	Dry	w/d	Dry	w/d	SE
ADG, g/d	893	940	955	930	927	965	900	930	13
G/F, g/kg	359	373	384	370	379	386	367	368	8
Water, L/p/d	7.4	7.0	9.2	5.3	8.1	6.0	8.0	6.2	.8
DM dig, %	88.6	87.3	87.8	88.5	88.8	87.2	85.7	86.5	.7
BF, mm	22.8	26.4	25.9	25.5	24.4	24.0	25.6	25.4	10
Ulcer score	.1	.1	.6	.6	.4	.2	.2	.5	.1

126 The effect of dietary organic acid supplementation on the digesta pH level at the terminal ileum in growing pigs. H. R. Nederveld*, L. L. Andersen, P. K. Ku, and N. L. Trottier, *Michigan State University*.

This study was conducted to determine the effect of dietary supplementation of organic acids (OA), on the digesta pH of growing pigs. Eight Yorkshire barrows (initial BW 65 kg) surgically fitted with simple T cannulas at the ileo-cecal junction, were used to test the hypothesis that OA decrease pH levels, as part of the mode of action on protein digestibility, in digesta samples obtained at the terminal ileum. All pigs were allowed a 7-day adjustment period to the same standard corn-soybean meal basal diet. Three different dietary levels of OA, i.e., 1, 2 , and 3 mg per kg of diet were fed respectively to 3, 2, and 3 randomly allocated barrows. Each barrow was used as its own control, as digesta was collected over a 24 h period prior to dietary supplementation of OA. Free access to water was provided and 1.5 kg of feed was given twice daily, at 0900 and 1700. Digesta samples were obtained daily at 4, 8, and 24 h post morning feeding. Samples of digesta were kept on ice until pH levels were measured (within 15 minutes of collection). Over the 5-day collection period, OA supplementation gradually decreased digesta pH measurements in all of the barrows. Overall, the pH were 6.92 ± .17, 7.00 ± .18 and 6.73 ± .18, for levels 1, 2, and 3, respectively, and lower when compared to their initial value ($P > .05$). The greatest effect of OA on digesta pH was found at 4 and 8 h post feeding on day 1 ($P < .05$). At 24 h post morning feeding, the OA tested decreased digesta pH only at the highest level (i.e., Level 3). When assessing the effect of dietary OA on digesta pH, samples should be obtained within 8 h post feeding. In conclusion, the OA tested affected digesta pH of the growing pigs at all three supplemented levels.

Key Words: Organic acid, Digesta pH, Growing pig

127 The effect of feeding a liquid milk replacer to small pigs after weaning. G. L. Allee, K. J. Touchette, and J. J. Berkemeyer*, *University of Missouri-Columbia*.

A total of 288 pigs (14-20 d, 4.4 kg) were used in four experiments to determine the effect of supplying a liquid milk replacer (Litter Life®, Merricks, Inc., Middletown, WI) after weaning. Pigs were allotted in a RCBD to three or four treatments with three or four pigs per pen. The treatments were: no liquid milk replacer (control), or liquid milk replacer for 3, 5, or 7 d postweaning. Experiment four was only 21-d long, and did not include the 7 d milk replacer treatment. All pigs had access to a phase I diet for 14 d, and a phase II diet after d 14. Pig weights and feed intake were recorded on d 0, 3, 5, 7, 14, 21, and 28 postweaning. In Exp. 1, pigs given a liquid milk replacer for 5 or 7 d were heavier ($P<.05$) on d 10 than the control pigs; however, there was no difference in pig weight on d 28. In Exp. 2, pigs given a liquid milk replacer for 5 or 7 d were heavier ($P<.05$) throughout the study than the control pigs. Additionally, these pigs were heavier ($P<.05$) after d 5 than pigs fed the milk replacer for only 3 d. After d 5, there were no weight differences between the control pigs and pigs fed milk replacer for 3 d. In Exp. 3, the control pigs were significantly lighter ($P<.05$) than pigs that consumed any milk replacer, while the length of feeding the milk replacer had no effect on weight gain. In Exp. 4, pigs fed milk replacer for 3 or 5 d were heavier ($P<.05$) throughout the study compared to the control pigs. Except for Exp. 3, total feed intake was not affected by treatment. In Exp. 3, the control pigs failed to gain weight in the first 3 d postweaning, while those that were fed the liquid milk replacer gained 224 g/d. Feeding a liquid milk replacer to small pigs (<5 kg at weaning) improves performance. The optimum length of feeding a liquid milk replacer is 3 to 5 d postweaning. This may be a management strategy to help reduce variation in the nursery phase of a commercial operation.

Key Words: Weaned Pigs, Liquid Diet, Milk Replacer

128 Effect of porcine serum concentrate on growth performance and mortality in young pigs. S.J. Miller*[1], J.D. Arthington[2], J.M. Campbell[2], B.S. Borg[2], and D.M. Webel[3], [1]*Michigan State University, E. Lansing,* [2]*American Protein Corp., Ames, IA,* [3]*United Feeds, Inc., Sheridan, IN*.

Consuming adequate colostrum within the first 24 hr of life is critical for the newborn pig to achieve passive immunity, thus improving chances for survival and growth. Experiments were conducted at two locations to investigate the effectiveness of a porcine serum concentrate (PSC), administered orally at birth, on pre-weaning growth, nursery performance and mortality. In Exp. 1, 50 litters were randomly assigned to either a treated (12 mL PSC/pig within 24 hr of birth) or control group. Pigs (n = 453) were weaned at 14 d (4.77 kg BW) and allotted by treatment and weight into a common nursery facility (10 pens/trt, 23 pigs/pen). During the 6 wk nursery trial, pen weights and feed intake were recorded biweekly. In Exp. 2, 80 litters were randomly assigned to one of the two previously described treatments. Pigs (n = 708) were weaned at 14 d (4.76 kg BW) and allotted by treatment and weight to 6 nursery rooms (4 pens/room, 25 pigs/pen); each room serving as the experimental unit (3 rooms/trt). Procedures were similar to those in the first experiment except that feed intake was recorded only at the end of the 6 wk period. Pre-weaning weight gain and mortality were similar ($P > .10$) when comparing the treated and control groups at both locations. Total weight gain during the 6 wk nursery period was similar at both locations for the treated and control pigs (387 g/d vs 362 g/d and 414 g/d vs 395 g/d, respectively). However, in Exp. 1, pigs treated with PSC gained more weight than untreated controls during the initial 14 d in the nursery (194 g/d vs 162 g/d; $P < .05$). Feed intake, feed efficiency and mortality were not affected by treatment in the nursery at either location. In conclusion, porcine serum concentrate administered orally at birth had no effect on pre-weaning growth, overall nursery performance or mortality. However, based on the data from Exp. 1, PSC may improve initial nursery growth performance in certain production environments.

Key Words: Young pig, Growth, Porcine serum concentrate

129 Evaluation of a high molecular weight, whey protein concentrate and spray-dried animal plasma on growth performance of weanling pigs. G.S. Grinstead*, R.D. Goodband, J.L. Nelssen, M.D. Tokach, and J.T. Sawyer, *Kansas State University, Manhattan.*.

Two 28-d growth trials were conducted to evaluate increasing high molecular weight, whey protein concentrate (HPWPC, 73% CP, 6.8% lysine) and spray-dried animal plasma (SDAP) on weanling pig performance. In both trials, pigs were blocked by initial weight and allotted randomly to one of five dietary treatments with eight or nine pigs/pen and seven pens/treatment. Diets were based on a corn-soybean meal based control diet containing 25% dried whey, 6% fish meal, 5% lactose, 1.75% blood meal, and 2.5% (Exp.1) or 6.7% (Exp.2) SDAP. In Exp. 1, additional SDAP (2.5 or 5.0%) or HPWPC (2.5 or 5.0%) was substituted for soybean meal on an equal lysine basis. In Exp. 2, HPWPC was substituted for 25, 50, 75, or 100% of the SDAP on an equal lysine basis. All diets were formulated to contain 1.7% lysine and were fed from d 0 to 14 after weaning in a pelleted form. From d 14 to 28, all pigs were fed a corn-soybean meal diet (1.35% lysine, .9%Ca, .8%P). In Exp. 1, 305 pigs (initially 4.1 kg and 13-d of age) were used. From d 0 to 14 after weaning, ADG, ADFI, and gain/feed (G:F) increased then decreased with increasing SDAP (quadratic, P = .003, .04, and .02, respectively). Average daily gain and ADFI tended to increase (quadratic, P = .07, and linear, P = .09, respectively), but G:F was not influenced by increasing HPWPC. In Exp.2, 320 pigs (initially 4.2 kg and 13-d of age) were used. From d 0 to 14, ADG and ADFI increased with increasing HPWPC (quadratic, P < .04, and .09, respectively). Pigs fed 5.0% HPWPC and 1.7% SDAP had higher ADG and ADFI than any other treatment. In either study, protein sources fed from d 0 to 14 had no effect on growth performance from d 0 to 28. In conclusion, increasing SDAP above 5% did not further improve growth performance and pigs fed HPWPC demonstrated similar growth performance compared to similar amounts of SDAP. Therefore, HPWPC can be an effective replacement for SDAP in diets for early-weaned pigs.

Key Words: starter pig, animal plasma, whey protein concentrate

130 Effect of spray-dried plasma and lipopolysaccharide (LPS) on intestinal morphology and the hypothalamic-pituitary-adrenal (HPA) axis of the weaned pig. K. J. Touchette*[1], G. L. Allee[1], R. L. Matteri[2], C. J. Dyer[2], and J. A. Carroll[2], [1]*University of Missouri-Columbia,* [2]*ARS-USDA, Columbia, MO.*

Twenty pigs (14 d, 5 kg) were weaned to an isolated environment to determine if feeding spray-dried plasma (SDP) affects the response to a LPS challenge. Pigs were allotted to one of four treatments in a 2 x 2 factorial arrangement, with two levels of spray-dried plasma (0 vs 7%) and two i.p. injections (LPS vs saline). Diets, formulated to contain equal ME and digestible essential amino acids, were fed for 7 d postweaning. On d 6, the pigs were non-surgically fitted with jugular cannulae. On d 7, i.p. injections of either saline or LPS were given, followed by collection of blood samples at 15-min intervals for three hr. After three hr, all pigs were killed, and intestinal samples were collected to measure villus height, crypt depth, and villus:crypt ratio(VCR). Spray-dried plasma did not affect weight gain. For pigs that received a saline injection, SDP decreased crypt depth (P<.05) and increased VCR (P<.05), with no effect on villus height. Injecting LPS to pigs fed the no SDP diet did not affect intestinal morphology. Injecting LPS to pigs fed the 7% SDP diet decreased villus height and (P<.05) and VCR (P<.05), with no effect on crypt depth. Serum ACTH and cortisol for the 3-hr post-LPS challenge were analyzed using basal levels as covariates. There was an interaction between SDP and LPS for both serum ACTH (P<.001) and cortisol (P<.05). After LPS injection, pigs fed SDP had an increase in ACTH, while pigs fed no SDP had no change in ACTH. The LPS challenge raised serum cortisol for pigs fed both diets; however, this increase was greater for pigs fed the SDP diet than the no SDP diet. These results indicate that feeding SDP alters the responsiveness of the HPA axis in young pigs following an immunological challenge. Further studies are needed to determine if these differences in responsiveness and intestinal morphology may compromise the immune function in young pigs.

Key Words: Weaned Pigs, Spray-dried Plasma, Stress

131 Effect of spray-dried plasma and *Eschericia coli* on intestinal morphology and the hypothalamic-pituitary-adrenal (HPA) axis of the weaned pig. K. J. Touchette*[1], G. L. Allee[1], R. L. Matteri[2], C. J. Dyer[2], L. W. Pace[1], and J. A. Carroll[2], [1]*University of Missouri-Columbia,* [2]*ARS-USDA, Columbia, MO.*

Twenty pigs (14 d, 5.6 kg) were weaned to an isolated environment to determine if feeding spray-dried plasma (SDP) affects the pigs response to an oral *E. coli* challenge. Weaned pigs were allotted to one of four treatments in a 2 x 2 factorial arrangement, with two levels of spray-dried plasma (0 vs 7%) and two oral doses (*E. coli*, F17 vs saline). Diets, formulated to contain equal ME and digestible essential amino acids, were fed for 7 d postweaning. On d 6, the pigs were non-surgically fitted with jugular cannulae. On d 7, an oral dose of either saline or *E. coli* was given, followed by blood samples for 10 hr. After 10-hr, all pigs were killed and intestinal samples were collected to measure villus height, crypt depth, and villus:crypt ratio (VCR). Spray-dried plasma did not affect weight gain. For pigs that received the saline, SDP increased villus height and VCR (P<.05), with no effect on crypt depth. There was no effect of the *E. coli* challenge on intestinal morphology regardless of diet. Serum ACTH and cortisol for the 10-hr post-*E. coli* challenge were analyzed using basal levels as covariates. There was an interaction between SDP and *E. coli* for both serum ACTH (P<.05) and cortisol (P<.001). Serum ACTH for pigs fed SDP was increased by *E. coli* from 1 to 4 hr after administration, while pigs fed no SDP had no significant increase in serum ACTH. Serum cortisol for pigs fed SDP was increased by *E. coli* from 1 to 5 hr after administration, while pigs fed no SDP had an increase in serum cortisol from 2.5 to 6 hr after *E. coli* administration. There was no significant histologic lesions seen in brain, heart, lung, liver, kidney, spleen, or intestinal sections. Our results indicate that feeding SDP alters the responsiveness of the HPA axis when stimulated by an *E. coli* challenge.

Key Words: Weaned Pigs, Spray-dried Plasma, Stress

132 Evaluation of a coproduct from pork slaughter plants as a protein source for starter pigs. D.J. Lee*[1], B.R. Dunsford[2], J.D. Hancock[1], K.L. Herkelman[2], M.D. Tokach[1], and J.D. Hahn[2], [1]*Kansas State University, Manhattan,* [2]*Farmland Industries, Inc., Kansas City, MO.*.

A total of 150 weanling pigs (average initial BW of 4.6 kg) were used to determine the effects of a porcine coproduct (primarily red blood cells and slaughter floor tissue) as a protein source in diets for weanling pigs. Treatments were: 1) a corn-soybean meal-based control and the control with; 2) 20% spray-dried whey; 3) 3.7% menhaden fish meal; 4) 2.1% spray-dried blood cells; and 5) 2.9% porcine coproduct. The animal protein sources (whey, fish meal, blood cells, and porcine coproduct) were substituted for soybean meal (on a lysine basis) and fed for d 0 to 14 of the 29-d growth assay. The diets had 1.30% total lysine (deficient compared to the 1998 NRC value of 1.50% lysine for this weight pig) and 14.4% total lactose. Otherwise, the diets were simple formulations to accentuate differences in growth performance among pigs fed the various protein sources. For d 14 to 29, the same corn-soybean meal-based diet (formulated to 1.25% lysine) was fed to all the pigs to determine the effects of Phase I protein source on subsequent growth performance. The diets were pelleted at 62 ^{o} C using a 2.54 cm thick die with 3.2 mm diameter holes. Pellet durability index was improved (P < .001) when the animal protein products were added to the diets. Among the animal protein products the ranking (from best to worst) for pellet durability index was whey > porcine coproduct > blood cells > fish meal (P < .001). As for the piglet growth assay, there were numerical advantages when animal protein products were used to replace soybean meal, but no statistically significant differences (P > .15) were observed for ADG, ADFI, or gain/feed among pigs fed the various protein sources. In conclusion, results from this experiment demonstrated improved pellet quality when animal protein products were added to diets for nursery pigs. However, growth performance was similar among pigs fed the various protein sources.

Key Words: Soybean Meal, Animal Protein, Pig

133 Effects of commercially available soybean cultivars and extrusion temperature on growth performance and nutrient digestibility in nursery pigs. H. Cao*, J. D. Hancock, T. L. Gugle, W. T. Schapaugh, J. M. Jiang, J. S. Park, and J. M. DeRouchey, *Kansas State University, Manhattan, KS* .

A total of 288 weanling pigs (average initial BW of 5.0 kg) were used to determine the effects of soybean cultivar and extrusion temperature on growth performance and nutrient digestibility. All pigs were fed the same adjustment diet (1.7% lysine, 5% lactose, and 20% spray-dried whey) to d 7 post-weaning. Then, the pigs were switched to experimental diets with a soybean meal (SBM, control) or dry-extruded (Insta-Pro) whole soybeans (DEWS) from Stein 3973, Stressland, and Flyer soybean cultivars. The extrusion temperature was 125C (under-processed) in Exp. 1 and 145C (adquately processed) in Exp.2. The diets were formulated to 90% of the NRC standard for lysine to accentuate difference in growth performance. In Exp. 1, urease activity of the soybeans (extruded at 125C) ranged from .8 to 1.9. Thus, the soybeans were severely under-processed and supported lower ADG and gain/feed than the SBM + oil control diet (P < .05). There were no differences in growth performance among pigs fed the full-fat soy products (P > .15), but pigs fed the Stressland DEWS had lower digestibilities of DM and N (P < .05) than pigs fed the other DEWS treatments. When extruded at 145C (Exp. 2), urease indexes were .02 to .2. Growth performance was not different for pigs fed SBM + oil vs the DEWS treatments (P > .15), but digestibilities of DM and N were greater in pigs fed DEWS (P < .05). Among the soybean genotypes, pigs fed Stein 3973 soybeans had the greatest gain/feed and digestibility of nutrients (P < .01). In conclusion, our results indicated extrusion temperature is critical to nutritional value of DEWS, and even with adequate heat treatment, differences exist in nutritional value of DEWS from different soybean cultivars.

Key Words: Extrusion, Soybeans, Nursery pig

134 Effects of exotic soybean genotypes on growth performance and nutrient digestibility in nursery pigs. Hong Cao*, J.D. Hancock, R. H. Hines, W. T. Schapaugh, T. L. Gugle, J. M. DeRouchey, C. A. Maloney, J. M. Jiang, and D. H. Lee, *Kansas State University, Mahattan, KS*.

A total of 180 weanling pigs (average initial BW of 7.5 kg) were used in a 28-d growth assay to determine the effects of exotic soybean genotypes on growth performance and nutrient digestibility in nursery pigs. All pigs were fed the same adjustment diet (1.7% lysine, 5% lactose, and 20% spray-dried whey) to d 7 post-weaning. Then, the pigs were switched to experimental diets with a soybean meal (SBM) control or dry-extruded (150C, Insta-Pro) whole soybeans (DEWS). The treatments were: 1) SBM + oil; 2) mill run DEWS; 3) low trypsin inhibitor (19 mg/g) DEWS; 4) high protein (53% CP) DEWS; 5) low oligosaccharide (.12% raffinose, and .11% stachyose) DEWS; and 6) high oleic acid (85% of oil as oleic acid) DEWS. The diets were formulated to 1.05% lysine for d 0 to d 11 and .86% for d 11 to 21 (i.e., deficient) to accentuate difference in growth performance. Urease activity of the soybeans ranged from .02 to .16. The SBM + oil control supported similar ADG and gain/feed (P > .15) compared to diets with DEWS. For d 0 to 14, pigs fed modified soybeans had greater gain/feed (P < .04) compared to pigs fed mill run soybeans. However, this advantage was not apparent for d 21 to 35 and overall (P > .15). There were no differences (P > .15) in growth performance or serum urea N among pigs fed the various modified soybean genotypes, although pigs fed low oligosacchride soybeans had lower digestibilities of DM and N than pigs fed the other soybean genotypes (P < .01). In conclusion, our results indicated that DEWS from genetically modified soybeans were somewhat better in nutritional value than mill-run DEWS, but similar to one another. Thus, the choice of which soybean source to use should depend on price and availability.

Key Words: Extrusion, Soybean, Pig

135 Effects of different fat sources on growth performance of early weaned pigs. M. De La LLata*[1], R.D. Goodband[1], M.D. Tokach[1], J.L. Nelssen[1], S.S. Dritz[1], G.S. Grinstead[1], and J.S. Herbert[2], [1]*Kansas State University, Manhattan,* [2]*Omega Proteins, Hammond LA*.

One hundred and eighty early-weaned pigs (initially 6.6 kg and 21 ± 2 d of age) were used in a 35 d growth trial to evaluate the effects of different fat sources on growth performance. Treatments consisted of a control diet (no added fat) or the control diet with 5% added fish oil, soybean oil, choice white grease, or a combination of 2.5% fish oil and 2.5% choice white grease. The diets were fed in two phases (d 0 to 14 and d 14 to 35 after weaning). Diets were fed in a meal form and formulated to a similar lysine:calorie ratio. From d 0 to 14, pigs fed either soybean oil or fish oil had improved (P < .05) ADG compared to pigs fed the control diet (.385, .381, vs .336g, respectively), with those fed choice white grease or the blend of choice white grease and fish oil having intermediate performance (.349 and .354g, respectively). From d 14 to 35 and from d 0 to 35, neither added fat nor source affected (P > .05) ADG; however, feed efficiency (G:F) was improved (P < .05) approximately 8% for pigs fed any of the fat sources compared with those fed the control diet. Feed efficiency was not affected (P > .05) among pigs fed the diets containing the different fat sources. These results indicate that 5% fish oil, soybean oil or choice white grease can be added to diets for early weaned pigs to improve feed efficiency from weaning to d 35. However, relatively few differences were found between fat sources.

Key Words: Fat source, Early-weaned pigs, Growth

136 Effects of dietary tryptophan on the growth performance of entire male, female, and castrated male pigs between 6 and 16 kg live weight. D. J. Cadogan*[1], R. G. Campbell[1], and J. Less[2], [1]*Bunge Meat Industries, Corowa, Australia,* [2]*ADM, Deacatur, IL*.

One Hundred and fifty pigs (Bunge genotype), comprising equal numbers of entire males, females, and castrated males were blocked by weight and allocated to 5 treatments. Pigs were housed in individual pens and offered ad libitum feed and water throughout the 21 d study. Experimental wheat based diets were formulated to contain 15.0 MJ DE/kg (3,600 kcal DE/kg), 1.55% total lysine (0.92 g/MJ DE available lysine) and crystalline amino acids were used to ensure all other essential amino acids were 115% of requirement. Tryptosine was used to provide five total tryptophan levels (0.22, 0.25, 0.28, 0.31 and 0.34%). Castrates exhibited lower ADG and ADFI when compared to males and females during the 21 d period. ADG and voluntary feed intake were improved by increasing dietary tryptophan, with 0.28% total tryptophan (0.25% available tryptophan) supporting optimum growth for the combined sexes. ADFI was increased to the highest level of tryptophan (linear, P< 0.001: quadratic, P< 0.001), although this effect was more pronounced in entire males and castrates. The results suggest that between 6 and 16 kg, entire male, female and castrated male pigs of improved genotype, have a similar tryptophan requirement of approximately 0.28% or 18% of lysine requirement to support most efficient growth. However tryptophan tended to exert an appetite stimulus on males and castrates, maximising ADG and ADFI at 0.34% or 22% of lysine requirement.

	Tryptophan content of diet					Effects[1]		
	0.22%	0.25%	0.28%	0.31%	0.34%	SEM	L	Q
Wt in (kg)	6.11	6.03	6.14	6.25	6.13	0.289	NS	NS
ADG (kg)	0.407	0.445	0.491	0.486	0.509	0.002	***	***
F:G	1.18	1.13	1.06	1.08	1.07	0.071	NS	*
ADI (kg)	0.473	0.494	0.522	0.529	0.543	0.002	***	***
Tryptophan intake (g/d)	1.05	1.25	1.48	1.66	1.88	0.092	***	***
Wt out (kg)	14.65	15.37	16.44	16.47	16.82	1.464	***	***

[1]Linear and Quadratic effect: NS, non significant, P>0.05, *P< 0.05, **P<0.01, ***P< 0.001.

Key Words: Pigs, Threonine, Amino Acids

137 Ascorbic acid synthesis in the fetal, nursing, and weaned pig. S. Ching* and D.C. Mahan, *The Ohio State University, Columbus*.

Ascorbic acid synthesis by the pig has been reported to be absent until 1 wk of age. This study was conducted to determine if ascorbic acid

synthesis (as measured by liver gulonolactone oxidase [GLO] activity) occurred and was affected by fetal development and pig weaning age. In the first experiment 3 fetuses from 3 sows each were collected on d 60, 80, 100, 107, and 111 of pregnancy, and the liver and kidney analyzed for GLO activity. In addition, 3 sows were each either injected with prostaglandin (112 d) or allowed to farrow naturally (115 d) to see if early farrowed pigs differed in their ability to synthesize the enzyme. Three pigs from each litter were killed and the liver and kidney collected for assaying GLO activity. The results showed that liver GLO activity was high in the 60 d old fetal pig but declined quadratically (P <.01) through gestation and was very low by 111 d of pregnancy. No enzyme activity was present in fetal kidney from 60 to 111 d. There was no difference in enzyme activity of pigs born early from prostaglandin injection or from natural farrowing. In Exp. 2, the effect of weanling age on pig liver GLO activity was evaluated. A total of 45 pigs were weaned at 3 ages (10, 17, or 24 d). Three pigs from each weaning group were killed each week postweaning to 38 d of age and liver enzyme activity measured. The results indicated that liver GLO activity was low from birth until weaning, increasing quadratically (P <.01) only after pigs were weaned. The increase in liver GLO activity was of the same magnitude in each of the three weaning groups. By d 38 all pigs from each weaning age group had the same liver enzyme activity. Pig serum and liver ascorbic acid concentrations declined from birth to weaning but then increased after weaning (P <.01). Ascorbic acid content was high in colostrum and declined in milk as lactation progressed (P <.01), suggesting that milk vitamin C suppressed the activity of the enzyme in the nursing pig, but upon weaning enzyme activity was stimulated.

Key Words: Ascorbic acid, Gulonolactone oxidase

138 Efficacy of vitamin E in the diets or drinking water of 2-week old weaned pigs.

I. Moreira, D.C. Mahan, S. Ching, and T.G. Wiseman*, *The Ohio State University, Columbus*.

Two experiments involving 347 pigs weaned at 151 d of age and 5.0 kg BW evaluated the efficacy of vitamin E (dl α-tocopheryl acetate) added to the diet or drinking water. The first trial involved 217 pigs allotted to a RCB designed experiment conducted in 7 replicates. Dietary levels of vitamin E were 0, 20, 40, 60, 80, 100, 150, or 200 IU/kg. Pigs were bled initially and at 7 d intervals for a 42-d period, with liver and subcutaneous fat samples collected from one pig for each treatment pen and replicate at 42-d. In Exp. 2, 130 pigs were allotted to a RCB design in 6 replicates. The drinking water was fortified with 0, 55, 110, 220, or 440 IU/L. Pigs were bled at 0, 3, 7, 10, 17, or 21 d, with tissues collected at 21-d. Serum concentration of the vitamin declined in Exp. 1 when the basal diet was fed. As dietary vitamin E level increased serum α-tocopherol increased (P < .01) at each weekly period. Both liver and adipose tissue had increasing α-tocopherol concentrations (P < .01) as the dietary vitamin E level increased, but the liver increased at a faster rate. In Exp. 2, serum α-tocopherol declined when pigs consumed the non fortified vitamin E water source. The addition of vitamin E to the drinking water resulted in higher (P < .01) serum α-tocopherol concentrations, particularly during the initial week postweaning. Although serum α-tocopherol declined over the 21 d period in all groups, the serum concentration of α-tocopherol was higher as the water fortification level increased (P < .01). Liver α-tocopherol content increased quadratically (P < .01) and adipose linearly (P < .05). These combined results indicate that vitamin E provided in the diet or drinking water improved the pigs α-tocopherol status, but the drinking water seemed to result in a higher liver concentrations of vitamin E. Vitamin E appeared to be readily cleared from the blood into the tissue of the weaned pig and serum values may not adequately reflect the pig's vitamin E status particularly during the initial weeks postweaning.

Key Words: Weaning pig, Vitamin E

139 Higher levels of selected B-vitamins improve performance and lean deposition in growing/finishing swine.

M. D. Lindemann*, G. L. Cromwell, J.L.G. van de Ligt, and H. J. Monegue, *University of Kentucky, Lexington*.

Crossbred pigs (70 barrows and 85 gilts) were used to determine the effect of graded levels of 5 B-vitamins (niacin, riboflavin, folic acid, pantothenic acid and vitamin B_{12}) on performance and carcass measurements. Pigs were weaned at about 21days of age and fed a diet that met or exceeded NRC (1988) nutrient requirement estimates with the exception of the 5 B-vitamins which were at 70% of NRC until 10 kg BW. At 10 kg BW, 155 pigs were chosen, blocked on the basis of ancestry, gender, BW and pre-assignment performance and randomly assigned from within blocks to 5 dietary treatments consisting of the basal (70% of NRC for the 5 vitamins) with 0, 100, 200, 400, and 800% of NRC levels of the 5 vitamins added. Six replicates were used for the grower phase (10-50 kg); four replicates continued for the finishing phase (50-100 kg). Lysine and P levels were elevated above NRC (1988) requirement estimates to assure that these nutrients were not limiting to growth; other amino acids were elevated to maintain acceptable ratios relative to lysine while Ca levels were elevated to maintain an acceptable Ca/available P ratio. At 100 kg all pigs were measured by real-time ultrasound. At the end of the grower phase, there was a quadratic response in daily gain (653, 707, 710, 704, and 701 g/d; P=.001) and feed/gain (2.00, 1.96, 1.96, 1.95, and 1.98; P=.07) to the vitamin additions. At the end of the finisher phase, there also was a quadratic response in daily gain (766, 810, 821, 815, and 802 g/d; P=.005) and feed/gain (2.49, 2.47, 2.42, 2.47, and 2.50; P=.045) to the vitamin additions. Backfat depth was not affected at 100 kg (P=.38) but loin depth (52.4, 56.9, 58.3, 57.4, and 57.7 mm) was quadratically affected (P=.038) resulting in a quadratic effect (P=.076) on percent carcass lean (52.9, 53.2, 53.6, 53.7, and 53.3). The results indicate that vitamin supplementation does affect performance and carcass measurements in pigs.

Key Words: Pigs, Vitamins, Performance

140 Assessment of chromium tripicolinate addition and dietary protein levels on performance and carcass composition of growing pigs.

C.P.A. van de Ligt*, M. D. Lindemann, and G. L. Cromwell, *University of Kentucky, Lexington*.

An experiment utilizing 36 PIC (Pig Improvement Company, Franklin, KY) barrows of 21.6 kg mean BW was conducted to evaluate potential interactions of chromium tripicolinate (CrPic) with dietary protein levels in a 2 × 3 factorial arrangement of supplemental Cr (0 and 200 ppb) and protein level (76, 83, and 90% of lysine requirement). Pigs were housed individually with ad libitum access to water; feed was supplied as 2 meals/d. A fortified corn-soybean meal diet was designed to supply 90% of the daily ME requirement (kcal = 569 + 148BW - .619BW^2) in 70% of voluntary feed intake (kg feed = .134 + .0348BW - .000145BW^2). The basal diet provided 76% of the lysine requirement (g/d = 2.18 + .345BW - .00211BW^2). Additional lysine to 83% (g/d = 2.39 + .377BW - .00230BW^2) and 90% (g/d = 2.59 + .409BW - .00249BW^2) of the requirement was provided by soy protein isolate. Protein was balanced with synthetic amino acids on an ideal ratio basis. Equations were derived by linear regression from data supplied by PIC and NRC nutrient requirement estimates. Meals were adjusted weekly based on the projected weight for the next week. Growth data were collected for a 50-d period and pigs were killed at a mean of 62.7 kg BW. There was no Cr × protein level interaction for any of the traits. Protein levels had a linear effect on ADG (714, 762, 808 g/d; P<.001) and liver weight (973, 985, and 1074 g; P<.01). Protein level affected 10^{th} rib backfat quadratically (10.6, 11.8, and 9.5 mm; P<.05). Cr also affected 10^{th} rib backfat (9.66 and 11.63 mm; P<.10). Carcass length, loin muscle area, and dressing % were not influenced by Cr or protein level. Dietary protein linearly (P<.05) affected carcass ash (3.96, 3.90, and 3.68%), lipid (22.57, 23.13, and 20.72%), and water (55.22, 54.25, and 57.10%). In this experiment, there was no evidence of a CrPic × dietary protein level interaction on grower pig performance.

Key Words: Pigs, Chromium, Protein

141 Effect of L-carnitine and(or) chromium nicotinate on glucose tolerance and insulin sensitivity in growing pigs.

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Two experiments were conducted to determine the effect of dietary chromium nicotinate (CrN) and(or) L-carnitine on glucose tolerance (IVGTT), insulin sensitivity (IVICT), and plasma metabolites and hormones of pigs. In Exp. 1, 30 pigs (BW 20 kg) were fed 0 or 200 ppb Cr from CrN for 24 d, at which time 19 pigs (9 or 10 per diet) were penned individually in metabolism crates. The pigs were fed twice daily approximating ad libitum intake. After an adjustment of 5 d, pigs were fitted with chronic indwelling catheters in the vena cava, and were allowed to

recover for 2 d. An IVGTT (500 mg glucose/kg BW) and an IVICT(.1 IU porcine insulin/kg BW) were conducted. The blood samples collected at -10 and 0 min before the IVGTT were analyzed for plasma metabolites and hormones. CrN did not affect gain, feed intake, or fasting plasma cholesterol and NEFA concentrations. CrN decreased gain/feed (P<.09) and fasting plasma glucose (P<.07) but increased plasma urea N (P<.01) and insulin (P<.10) concentrations. CrN decreased (P<.07) glucose clearance (k, %/min) and increased half-life (min) during the IVGTT, but it did not affect glucose kinetics during the IVICT or insulin kinetics during the IVGTT or IVICT. In Exp. 2, 90 pigs (2 groups, BW 27 kg) were fed: 1) basal (B) diet, 2) B + 200 ppm Cr as CrN, 3) B + 50 ppb L-carnitine, or 4) B + CrN + L-carnitine for 28 d. Neither Cr nor carnitine affected growth performance. CrN decreased (P<.07) fasting plasma urea N and thyroxine, but tended to increase (P<.12) NEFA concentrations. Cortisol, triiodothyronine, insulin, and glucose concentrations were not affected by diet. Ten or 11 pigs per diet were administered IVGTT and IVICT as in Exp. 1. CrN decreased glucose k (P<.08) and increased glucose half-life (P<.10) during the IVGTT. Chromium as CrN and(or) L-carnitine for growing pigs had little effect on growth performance. Chromium nicotinate increased glucose half-life and decreased glucose k.

Key Words: Pigs, Chromium, Glucose

142 Effect of chromium tripicolinate supplementation on total immunoglobulin concentration in sows and their offspring.

J.L.G. van de Ligt*, M. D. Lindemann, R. J. Harmon, H. J. Monegue, and G. L. Cromwell, *University of Kentucky, Lexington*.

A total of 36 gilts were used to assess the effects of Cr tripicolinate (CrPic) supplementation on total Ig concentration in sows and their offspring during late gestation, lactation, and the neonatal period. Gilts were raised from weaning to reproductive age on diets with either 0 (-Cr) or 200 (+Cr) ppb supplemental Cr from CrPic. Subsequently, 22 gilts (9 -Cr and 13+Cr) in parity 1 and 16 sows in parity 2 (7 -Cr and 9 + Cr) underwent immune status testing. Only sows that completed all procedures in parity 1 were included in parity 2. Serum was collected from the dam 21 d prior to anticipated farrowing (Day 0) and at 14-d intervals for a total of 4 samples. Serum was collected for measurement of total IgG and IgM from 5-6 pigs/litter at 24 hr after birth, 3 or 6 pigs/litter the day after weaning (25 d of age) in parity 1, and 3 pigs/litter the day of weaning (20 d of age) in parity 2. Milk was collected for measurement of total IgG, IgM, and IgA at 1 hr (colostrum), 6.5 d (early), and 19 d (late) after farrowing. The only effect of Cr was on sow serum IgG (21.7 and 24.2 mg/mL for -Cr and +Cr; $P<.10$) and IgM (11.0 and 12.6 mg/mL; $P<.05$) on Day 0. Sow serum IgG decreased the week before farrowing and then increased (22.7, 19.4, 20.5, 20.9 mg/mL on Day 0, 14, 28, and 42), but IgM decreased from late gestation through lactation (11.6, 10.7, 7.1, and 6.6 mg/mL). The highest milk concentrations of IgG, IgM, and IgA were detected in colostrum (85.3, 8.5, and 12.1 mg/mL) with early (5.4, 3.4, and 4.4 mg/mL) and late (5.5, 3.3, and 4.6 mg/mL) milk being considerably lower. In parity 2, colostral IgG increased (80.1 and 92.7 mg/mL for parity 1 and 2; $P<.05$) which was reflected in the neonate at 24 hr (32.8 and 39.2 mg/mL; $P<.01$) and weaning (7.7 and 13.5 mg/mL; $P<.001$). Supplementation of CrPic had minimal effects on total Ig concentration of the dam or neonate; however, parity greatly influenced IgG in the milk and its transfer to the neonate.

Key Words: Pigs, Chromium, Immune Status

143 Effect of maternal chromium tripicolinate supplementation on growth performance and immune status of weanling pigs.

J.L.G. van de Ligt*, M. D. Lindemann, R. J. Harmon, H. J. Monegue, and G. L. Cromwell, *University of Kentucky, Lexington*.

A total of 60 pigs from 15 litters were used during 2 experiments to assess the effects of maternal supplementation of Cr tripicolinate (CrPic) on performance and immune status of the offspring during a 42-d nursery period. Gilts were raised on diets with either 0 (-Cr) or 200 (+Cr) ppb supplemental Cr from CrPic. Their offspring were weaned at about 25 d of age, fed diets respective of the dams, and housed in groups of 3 according to litter origin (6 -Cr and 9 +Cr) and BW. Feed and water were available on an ad libitum basis. Serum was collected 24 hr after birth, the day after weaning (Day 0), and every 7 d through Day 28 for measurement of total IgG and IgM. For the 42-d nursery period, ADG (511 and 531 g/d for -Cr and +Cr), ADFI (827 and 851 g/d), and gain:feed (.62 and .62) were not affected ($P>.10$) by Cr; however, there was a Cr×trial interaction ($P<.10$) for ADG and ADFI. Total IgG was not affected ($P>.10$) by Cr on Day 0 (7.6 and 7.7 mg/mL) or on Day 7 (6.3 and 6.1 mg/mL) where the lowest concentrations were observed. By Day 28, total IgG had risen (11.6 and 8.9 mg/mL) and was affected by both Cr ($P<.05$) and Cr×trial ($P<.005$). Total IgM followed a similar pattern with the low point occurring on Day 7. In each trial, IgG at 24 hr after birth was inversely related to IgG from Day 14 through Day 28 in the nursery. By Day 21, lower Ig concentrations were associated with larger weight gains implying that an increased immune status is not necessarily indicative of enhanced performance. Additionally, the lowest Ig concentrations occurred between 4 to 5 wk of age rather than at weaning and may represent a vulnerable period for weanling pigs. These findings suggest that acquisition of IgG from colostrum represents a major factor in pig performance for the entire nursery period. However, maternal supplementation of CrPic did not significantly affect performance and immune status of the offspring during the nursery period.

Key Words: Pigs, Chromium, Immune Status

144 Dietary Available Phosphorus Needs of High Lean Pigs.

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Seven sets of five littermate gilts from a high lean strain were used to determine the dietary available phosphorus (AP) needs for high lean pigs fed from BW (± 1) of 7 to 23.5 kg. Pigs were weaned via a SEW scheme, individually penned, and randomly allotted to a basal corn-soybean diet containing one of five dietary available phosphorus (AP) concentrations (.30, .40, .50, .60, and .70%). Dietary AP concentrations were achieved by the substitution of mono-dicalcium phosphate for starch while the calcium concentration remained constant at 1.15%. Dietary AP in each feedstuff was estimated as analyzed phosphorus times the following assumed bioavailability (%): corn, 13; soybean meal, 26; whey 77; monodicalcium phosphate, 100. Pigs were fed the basal diet (.30% AP) from BW of 5 to 7 kg and then placed on their experimental diet. Pigs were allowed access to feed and water ad libitum. A deuterium oxide dilution technique was used to estimate body protein and fat gain. Serum alpha-1-acylglycoprotein concentrations indicated the pigs experienced a moderate level of antigen exposure. As dietary AP concentration increased, gain to feed ratios improved linearly (.685, .735, .757, .766, .788, $P < .01$). Rate of body protein accretions also increased linearly (98, 100, 105, 108, 105 g/day, $P < .11$) as dietary AP increased, whereas body fat accretions decreased linearly (51, 48, 50, 48, 37 g/day, $P < .09$). Body weight gains were not altered by increased AP concentrations (565, 568, 597, 589, 583 g/day). Based on breakpoint analysis, high lean pigs fed from 7 to 23.5 kg body weight require daily 5.2 ± .6, 5.3 ± .9, and 5.0 ± 1.0 grams of dietary AP to maximize body protein gain, efficiency of feed utilization, and body weight gain, respectively. Inadequate intakes of dietary AP lower the pig's capacity for proteinaceous tissue accretion.

Key Words: Pigs, Phosphorus, Growth

145 Performance and phosphorus excretion of growing-finishing pigs fed low-phytic acid corn.

J. L. Pierce* and G. L. Cromwell, *University of Kentucky, Lexington*.

Two near-isogenic corns (Optimum Quality Grains), one with the mutant *lpa1-1* allele, were evaluated in corn-soybean meal diets for growing-finishing pigs. The normal (N) and low-phytic acid (LP) corns analyzed .25 and .28% total P and .20 and .10% phytic acid P, with P bioavailability assumed at 20 and 75%, respectively. Five pen-replicates of five pigs (28 kg BW) were fed fortified corn-soybean meal diets with N- (Diets 1 and 2) or LP-corn (Diets 3 and 4) from 28 to 113 kg BW. Diets were formulated to contain .50 (Diets 1 and 3) or .40% total P (Diets 2 and 4); P was reduced to .45 and .35% at 52 kg, then to .40 and .30% at 85 kg BW. Bioavailable dietary P was estimated at .26, .16, .36, and .26% during Phase 1 and it decreased by .03 percentage units for each diet at each subsequent phase. Bioavailable P was the same in Diets 1 and 4. Dietary Ca was .60, .50, and .45% and lysine was .90, .75, and .60% during the 3 phases. Feces were collected at the end of each phase to estimate fecal excretion of P using Cr_2O_3 as a marker. Breaking strength was determined on the 3rd and 4th metacarpals of all pigs. Lowering total P reduced ADG (P<.05) and bone strength (P<.01) in pigs fed N-corn, but not in those fed LP-corn (.85, .79, .87, .84 kg/d; 209, 157, 213, 202 kg). Dietary P level did not affect F:G (2.94, 2.92,

2.88, 2.88). Apparent digestibility of P was higher (P<.01) in the LP- vs N-corn diets at each phase (35, 23, 45, 42%; 27, 20, 49, 42%; 37, 26, 55, 52%). Fecal P (% of DM) was lower (P<.01) in the LP-corn diets at each phase (2.4, 2.2, 2.1, 1.6%; 2.7, 2.1, 1.8, 1.7%; 2.4, 2.2, 1.7, 1.3%) as was the estimated fecal P excretion (7.1, 5.8, 5.6, 4.7 g/d; 9.5, 7.7, 6.4, 5.7 g/d; 7.6, 6.3, 5.5, 4.5 g/d, P<.01). When consuming diets with similar bioavailable P (Diets 1 and 4), pigs fed LP-corn excreted 35-40% less fecal P than those fed N-corn. These results indicate that the use of LP-corn in diets with .1 percentage point less total P can markedly reduce P excretion without affecting performance or bone strength in growing-finishing pigs.

Key Words: Pig, Corn, Phytic acid

146 Effects of phytase on bioavailability of phosphorus in normal and low-phytic acid corn.

J. L. Pierce* and G. L. Cromwell, *University of Kentucky, Lexington*.

The bioavailability of P in low-phytic acid (LP) corn with the mutant *lpa1-1* allele is greater than in normal (N) corn for chicks (52 vs 10%) and pigs (77 vs 22%). This study assessed whether supplemental phytase would further increase bioavailability of P in the two corns. The near-isogenic N- and LP-corns (Optimum Quality Grains) analyzed .25 and .28% P. In Exp. 1, 300, 3-d-old chicks (5 pens of 6 birds/treatment, 77 g) were fed 10 diets for 14 d. Diets 1-5 were: low-P (.43%) basal (dextrose-starch-soybean meal), basal + .06 or .12% added P from monosodium phosphate (MSP), and basal + .12% P from N-corn or LP-corn. Diets 6-10 were as 1-5 except phytase was added at 1,200 FTU/kg. Gain, tibia strength, and tibia ash weight were, respectively: 403, 461, 486, 410, 455, 476, 483, 510, 470, 484 g; 6.6, 11.6, 14.9, 7.0, 10.4, 12.2, 14.6, 17.6, 12.0, 15.8 kg; 446, 563, 694, 456, 590, 593, 694, 777, 582, 671 mg. In Exp. 2, 40 pigs (5 reps/treatment, 18 kg) were fed 8 diets for 34 d. Diets 1-4 were: low-P (.22%) basal, and basal + .16% P from MSP, N-corn, or LP-corn. Diets 5-8 were as 1-4 except added P was .12% in Diet 5 and phytase was added to all diets at 600 FTU/kg. ADG, femur strength, and metatarsal-metacarpal strength and ash were: 647, 883, 706, 839, 774, 849, 782, 833 g/d; 99, 234, 120, 209, 147, 211, 176, 230 kg; 30, 68, 36, 54, 47, 71, 51, 67 kg; 1.8, 3.0, 2.1, 2.6, 2.3, 3.2, 2.4, 3.0 g. In both chicks and pigs, added P from MSP or LP-corn, but not N-corn, increased gain and bone strength and ash (P<.01). Phytase addition to diets improved bone traits (P<.05). For nonphytase diets, slope-ratios of bone traits regressed on added P intake indicated that the P was more available in LP- vs N-corn for both chicks (52 vs 5%) and pigs (79 vs 22%). Similar procedures with diets containing phytase indicated that phytase did not further improve the bioavailability of P in the LP- or N-corn for chicks (56 vs -6%) or pigs (73 vs 16%), suggesting that the positive responses to phytase were primarily due to its effect on the phytate in soybean meal.

Key Words: Pig, Corn, Phytic acid

147 Bioavailability of phosphorus in low- and high-ash meat and bone meal of pork and beef origin for pigs.

S. L. Traylor*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington*.

Meat and bone meal (MBM) of pork origin is low in ash and high in protein. In contrast, MBM of beef origin is high in ash and low in protein. MBM of pork (23.1% ash, 59.7% CP, 7.4% Ca, 3.7% P) and beef (42.7% ash, 40.0% CP, 14.3% Ca, 7.1% P) origin were used in two experiments. In Exp. 1, barrows (6 reps, 57 kg BW) were in metabolism crates for 5-d collections. The basal diet (.80% lysine, .32% Ca, .33% P) was corn-soy based. In diets 2-4, monosodium phosphate (MSP), pork MBM, or beef MBM were added to provide .125% added P. In Exp. 2, 36 individually-penned pigs (6 reps, 12.7 kg BW) were fed a low-P, corn-soy basal (.95% lysine, .70% Ca, .34% P) or the basal with .10 and .20% added P from MSP or .20% added P from MBM (pork, beef, or 50:50 blend). Ca was maintained at .70%. Pigs were killed on d 35 and metacarpals and metatarsals (MM) and femurs were removed. In Exp.1, no differences (P=.25) were found although MBM had lower true P absorption (85.8 vs 81.0, 82.9%) and retention (83.4 vs 79.2, 81.9%) than MSP. Source of MBM did not affect P balance. In Exp. 2, ADG and feed:gain (F:G) were: 422, 626, 681, 678, 670, 682 g/d; 2.35, 1.94, 1.82, 1.91, 1.91, 1.76. Femur and MM strength and MM ash were: 71, 141, 196, 164, 184, 177 kg; 13.0, 25.0, 33.5, 28.0, 31.7, 28.5 kg; 1.26, 1.82, 2.19, 2.00, 2.14, 1.99 g. ADG and F:G improved (P<.01) with P addition from either MSP or MBM, and P additions from MSP linearly (P<.01) improved growth and bone traits. Growth was unaffected (P=.12) by P source (diet 3 vs 4-6); however, MM strength was lower (P<.02) for the MBM treatments. Ash content of MBM tended to linearly affect MM strength (P<.08) and ash (P<.11). Bone traits were regressed on added P intake for each P source. Based on slope-ratio (MSP=100%) the bioavailability of P averaged 72, 82, and 89% (linear, P<.05, SE=3) for the pork, blended, and beef MBM. These results indicate that the bioavailability of P in MBM is relatively high for pigs, and that the P in high-ash, beef MBM is more bioavailable than the P in low-ash, pork MBM.

Key Words: Pig, Phosphorus, Meat and Bone Meal

148 Prolonged feeding of high levels of organic and inorganic selenium to primiparous sows.

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An experiment with 22 first parity gilts evaluated the effects of Se source and level on sow reproduction, tissue responses, and the transfer of Se to their progeny. Corn-SBM diets with Se levels of .3, 3, 7, and 10 ppm from organic (Se-enriched yeast) and inorganic (sodium selenite) sources were fed which was initiated at 20 kg BW and fed through one parity. The experiment was a 2x4 factorial arrangement of treatments in a CRD design. Gilts were bled at periodic intervals with serum Se and GSH-Px activity measured. Colostrum and milk were collected daily from 1 to 7 d, and at 10, and 14 d postpartum (weaning) and analyzed for Se. Pig tissue (3/treatment) was collected prior to colostrum consumption and at weaning. Pig blood was collected at 0, 7, 14 and at 49 d of age. Reproductive performance of sows tended to decline as Se level increased particularly when inorganic Se was provided, but the response was not significant (P < .15). Pig leg deformity occurred at 3 ppm and hoof separation occurred at 7 ppm when inorganic Se was fed. Alopecia occurred in the progeny of sows fed 7 to 10 ppm inorganic Se, but no hair losses or leg deformities occurred when the organic Se source was fed. Milk Se increased as dietary Se level increased and was higher when sows were fed the organic Se source resulting in an interaction response (P <.01). Pig tissue and serum Se increased as dietary Se level increased when the organic Se form was provided, resulting in an interaction (P < .01). Neither Se source or level affected serum GSH-Px activity in the sow, neonate or weaned pig. Weanling pig tissue Se increased as dietary Se level increased when the organic Se source was provided resulting in an interaction (P < .01). Serum Se in all pigs returned to normal values by 49 d of age when pigs were fed postweaning diets containing .3 ppm Se (inorganic Se) diet. These results suggest that Se transfer from the dam to the litter was higher during gestation and lactation when sows were fed organic Se, but the inorganic form was more toxic at a lower dietary level.

Key Words: Selenium, Reproduction, Pigs

149 Bioavailability of iron in iron proteinate for weanling pigs.

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A total of 288 weanling pigs were used in two experiments to determine the bioavailability of iron in two different sources of iron proteinate relative to the iron in ferrous sulfate ($FeSO_4$). Pigs were given no supplemental iron (either oral or injectable) from birth until weaning. At weaning (approximately 21 d), 72 barrows and 72 gilts were selected for each experiment based on their blood hemoglobin (Hb) concentration. The average initial BW and initial Hb were 5.25 and 5.04 kg and 4.5 and 4.0 g/dL in Exp. 1 and 2, respectively. In Exp. 1, pigs were allotted to a basal diet (56 mg/kg Fe) or to diets containing an additional 75 or 150 mg/kg Fe from feed-grade $FeSO_4$ or 50, 100, or 150 mg/kg Fe from iron proteinate (Optimin^{TM}). The major ingredients in the diets were corn, soybean meal, dried skim milk, and spray-dried porcine plasma. There were 36 pens (six pens per treatment) with two barrows and two gilts per pen. Pigs were allowed ad libitum access to feed and water during the 3-wk experimental period. Pigs and feeders were weighed and blood samples were taken weekly to determine ADG, ADFI, ADG/ADFI, Hb concentration, and Hb repletion. The bioavailability of iron proteinate was determined using slope-ratio methods. The procedures in Exp. 2 were similar to those in Exp. 1, except that a different source of iron proteinate (Buffermin^{R}) was used. The results from the slope-ratio assays indicated that the bioavailabilities (relative to $FeSO_4$) of the two sources (Optimin^{TM} and Buffermin^{R}) of iron proteinate were 94 and

100% for ADG, 110 and 94% for Hb concentration at wk 3, and 103 and 92% for Hb repletion. In conclusion, the bioavailability of iron in iron proteinate was similar to that of iron in ferrous sulfate.

Key Words: Pigs, Iron, Bioavailability

150 The effects of added zinc from zinc sulfate or zinc sulfate/zinc oxide combinations on weanling pig growth performance. J. C. Woodworth*[1], M. D. Tokach[1], J. L. Nelssen[1], R. D. Goodband[1], P. R. OQuinn[1], and T. M. Fakler[2], [1]*Kansas State University, Manhattan,* [2]*Zinpro Corp., Eden Prairie, MN.*

Three hundred and sixty early-weaned pigs (5.5 kg and 12 d of age; Genetipork) were used to determine the influence of zinc sulfate ($ZnSO_4$) or $ZnSO_4$ and zinc oxide (ZnO) combinations on weanling pig growth performance. Pigs were blocked by initial weight and allotted randomly to each of eight dietary treatments with five pigs per pen and nine replications per treatment. The eight treatments consisted of a control diet containing no added Zn, three diets containing added Zn (100, 200, or 400 ppm) from $ZnSO_4$, three diets containing added Zn (100, 200, or 400 ppm) from a combination of $ZnSO_4$ and ZnO (50:50 ratio), or a diet containing 3,000 ppm of added Zn from ZnO. Zinc additions replaced cornstarch in the control diet. There was no additional Zn in the trace mineral premix. Diets did not contain feed grade antibiotic. All diets were fed in meal form in four phases: d 0 to 5, d 5 to 10, d 10 to 20 and d 20 to 34. For the duration of the trial, ADG and ADFI were highest ($P < .0009$) for pigs fed diets containing 3,000 ppm of Zn from ZnO compared to all other treatments. Pigs fed diets containing $ZnSO_4$ or combinations of $ZnSO_4$ and ZnO had ADG, ADFI, and G/F that were similar (P ¿ .05) to the control diet containing no added Zn. There was no consistent effect (P ¿ .05) on ADG, ADFI, or G/F with increasing levels of $ZnSO_4$ or combinations of $ZnSO_4$ and ZnO. These results suggest that 3,000 ppm of Zn from ZnO should be added to weanling pig diets to achieve maximum growth performance.

Key Words: Weanling Pig, Growth, Zinc

151 The effects of added zinc from an organic zinc complex or inorganic zinc sources on weanling pig growth performance. J. C. Woodworth*[1], M. D. Tokach[1], J. L. Nelssen[1], R. D. Goodband[1], P. R. O Quinn[1], and T. M. Fakler[2], [1]*Kansas State University, Manhatten,* [2]*ZinPro Corp., Eden Prairie, MN.*

We conducted two trials to determine the influence of added Zn from an organic zinc amino acid complex (ZnAA) and inorganic (ZnO and ZnSO4) Zn sources on weanling pig growth performance. In both trials, pigs were blocked by initial weight and allotted randomly to their respective treatments. In Exp. 1, 360 early-weaned barrows (initially 4.25 kg and 12 d of age, Newsham Hybrids) were fed either a control diet, diets containing added Zn (100, 200, 300, 400, or 500 ppm) from ZnSO4 or ZnAA, or a diet containing 3,000 ppm of added Zn from ZnO. Diets did not contain feed grade antibiotic. All diets were fed in three phases: d 0 to 5, 5 to 10, and 10 to 20, and contained 165 ppm of Zn from ZnO from the trace mineral premix. For the entire trial pigs fed 3,000 ppm of Zn from ZnO had increased ($P < .07$) ADG compared to all other diets, while those fed added ZnSO4 and ZnAA showed intermediate results relative to the negative control and the diet containing 3,000 ppm of Zn from ZnO. In Exp. 2, 360 pigs (initially 5.3 kg and 16 d of age, PIC) were fed a negative control diet containing no added Zn, one of six diets containing 165 ppm Zn from ZnO from the trace mineral premix and added ZnAA (0, 100, 200, 300, 400, or 500 ppm of Zn), or a positive control diet containing 3,165 ppm added Zn from ZnO. Diets did not contain feed grade antibiotic. All diets were fed in four phases: d 0 to 5, 5 to 10, and 10 to 20, and 20 to 34. Pigs fed the positive control diet had higher ($P < .02$) ADG and ADFI compared to all other treatments for the duration of the trial. Pigs fed diets containing ZnAA had numerically higher ADG and ADFI than pigs fed the diet containing no added Zn for the entire trial. These results suggest that 3,000 ppm of Zn from ZnO improved weanling pig growth and diets containing lower levels of Zn from an organic complexed Zn source (ZnAA) or ZnSO4 do not elicit the same growth response as 3,000 ppm of Zn from ZnO.

Key Words: Weanling Pig, Growth , Zinc

152 Mineral composition of spray-dried animal plasma and spray-dried blood cells. G. L. Cromwell*[1], G. M. Hill[2], D. C. Mahan[3], G. C. Shurson[4], and T. L. Ward[5], [1]*University of Kentucky, Lexington,* [2]*Michigan State University, E. Lansing,* [3]*Ohio State University, Columbus,* [4]*University of Minnesota, St. Paul,* [5]*Consolidated Nutrition, L.C., Decatur, IN.*

Spray-dried animal plasma (plasma) and spray-dried blood cells (cells) are two relatively new feed ingredients available to the swine industry. These two products are commonly used in pig starter feeds. Very little information is available on the mineral composition of these two products. In fact, values for only about half of the mineral elements known to be required by pigs were listed for these two blood products in the NRC's 1998 Nutrient Requirements of Swine. Therefore, representative samples of plasma and cells were obtained from three companies that are the major suppliers of these products to the feed industry (plasma from American Protein Corporation, Ames, IA; DuCoa, Highland, IL; and Merrick's, Union Center, WI; and cells from American Protein Corporation and Merrick's). The samples of plasma and cells from American Protein Corporation and Merrick's were of mixed porcine and bovine origin. Seperate samples of plasma from porcine and bovine were obtained from DuCoa. The samples were analyzed for minerals at the laboratories represented by the five authors listed above. Mean analytical values (air-dry basis) for the plasma and cells were, respectively: DM: 91.8, 92.1%; CP: 78.8, 94.3%; ether extract: .08, .05%; Ca: .15, .015%; P: 1.48, .34%; Na: 2.76, .55%; Cl: 1.19, .61%; K: .02, .80%; Mg: .03, .02%; S: 1.02, .49%; Fe: 77, 2,618 ppm; Cu: 18, 3 ppm; Zn: 13, 16 ppm; Mn: 2.5, .4 ppm; and Se: 1.6, 1.0 ppm. The Na and Cl in the plasma samples ranged from 2.14 to 3.07 and from 1.05 to 1.43%, respectively. In cells, Na and Cl were similar for the two sources (.53 vs .56 and .61 vs .61%, respectively). Most of the mineral concentrations were similar to those listed in the NRC's 1998 Nutrient Requirements of Swine except for concentrations of Mg and K in plasma which were approximately 10 times lower in our study.

Key Words: Feed Composition, Plasma, Blood Cells

153 Spray dried animal blood cells in diets for weanling pigs. Q. Zhang*, T. Veum, and D. Bollinger, *University of Missouri. Columbia, MO USA.*

A 28-day experiment with two trials was conducted to evaluate the effects of increasing levels of spray dried blood cells (SDBC) in Phase 1 (P1) (d 0-14) diets. A total of 288 crossbred pigs were weaned at an average of 19 days of age and 6.1 kg BW and allotted to treatments (Trt) by litter, sex and weight. P1 Trt 1 to 5 were made by replacing corn and soybean meal on a total lysine basis with 0, .9, 1.8, 2.7 or 3.6% SDBC. Trt 1 to 5 contained 2% spray dried animal plasma (SDAP). Trt 6 contained 4% SDAP and 0% SDBC. The P1 diets contained 20% dried whey (DW), 10% lactose, mineral and vitamin supplementation, lard to equalize ME at 3.39 Mcal/kg, 1.50% lysine, and .45% methionine. In P2 (d 14-28) all pigs were fed the same diet containing 0% SDAP, 1.8% SDBC, 20% DW, 1.4% lysine, .43% methionine and 3.4 Mcal of ME/kg. Gain:feed ratio in P1, P2 or overall was not affected (P>.13) by the level of SDBC in P1. For week 1, P1, and overall there were quadratic responses (P<.05) for ADFI and ADG because of the sharp decline (P<.05) in ADFI and ADG for pigs fed the diet containing 3.6% SDBC compared to the other Trt. However, there was a linear increase (P<.03) in overall BW and ADG with increasing level of SDBC up to 2.7%. For P2, ADG and ADFI were not affected (P>.06) by P1 dietary Trt. In conclusion, increasing levels of SDBC in the P1 diet up to 2.7% did not reduce pig performance, whereas 3.6% SDBC reduced pig performance. Increasing SDAP from 2% to 4% in the P1 diet did not improve pig performance.

Key Words: Performance, Weaning Pigs, Blood Cells

154 Menhaden fish meal and spray dried animal plasma in weanling pig diets. T. L. Veum*, D. W. Bollinger, and C. Mitchell, *University of Missouri, Columbia, MO USA.*

An experiment with two trials was conducted to evaluate Menhaden fish meal (MFM) as a partial substitute for spray dried animal plasma (SDAP; AP920®) in Phase (P) 1 diets (d 0-14) that were pelleted and crumbled, and P2 (d 14-28) diets that were pelleted. Crossbred pigs (total n=270) were weaned at an average of 6.0±.01 kg BW and 21±.2

days of age and allotted to treatment (Trt) by sex, litter and weight. Pens were the experimental units with 90 pens of 3 pigs/pen. The basal P1 diet contained 6.0% SDAP. Two more P1 Trt were made by replacing 2 or 4% of the SDAP on a lysine basis with 2.9 or 5.8% MFM, respectively. All P1 diets contained 30% dried whey (DW), 15% soybean meal (SBM), 1% blood cells (BC), ground corn, mineral and vitamin supplementation, lard to equalize ME at 3.4 Mcal/kg, 1.5% lysine and .45% methionine. In P2, the P1 Trt replicates were allotted to one of two Trt, either 2.0% SDAP or 2.9% MFM in a 3 (P1) x 2 (P2) factorial arrangement. The P2 diets contained 20% DW, 20% SBM, 2.0% BC, 1.4% lysine, .42% methionine and 3.4 Mcal of ME/kg. There were no P1 x P2 interactions (P>.2 to .9). For P1 Trt, there were quadratic responses for gain:feed (G:F) ratio in P1 (P<.06) and overall (P<.02) because of the higher efficiency for the 2.9% MFM Trt compared to the other two Trt. For P2 Trt, the 2% SDAP Trt had a higher (P<.01) ADG, ADFI, and G:F ratio compared to the 2.9% MFM Trt. In conclusion, pig performance for the entire experiment was highest for the P1 Trt containing 4% SDAP plus 2.9% MFM and the P2 Trt containing 2% SDAP.

Key Words: Fish Meal, Animal Plasma, Pig Performance

155 Performance of two-week old piglets fed Phase I starters containing different sources of fishmeal.

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One hundred twenty, two-week weaned piglets (4.14 kg) were randomly allotted based on weight and gender to twenty pens with six animals each. The purpose of the study was to determine the effects of fishmeal source and level of inclusion on piglet performance during Phase I. The SEW Phase I treatments (1.7% lysine) employed contained 6% Select Menhaden fishmeal; 6% International Protein Corporation (IPC) 790; 6% IPC 700 or 8% IPC 700. Pigs were fed the SEW Phase I diets for two weeks followed by common Phase II (1.3% lysine) and Phase III (1.2% lysine) diets. Phase II and III diets were each fed for two weeks. Diets were offered ad libitum. Pigs were weighed weekly and performance was measured. Data were analyzed via GLM procedures of SAS. Pigs had an average weight gain of 15.94 kg across treatments during the six week trial. During Phase I, Phase II, Phase III and overall, no significant differences (P>.05) in average daily gain, average daily feed intake or feed conversion were noted. Based upon performance data from this study, these fishmeal sources could be used interchangeably in a least cost formulation.

Key Words: Pig, Starter, Fishmeal

156 The effect of lactose and acidification on nursery pig performance.

G. L. Allee, K. J. Touchette*, and H. Liu, *University of Missouri-Columbia*.

A total of 192 weaned pigs (17 d, 4.7 kg) were used to determine the effects of lactose and acidification (Syneracid®, Agrimerica Inc., Northbrook, IL) and their potential interactions in the nursery period. The pigs were allotted in a RCBD to one of six treatments in a 3 x 2 factorial arrangement, with two levels (none or added) of an acidifier and three levels (none, medium, or high) of lactose. The acidifier was added at .35% in phase I and II, and .1% in phase III. The treatments that contained the medium levels of lactose had 7.5% in phase I and 3.75% in phase II. The treatments that contained the high levels of lactose had 15% in phase I and 7.5% in phase II. None of the phase II diets contained lactose. The phase I diet, fed from d 0 to 14, contained 3.5% spray-dried plasma, 1.5% blood cells, and was formulated to contain 1.5% lysine and .84% sulfur amino acids. The phase II diet, fed from d 14 to 28, contained 2.5% blood cells, and was formulated to contain 1.3% lysine and .73% sulfur amino acids. The phase III diet, fed from d 28 to 42, was a corn and soybean meal based diet formulated to contain 1.2% lysine and .70% sulfur amino acids. Pigs were weighed and feed intake measured every 7 day throughout the 42-d study. For the phase I period (d 0 to 14), there was an acidifier x lactose interaction (P<.1) for ADG, with the acidifier improving ADG only when no lactose was in the diet, and lactose only improving performance when no acidifier was in the diet. Lactose improved Gain:Feed in this period, while neither lactose nor acidifier had an effect on ADFI. There was no effect of acidifier or lactose from d 14 to 42 postweaning during the phase II and III periods. These results suggest that an acidifier may be beneficial in the first diet postweaning if there is limited lactose in the diet.

Key Words: Weaned Pigs, Lactose, Acidification

157 The effect of a sugar food product on nursery pig performance.

G. L. Allee*, K. J. Touchette, and J. J. Berkemeyer, *University of Missouri-Columbia*.

A total of 132 weaned pigs (17 d, 6.3 kg) were used in two experiments to evaluate the addition of a Sugar Food Product®(SFP, International Ingredients Corp., St. Louis, MO) to phase I and phase II pig starter diets. In both phase I and phase II diets, the SFP was added at 0, 5, 10, or 15% of the diet. The phase I corn-soybean meal diets, fed from weaning to d 15, contained 3.5% plasma protein, 1.5% blood cells, 15% dried whey, and contained 1.56% lysine. The phase II corn-soybean meal diets fed from d 15 to 29, contained 7.5% dried whey, 2.5% blood cells, and contained 1.3% lysine. Experiment 1 utilized 72 weaned pigs (18 d, 6.5 kg), with six replications of the four dietary treatments. Experiment 2 utilized 60 pigs (16 d, 6.2 kg), with five replications of the four dietary treatments. The combined results of the 11 replications show a linear increase in adding SPF for ADG (P<.04) and ADFI (P<.01). There were no significant effects of the SPF on pig performance during the phase II period. At the end of the 29 d nursery trials, pigs fed the SPF were heavier (P<.08) than pigs fed the control diet. These results suggest that the addition of the SPF to phase I nursery diets will increase feed intake and gain in typical pig starter diets.

SFP%	0	5	10	15	P-value[a]
Wean wt, kg	6.36	6.29	6.39	6.35	NS
d 29 wt, kg	16.19	16.93	17.19	17.28	.08
d 0 to 15					
ADG, g	167	210	196	216	.04
ADFI, g	266	307	327	345	.01
d 0 to 29					
ADG, g	339	366	371	376	.03
ADFI, g	491	533	553	559	.06

[a]Linear effect of SFP

Key Words: Weaned Pigs, Sugar, Phase I

158 Effects of replacing whey protein concentrate with crystalline amino acids on weanling pig performance.

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An experiment was conducted to evaluate the efficacy of replacing whey protein concentrate (WPC, 77% CP) with crystalline amino acids (AA) on growth performance and plasma urea nitrogen (PUN) of weanling pigs. Eighty-four pigs (20-d, 5.53 kg BW) were allotted to 6 dietary treatments based on BW, litter, and sex. The control diet (1.65% Lys) contained 9.6% WPC. In Diet 2, WPC was replaced with an ideal mixture of essential AA (Lys, Thr, Met, Trp, Val, Ile). Diets 3-6 were: 3) as Diet 2 + Leu, Ile, Val; 4) as Diet 2 + Phe, Tyr, Trp; 5) as Diet 2 + His, Arg, Pro; and 6) as Diet 2 + AA added to Diets 3, 4, and 5. Amino acids were added to Diets 3-6 to approximate ratios to Lys in the control diet. There were 4 pens/trt (3-4 pigs/pen). Pigs were fed the six diets during Phase 1 (d 0-14), then all pigs were fed a common Phase 2 (d 14-28) and 3 (d 28-35) diet. For Phase 1, ADG and F/G were, respectively: 304, 251, 266, 296, 283, and 281 g; and .97, 1.09, 1.03, .99, 1.08, and .99. Pigs fed the control diet grew faster and were more efficient (P < .05) than pigs fed Diet 2. Addition of AA to Diet 2 tended to improve ADG and F/G with the greatest improvement from the addition of Phe, Tyr, and Trp. ADFI was not affected by treatment. At the end of Phase 1, PUN was markedly lower in pigs fed Diet 2 as compared with pigs fed the control diet (2.88 vs 7.13 mg/dL, P < .01). In general, addition of AA to Diet 2 increased (P < .10) PUN. For the entire 35-d test period, pigs fed the control diet during Phase 1 grew faster and were more efficient (P < .10) than those fed Diet 2 during Phase 1. Among the AA additions to Diet 2 during Phase 1, the addition of Phe, Tyr, and Trp to Diet 2 elicited the greatest improvement in ADG and F/G over the 35-d experiment. These results suggest that replacing WPC with an ideal blend of AA during Phase 1 reduced pig performance; however, the addition of specific AA to an ideal mixture of AA improved growth performance.

Key Words: Amino acids, Weanling pigs, Growth performance

159 Incorporation of short-chain fructooligosaccharides and Tylan® into diets of early weaned pigs. M.D. Howard*, H. Liu, J.D. Spencer, M.S. Kerley, and G.L. Allee, *University of Missouri, Columbia, MO.*

Two experiments (263 pigs, average initial BW 6.0 kg, 16 to 23 days of age) were conducted to determine the effect of supplementing three-phase diets with short-chain fructooligosaccharides (SCFOS) and Tylan®. The objective was to determine if the effects of feeding SCFOS and Tylan® on pig performance were additive, synergistic, or antagonistic. The feeding program used three-phase complex diets, with Phase 1 diets containing 3.5% plasma protein and 1.75% red blood cells. The experiments used a 4 x 2 factorial arrangement: SCFOS was added at 0, .45 kg (.1%), 1.13 kg (.25%), or 2.27 kg (.5%)/454 kg, and Tylan® was added at either 0 or 100g/908 kg. Experiment 1 lasted 42 d. During Phase 1 (2 wk), Tylan® addition increased ADG (P = .02) and ADFI (P = .02) by 27 g/d. Addition of SCFOS, linearly increased feed efficiency in both Phase 1 (P = .04) and Phase 2 (P = .08). For the entire 42 d, feed efficiency showed a SCFOS x Tylan® interaction (P = .09): feed efficiency was linearly increased (P = .005) as SCFOS increased in the presence of Tylan®. Experiment 2 lasted 38 d. For Phase 1 (18 d) SCFOS addition quadratically affected (P = .04) ADG and feed efficiency. During Phase 2, Tylan® addition increased (P = .04) ADG by 36 g/d. SCFOS quadratically affected ADG (P = .01) and ADFI (P = .03). For the entire 38 d, SCFOS addition quadratically affected ADG (P = .004), ADFI (P = .02), and feed efficiency (P = .06). The quadratic response was typified by highest performance for .1% and .5% SCFOS diets, indicating a positive response could be elicited with as little as .1% SCFOS. The effects of Tylan® and SCFOS seldom showed an interaction suggesting that their mode of action are different: Tylan® is likely inhibiting pathogenic bacteria, while SCFOS may be stimulating beneficial bacteria, providing short-chain fatty acids for energy metabolism in the large intestine, and altering intestinal morphology.

Key Words: Fructooligosaccharides, nursery diets, weaned pigs

160 Evaluation of spirulina plantensis in diets for weanling pigs. G.S. Grinstead*, M.D. Tokach, R.D. Goodband, J.L. Nelssen, J.T. Sawyer, C.J. Maxwell, and R.D. Stott, *Kansas State University, Manhattan..*

Three experiments were conducted to evaluate the effect of an algae derived feed additive, spirulina platensis (SP), on weanling pig performance. In all experiments, pigs were blocked by BW and allotted to treatments at weaning. Standard KSU diets and feeding regimens were used. In Exp.1, a control diet or diets containing .2, .5, or 2% SP were fed in a pellet form from d 0 to 14 after weaning then in meal form from d 14 to 28. In Exp.2, treatments included a control diet (no SP, fed for 6 wk), .1% SP (fed for 6 wk) or .2% SP (fed for 1, 2, 4 or 6 wk) with pigs switched to a control diet at the end of the 1, 2, or 4 wk period. In Exp.3, control or .2% SP diets were fed in either pellet or meal form. In all experiments, SP replaced soybean meal on a lysine basis. From d 0 to 14 in Exp. 1, no difference in ADG or gain/feed (G:F) were observed. For d 0 to 28, a cubic (P < .05) response was observed for ADG and ADFI with increasing SP with the optimal response at .2% SP. From d 0 to 14 in Exp.2, no differences in ADG or ADFI were observed between treatment groups. However, pigs fed .2% SP for 2 wk had numerically higher ADG than pigs fed the control diet or pigs fed .1% SP. From d 14 to 28 or d 0 to 28, pigs fed .2% SP for only 2 wk had the highest ADFI (P < .01) and numerically higher ADG than any other treatment. Pigs fed diets containing .1% or .2% SP for the entire 28 days had improved G:F (P < .02) compared with other treatments. From d 0 to 42, no differences in ADG or ADFI were observed. From d 0 to 14 in Exp. 3, adding SP to pelleted diets tended to decrease ADG (SP x Pellet, P < .10) while adding SP to meal diets tended to improve ADG. From d 14 to 28 or d 0 to 28, no differences in growth were observed. However, pigs fed SP had numerically higher ADG compared to pigs fed the control diets with the greatest gain when adding SP to the meal diet. These experiments suggest that adding low inclusions of SP to meal diets can enhance performance, although the response was not consistent.

Key Words: starter pig, algae, performance

161 Efficacy of mannan oligosaccharide (Bio-Mos®) addition at two levels of supplemental copper on performance and immunocompetence of early weaned pigs. M. E. Davis*[1], C. V. Maxwell[1], E. B. Kegley[1], B. Z. de Rodas[1], K. G. Friesen[1], D. H. Hellwig[1], and R. A. Dvorak[2], [1]*University of Arkansas, Fayetteville,* [2]*Alltech, Inc., Nicholasville, KY.*

An experiment involving 216 weanling barrows (1/2 Large white x Duroc x Landrace from a commercial operation; 6 kg BW and 21pm2 d of age) was conducted to determine the efficacy of dietary Bio-Mos® addition at two levels of supplemental Cu on performance and immune response. Pigs were blocked based on initial weight and penned in groups of six (9 pens/treatment) in an off-site nursery. Dietary treatments were arranged as a 2x2 factorial consisting of two levels of Cu (10 or 185 ppm from CuSO4), with and without addition of Bio-Mos® (0 or .2%). Experimental diets were fed throughout the entire study (d 0 to 38 postweaning) and contained 1.50% lysine during phase 1 (d 0 to 10), 1.35% lysine during phase 2 (d 10 to 24), and 1.20% lysine during phase 3 (d 24 to 38). Two pigs from each pen were bled between d 28 and 34 postweaning to measure in vitro cellular immune response using a lymphocyte blastogenesis assay. During phase 1, ADG, ADFI and G/F increased with the addition of Bio-Mos® at 10 ppm Cu, but decreased with the addition of Bio-Mos® at 185 ppm Cu (interaction, P<.01; P<.1, and P<.02, respectively). Pigs fed diets supplemented with 185 ppm Cu during phases 2 and 3 had greater (P<.04) ADG and ADFI than those fed diets with 10 ppm Cu. Similarly, pigs fed diets supplemented with Bio-Mos® had greater ADG (P<.05) and G/F (P<.1) than those fed diets without Bio-Mos®. Overall (d 0 to 38), pigs fed diets containing 185 ppm Cu had greater (P<.02) ADG, ADFI, and G/F than those fed diets containing 10 ppm Cu. Pigs fed diets containing Bio-Mos® had greater (P<.04) ADG and G/F than those fed diets with no Bio-Mos®. Dietary treatments did not affect lymphocyte proliferation from mitogen stimulation. This study indicates that the performance response to Bio-Mos® in phase 1 varied with level of dietary Cu. However, in phases 2 and 3, diets containing either Bio-Mos® or 185 ppm Cu resulted in improved performance.

Key Words: Swine, Oligosaccharide, Copper

162 Evaluation of the optimal growth promoting level of dietary Zn from a Zn amino acid complex for weanling pigs. J.M. McCalla[1], D.D. Gallaher[1], L.J. Johnston[2], M.H. Whitney[1], and G.C. Shurson*[1], [1]*University of Minnesota, St. Paul, MN,* [2]*University of Minnesota, Morris, MN.*

A total of 324 pigs weaned at 18 ± 2 d of age were used to determine the optimal growth promoting dietary level of Zn from a Zn amino acid complex (ZnAA). Forty-eight pens (6 or 7 pigs/pen) of pigs were blocked by initial weight, sex and litter and assigned to one of six dietary treatments. Pigs were provided *ad libitum* access to diets for five weeks. Treatments consisted of: 100 ppm Zn from $ZnSO_4$ (NC), 2000 ppm Zn from ZnO (PC), and 100, 200, 300, and 400 ppm Zn from ZnAA, respectively. A three-phase feeding program was used, and all diets within each phase contained the same nutrient levels except Zn. Blood samples from half of the pigs were obtained by venipuncture at the beginning and end of the 5 wk feeding period. Red blood cells were analyzed for superoxide dismutase (SOD) activity. Initial and final plasma Zn, Cu, and Fe levels were determined. Linear and quadratic contrasts were used to compare growth performance, change in SOD activity, change in plasma Zn, Cu, and Fe, and wk 1 fecal scores among ZnAA treatments. Pigs fed PC had greater overall ADG (418 vs. 376 g/d, P < .05) and overall ADFI (670 vs. 587 g/d, P < .01) than pigs fed NC. Pigs fed PC had higher overall ADFI (P < .05) than pigs fed ZnAA diets. Within the ZnAA treatments, no linear or quadratic trends were observed for ADG, ADFI, and G/F (P > .10). Dietary treatments had no effect on change in SOD activity during the 5 wk feeding period (P > .10). Pigs fed PC had a greater increase in plasma Zn levels than pigs fed ZnAA diets (P < .07). Pigs fed NC had a greater increase in plasma Fe (P < .06) than pigs fed ZnAA diets. Fecal scores during wk 1 tended to increase quadratically (P < .10) as dietary ZnAA level increased. These results suggest that feeding between 100 and 400 ppm Zn from a Zn amino acid complex for a 5 wk feeding period does not elicit a level of growth promotion equivalent to that obtained by feeding 2000 ppm Zn from ZnO.

Key Words: Zinc Amino Acid Complex, Pig Growth, SOD activity

163 Bioavailability of iron in organic iron sources. A. J. Lewis*[1], H.-Y. Chen[1], and P. S. Miller[1], [1]*University of Nebraska, Lincoln.*

Organic iron sources result from complexing a soluble iron salt with an organic molecule such as an amino acid or protein. There have been many claims that the bioavailability of organic iron is greater than iron in inorganic sources. The objective of this study was to compare the bioavailability of iron in iron methionine and two different sources of iron proteinate with that in ferrous sulfate. Eighty-three rats were fed an iron-deficient diet (9 mg/kg) for 1 wk (depletion period). Rats were weighed at the end of depletion period and eleven were selected as an initial group. Blood samples were obtained from the initial group and hemoglobin concentrations (Hb) were measured. The remaining 72 rats were assigned to the diet fed during the depletion period or to diets that contained 7, 14, or 21 mg/kg from feed-grade ferrous sulfate ($FeSO_4.H_2O$), reagent-grade ferrous sulfate ($FeSO_4.7H_2O$), iron methionine, or two sources of iron proteinate. Rats were fed the treatment diets for 3 wk (repletion period). Body weight and feed consumption were determined weekly. Blood samples were taken at the end of the repletion period to determine final Hb. Average daily gain, final Hb, and Hb repletion were calculated, and bioavailability of the iron sources was determined using slope-ratio methods. Average daily gain, final Hb, and Hb repletion increased linearly ($P < .001$) as the supplemental iron concentration increased. The results from the slope-ratio assays indicated that the two forms of ferrous sulfate were equally bioavailable. The results also revealed that the bioavailabilities (relative to ferrous sulfate) of iron methionine and the two forms of iron proteinate (Optimin^{TM} and Buffermin^{R}) were 70, 91, and 124% for ADG, 52, 71, and 106% for final Hb, and 53, 73, and 108% for Hb repletion. In conclusion, the bioavailability of organic iron sources varies with different forms and is not greater than iron in ferrous sulfate.

Key Words: Rats, Iron, Bioavailability

164 Evaluation of the effect of feeding a micro-pellet to an early weaned pig. T. E. Johnson, E. L. Stephas*, and B. L. Miller, *Land O'Lakes, Webster City, Iowa.*

A 1.7% lysine SEW diet was fed as either a 2.4 mm pellet or a 1 mm micro-pellet to a total of sixty, 15 day old, 4.5 kg, PIC crossbred pigs. Pigs were assigned by weight and sex to 10 pens (5 per treatment) of six animals each. These diets were fed to two week old weaned pigs for a period of two weeks. Common Phase II and Phase III diets were then fed to all pigs for two weeks each. During week 2, pigs fed the micro-pellet gained 15.5 percent less (P=.07) weight (275 vs. 325 g/day) and were less efficient (P=.02) than the pigs fed the 2.4 mm pelleted diet. For the combined two-week Phase I period pigs gained on average 244 g/day with no significant (P=.10) differences in weight gain, feed intake, or feed conversion noted. Similarly, no significant (P=.10) differences were detected during Phase II, Phase III or overall. In conclusion, given the increased manufacturing cost, and no improvement in piglet performance, the use of a micro-pellet cannot be recommended.

Key Words: Pellet, Pig, Extrusion

165 Determination of apparent ileal digestibility and digestible and metabolizable energy values for conventional or dry extruded-expelled soybean meal for swine diets. J. C. Woodworth*[1], M. D. Tokach[1], J. L. Nelssen[1], R. D. Goodband[1], P. R. OQuinn[1], D. A. Knabe[2], and N. W. Said[3], [1]*Kansas State University, Manhattan,* [2]*Texas A&M University, College Station,* [3]*Insta-Pro International, Des Moines, IA.*

Two replicated 3 X 3 Latin square designed digestion trials were conducted to determine the apparent ileal digestibility of amino acids (Exp. 1) and DE and ME values (Exp. 2) for conventional solvent-extracted soybean meal (SBM) and dry, extruded-expelled soybean meal (Insta-Pro Express^{TM} extruder/press system). The two extruded meals tested were produced from soybean meal with (DEH) or without hulls (DENH). The DM, CP, lysine, crude fat, and crude fiber contents (%, as-fed basis) were, respectively: SBM, 88, 47.1, 2.97, 1.14, 3.60; DEH, 95, 47.5, 2.96, 4.89, 4.80; DENH, 96, 50.5, 3.11, 5.86, 3.30. In Exp. 1, six barrows (initially 39 kg) were fitted with ileal T-cannula and allotted to three isolysinic treatments that were cornstarch based and formed by adding soybean meal from one of the three sources as the only dietary lysine source. Diets containing either DEH or DENH had higher ($P < .05$) apparent ileal digestibilities of CP (86 vs. 84%), lysine (91 vs. 89%), and other amino acids (Arg, Iso, Leu, Phe, Val, Ala, Asp, Glu, and Ser) compared to SBM. There were no differences ($P > .10$) in digestibility between DEH and DENH. In Exp. 2, six barrows (initially 41 kg) were allotted to three dietary treatments that were corn based and contained 25% soybean meal from one of the three sources. A fourth diet was fed at the end of the trial containing all ingredients except soybean meal so that energy values could be determined by difference. Digestible energy and ME values (kcal/g, DM basis) were, respectively: SBM, 4.15, 3.87; DEH, 4.35, 4.10; DENH, 4.38, 4.13. Energy values for DEH and DENH were similar ($P > .05$), but greater ($P < .05$) than those for SBM. In conclusion, dry, extruded-expelled soybean meal with or without hulls had higher nutritional value for swine than conventional solvent-extracted soybean meal.

Key Words: Pigs, Soybean Meal, Extrusion

166 Evaluation of different soybean meal processing techniques on growth performance of pigs. J. C. Woodworth*[1], M. D. Tokach[1], J. L. Nelssen[1], R. D. Goodband[1], and N. W. Said[2], [1]*Kansas State University, Manhattan,* [2]*Insta-Pro International, Des Moines, IA.*

Two hundred and sixteen pigs were used to determine the influence of different soybean meal (SBM) processing techniques on starter pig growth performance. Pigs were fed a common diet for 14 d postweaning after which pigs (10.6 kg BW) were blocked by weight and randomly allotted to six different dietary treatments and fed for 21 d. Four iso-lysinic, iso-caloric treatments were formulated using apparent ileal digestible amino acid values and metabolizable energy values determined in a previous experiment. Corn-SBM based diets containing dry extruded-expelled SBM with and without hulls (Insta-Pro) were compared to corresponding 44% CP (with hulls) and 46.5% CP (without hulls) solvent-extracted SBM diets with 3.21 and 4.57% added soy oil, respectively. Two additional corn-SBM based iso-lysinic, iso-caloric diets were formulated using total amino acid values and crude fat values determined from laboratory analysis. In this comparison, a second expelled SBM source with hulls (Soyplus) was compared to a 44% CP (with hulls) solvent-extracted diet with 1.61 % added soy oil. For the entire trial, pigs fed diets containing either Insta-Pro extruded-expelled SBM product did not differ ($P > .14$) for ADG, ADFI, and G/F compared to the corresponding diets containing solvent-extracted SBM and soy oil. Pigs fed diets containing Soyplus expelled SBM had lower ($P < .001$) ADG (513 vs. 566 g) and G/F (.52 vs. .58) compared to the corresponding solvent-extracted SBM and soy oil diet. These results suggest differences exist in the quality of various expelled SBM sources for swine diets. In our trial, pigs fed diets containing Insta-Pro dry extruded-expelled SBM had similar growth performance to pigs fed diets containing conventional solvent-extracted SBM and soy oil.

Key Words: Starter Pig, Growth, Soybean Meal

167 Supplementing grain energy sources with field peas and full-fat canola seed in swine growing-finishing diets.. D.G. LANDBLOM*[1] and W.W. POLAND[1], [1]*North Dakota State University, Dickinson Research Extension Center, Dickinson, ND.*

Two growing-finishing trials were conducted to evaluate growth performance and carcass characteristics when various grain energy bases were supplemented with field peas (*P. sativum*Profi') and canola seed (*B. napus*) as protein sources. In **Exp. 1**, pigs (n = 75; initial BW = 29.0 kg) were assigned to corn (*Z. mays*), barley (*H. vulgare*), naked oat (*A. sativa*Paul'), barley/corn, and barley/naked oat diets supplemented with field peas. Compared to the other test grains, barley fed pigs grew faster (P<.05), required less days on feed (P<.05), and were more efficient (P<.01). When corn and naked oats were compared to barley/naked oats or barley/corn fed pigs, no growth or efficiency differences were noted. Pigs fed barley/naked oats or barley/corn had higher percent lean values (P<.02); other carcass measures did not differ. In **Exp. 2**, pigs (n = 84; initial BW = 25.5 kg) were fed either corn, barley, or naked oat diets fortified with field peas and either 0 or 10% canola seed. Compared to barley, feeding either corn or naked oats was associated with faster growth (P<.05), and reduced feed consumption (P<.01). Pigs fed naked oats were markedly more efficient (P<.001). Loin depth was greater (P<.10) for pigs fed a corn/pea diet. Fat depth

was greater (P<.05), and fat free lean index lower (P<.10), for pigs fed naked oats. Carcass yield and percent lean values were similar among the three test grains. Addition of 10% canola seed, as a methionine source, resulted in nearly equal growth performance. Diets containing canola seed reduced fat depth (P<.05) and increased fat-free lean index (P<.05). Diets fortified with field peas adequately supply protein and energy for the growing-finishing pig, while dietary inclusion of canola seed may enhance carcass quality.

Key Words: Pigs, Field peas, Canola seed

168 Nutritional value of genetically improved high-lysine, high-oil corn for young pigs. P. R. O'Quinn*[1], J. L. Nelssen[1], R. D. Goodband[1], D. A. Knabe[2], J. C. Woodworth[1], M. D. Tokach[1], and T. T. Lohrmann[3], [1]*Kansas State University, Manhattan,* [2]*Texas A&M University, College Station,* [3]*Optimum Quality Grains, L. L. C., Des Moines, IA.*

Two trials were conducted to compare the nutritional adequacy of genetically improved high-lysine, high-oil corn (.408% lysine, 6.21% fat; as-fed basis) and high-oil corn (.289% lysine, 5.97% fat; as-fed basis) for young pigs. Experiment 1 used four non-littermate barrows (initially 20 kg) fitted with ileal T-cannula in a crossover-designed digestion study. The .80% total lysine diets contained 8.5% casein and equal amounts of lysine from the test corn. Apparent digestibilities of amino acids, GE, DM, CP, and ash were similar (P > .10) between diets. Apparent digestibilities of lysine, threonine, and total sulfur amino acids were 68, 61, and 78% and 72, 62, and 80% for the high-oil corn and high-lysine, high-oil corn, respectively. Digestibilities were calculated by difference assuming 100% digestibility for casein. Experiment 2 used 100 barrows (initially 8.4 kg and 27 d of age) in a 2 x 2 factorially designed growth trial lasting 10 d. Main effects were corn type and dietary lysine (.80 or 1.15% digestible lysine). The corn-soybean meal-dried whey based diets contained equal amounts of all dietary ingredients within each lysine level except L-Lysine·HCl was added to the high-oil corn diets to make them isolysinic. A fifth diet (.80% digestible lysine high-oil corn diet plus .23% L-Lysine·HCl) verified that lysine was the first limiting amino acid for growth. Increasing lysine increased ADG (P < .001) and improved feed efficiency (G:F; P < .001) regardless of corn type. Within lysine level, corn type did not affect ADG, ADFI, or G:F (P > .10). Combined ADG and G:F were 347 g and .64 and 442 g and .79 for the .80 and 1.15% digestible lysine diets, respectively. These results suggest that the lysine in high-lysine, high-oil corn is as available as the lysine in high-oil corn, and that high-lysine, high-oil corn can be successfully used in swine diets.

Key Words: Digestibility, High-oil corn, High-lysine, high-oil corn

169 Evaluation of high-oil corn feeding strategies for grow-finish pigs. D. C. Kendall, K. A. Bowers*, B. T. Richert, and T. R. Cline, *Purdue University, West Lafayette, IN.*

One hundred ninety two pigs (96 barrows (B), 96 gilts (G); initial BW=25 kg) were used to evaluate feeding high-oil corn (HOC) or normal corn (NC) to grow-finish pigs. Average daily gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G/F) were determined at 14-day intervals. Fat and loin depth, percent lean, carcass weight, and carcass premium were determined at slaughter. Pigs were blocked by sex, ancestry, and weight into 32 pens (6 pigs/pen) and fed one of four dietary treatments: 1) NC diet 16 weeks (NC/NC); 2) NC diet for the first 8 weeks, period 1 (P1), and HOC diet for the second 8 weeks, period 2 (P2), (NC/HOC); 3) HOC diet during P1 and NC diet during P2 (HOC/NC); and 4) HOC diet for 16 weeks (HOC/HOC). The HOC and NC diets were fed at the same Lys:Cal ratio by BW and sex of the pigs. BW and g Lysine/Mcal ME for B and G, respectively, were: 1) 25 to 45 kg, 2.89 and 3.19; 2) 45 to 68 kg, 2.42 and 2.72; 3) 68 to 91kg, 1.96 and 2.26; 4) 91 to 113 kg, 1.65 and 1.95. This project was conducted from May to August, 1998. Pigs fed HOC had greater G/F in P1 (.400 vs. .387; P<.05) and also in P2 (.280 vs. .270; P<.05). Barrows had higher ADG in P1 (851 vs. 807 g/d; P<.01) and P2 (812 vs. 757 g/d; P<.01) and greater ADFI in P1 (2188 vs. 2044 g/d; P<.05) and P2 (2998 vs. 2729 g/d; P<.05). Pigs fed NC/NC had a greater fat depth (P<.01) and decreased loin depth (P<.01) compared to pigs fed HOC/HOC. Barrows had a greater fat depth (25.1 vs. 20.0 mm; P<.0001). Gilts had a greater loin depth (59.4 vs. 55.9 mm; P<.0001) and percent lean (53.2 vs. 51.3; P<.0001). Gilts also had a higher carcass premium ($.0871/kg vs. $.0291/kg; P<.0001). Barrows had a higher carcass weight at slaughter (90.7 kg vs. 88.0 kg; P<.01). These results suggest that HOC can increase G/F in grow-finish pigs. High-oil corn may also reduce backfat and increase loin depth when fed throughout the grow-finish period during hot weather.

Key Words: Pigs, Grow-finish, High-oil corn

170 A protease complement increases fecal digestibility coefficients in pigs fed soybean meal and canola meal. J. R. Pluske[1], P. C. H. Morel[1], E. A. C. James[1], and K. A. Jacques*[2], [1]*Monogastric Research Centre, Massey University, Palmerston North, New Zealand,* [2]*Alltech Inc., Nicholasville, Kentucky, USA.*

Thirty entire male pigs (initial BW 47.8 kg) were used to test the hypothesis that addition of an enzyme complement (Allzyme Vegpro, Alltech, Inc.) to diets containing soybean meal (SBM) and canola meal (CM) would increase apparent fecal nutrient digestibility. Pigs were blocked by weight and randomly assigned to four barley-based dietary treatments in a 2 x 2 factorial arrangement of vegetable protein source (SBM, 250 g/kg; and CM, 340 g/kg) and enzyme (0 and 100 mg/kg Vegpro). A basal diet consisting of barley with added vitamins and minerals, in the presence and absence of enzyme complement, was also fed. Pigs were group-housed but individually fed twice daily an amount equivalent to 10% $W^{0.75}$. The amount fed was adjusted weekly, and diets were fed in meal form. Water was available *ad libitum*. Chromic oxide was added as an indigestible marker (4 g/kg). After an adaptation phase of seven days, feces were collected from each pig each morning for the ensuing five days. Feces were then pooled, freeze-dried, and analyzed for GE, N and OM. Apparent fecal digestibility coefficients for both the complete diet and the vegetable protein source *per se* were calculated. No interactions between vegetable protein source and enzyme occurred. However, main effects of vegetable protein source and enzyme on apparent fecal digestibility coefficients were observed. For the type of vegetable protein ingredient, digestibility coefficients of GE (83.1 *vs.* 57.8%), OM (80.7 *vs.* 55.5%) and N (83.4 *vs.* 69.5%) were higher (P < .001) in SBM than in CM. Addition of the enzyme improved the digestibility of GE (73.2 *vs.* 67.7%, P = .008) and OM (71.1 *vs.* 65.0%, P = .010), but not that of N (77.3 *vs.* 75.5%, P = .19). These data suggest that the efficiency of utilization of vegetable protein sources commonly fed to pigs can be improved by the use of an enzyme complement.

Key Words: Pigs, Fecal digestibility, Enzyme

171 The influence of hydrolysis time, hydrochloric acid concentration and measurement method on the determination of amino acid levels in soybean products included in swine diets. D.M. Albin*, J.E. Wubben, and V.M. Gabert, *University of Illinois, Urbana, IL.*

Accurate determination of amino acid (AA) levels in soy products used in swine diets facilitates optimum diet formulation and AA supplementation. A study was carried out to investigate the effect of hydrolysis time, acid concentration and method of AA measurement on AA levels. Correction factors to standardize AA levels to 24 h of hydrolysis were also determined. The samples evaluated were: whole soybeans, soybean hulls, soybean meal (SBM), soy protein concentrate (SPC) and soy protein isolate. Hydrolysis was carried out in an oven at 110°C for 0, 2, 6, 10, 16, 24, 32, 44, 56 or 72 h. In the second part of the study, samples were hydrolyzed for 24 h in 1, 3, 6, 9 or 12 M HCl. Ion-exchange chromatography (IEC) was used to determine AA levels in SBM and SPC. Pre-column derivatization with phenyl isothiocyanate (PITC) was used to determine AA concentrations in all of the samples. After 24 h of hydrolysis, lysine in SBM was higher (P < .01) when determined with PITC (3.27% DM) than with IEC (2.77% DM). Lysine level for SPC, determined with PITC (4.47% DM), was higher (P < .05) than that determined with IEC (3.83% DM). Both hydrolysis time and acid concentration affected (P < .05) AA levels. Use of 6 M HCl did not always provide the highest AA levels in the samples. In SBM, lysine level was highest (P > .05) after 32 h (3.38% DM) of hydrolysis. After 24 h of hydrolysis, lysine level in SBM was 3.27% DM. The correction factor for this sample was 1.03. In SBM, 6 M HCl provided the highest (P > .05) threonine level (2.53% DM), however the highest (P > .05) arginine level (4.27% DM) was obtained with 9 M HCl. In conclusion, measurement method, hydrolysis time and acid concentration are important factors which affect AA levels. Standard hydrolysis conditions do not always

provide the correct AA values, therefore sequential hydrolyses curves are very useful.

Key Words: Amino Acids, Determination Methods, Soybean

172 The influence of hydrolysis time on the determination of amino acid levels in pig carcass. J.E. Wubben*, D.M. Albin, and V.M. Gabert, *University of Illinois, Urbana, IL.*

Comparing amino acid (AA) retention levels in pig carcass to true ileal digestible AA intake provides an estimate of the marginal efficiency of AA utilization. Differences in AA levels in the carcass impact this determination, therefore, accurate analysis of AA in carcass samples is critical. A study was carried out to investigate the effect of hydrolysis time on AA measurement in pig carcass. Correction factors to standardize AA levels to 24 h of hydrolysis were also determined. Three pigs were exsanguinated and the internal organs were removed. The empty body was frozen, ground, sampled and freeze-dried. Samples were ground with liquid nitrogen in a coffee mill. Hydrolysis in duplicate was carried out in an oven at 110°C for 2, 6, 12, 24, 36, 46, 56 or 66 h. Pre-column derivatization with phenyl isothiocyanate (PITC) was used to determine AA concentrations in all of the samples. Hydrolysis time significantly affected ($P < .05$) AA levels. Twenty-four hours of hydrolysis did not always provide the highest AA value. Lysine and threonine levels changed ($P < .001$) over time of hydrolysis. In freeze-dried matter, lysine levels were: 3.23% (18 h) and 3.38% (24 h). The highest ($P > .05$) lysine level was determined with 24 h hydrolysis. For threonine levels, the values were: 1.69% (18 h) and 1.69% (24 h). Threonine levels decreased ($P > .05$) after 24 h hydrolysis. However, for valine, isoleucine, serine and glycine the highest value ($P > .05$) was not observed after 24 h hydrolysis. The highest value occurred after 66 h (valine and isoleucine), 6 h (serine) and 12 h (glycine) hydrolysis. Therefore, correction factors are important for these AA. In conclusion, hydrolysis time is an important component of AA analysis. Twenty-four hours of hydrolysis does not always provide the correct AA values, therefore sequential hydrolyses curves are very useful in the accurate determination of AA in carcass samples.

Key Words: Amino Acids, Pig, Carcass

173 Effect of K-diformate in Diets for Grow-finish Pigs. M. Overland*[1], T. Granli[2], S. H. Steien[2], and O. Fjetland[3], [1]*Agricultural University of Norway,* [2]*Hydro Nutrition,* [3]*Norwegian Pig Health Service.*

The effect of adding 0%, 0.6% or 1.2% K-diformate (FormiTMLHS) to conventional diets on growth performance, carcass characteristics, concentration of microbes in the gastro-intestinal tract, and incidence of stomach keratinization and/(or) ulceration of pigs was evaluated. A total of 96 crossbred grow-finish pigs [(Landrace x Yorkshire) x (Landrace x Duroc)] from 16 litters (Init. BW = 27.1 kg) were utilized. Pigs were allotted by litter, weight and sex to each of the three dietary treatments. Pigs were limit-fed twice daily and individual feed intake was recorded. At slaughter, stomachs were collected and analyzed within 2-h post mortem for determination of stomach keratinization and/(or) ulceration. Also, digesta samples from eight littermates in the control and 1.2% FormiTMLHS treatment were taken for microbiological investigations. The potential increase in bacterial tolerance to (FormiTMLHS) in vivo was investigated. Increasing levels of FormiTMLHS increased (linear $P < .05$) ADG (863, 886, and 915 g/d, respectively) and ADFI (2409, 2451, and 2589 g/d, respectively) and tended (linear $P < .10$) to increase G/F (.36, .36, and .37, respectively). Percentage carcass fat decreased (linear $P < .05$) and percentage carcass lean increased numerically (linear $P < .18$) with increasing levels of FormiTMLHS. There was a reduction ($P < .05$) in the number of coliform bacteria in duodenum, jejunum and rectum in pigs receiving 1.2% FormiTMLHS compared to the control. No increased bacterial tolerance to FormiTMLHS was found. Adding FormiTMLHS to diets did not cause an increase in stomach keratinization and/(or) ulceration compared to the control. In conclusion, supplementing diets with FormiTMLHS improved growth performance and carcass quality of grow-finish pigs. FormiTMLHS exerts an antimicrobial effect in the gastro-intestinal tract.

Key Words: Swine, K-diformate, Performance

174 Evaluation of meat and bone meal as the sole source of supplemental Ca and P for finishing pigs. S. L. Traylor*, G. L. Cromwell, M. D. Lindemann, and H. J. Monegue, *University of Kentucky, Lexington.*

An experiment was conducted to evaluate meat and bone meal (MBM) as a source of Ca and P in diets for finishing pigs. One hundred pigs were fed fortified corn-soybean meal or corn-soybean meal-MBM diets in two phases from 45 to 78 kg (.76% lysine) and 78 to 110 kg BW (.65% lysine). MBM (54.0% CP, 2.3% lysine, 9.2% Ca, 4.4% P) was substituted on a lysine basis and crystalline lysine was added to all diets at .15%. Tryptophan was included in diets containing MBM. Treatments were arranged in a 2 × 2 factorial with P source, either dicalcium phosphate (DCP) or MBM, and P level as the two factors. Diets 1 and 2 were formulated using DCP as the P source while diets 3 and 4 contained MBM. Levels of Ca and P for phase I were: .50 and .45% for diets 1 and 3 and .66 and .55% for diets 2 and 4. During phase 2, diets 1 and 3 were reduced to .45% Ca and .40% P and diets 2 and 4 were reduced to .55% Ca and .50% P. At 105 kg, the pigs were scanned using real time ultrasound. At 110 kg, all pigs were killed and the 3rd and 4th metacarpals were collected for determination of breaking strength. ADG, ADFI, and feed:gain (F:G) for the overall period were: .85, .88, .89, .89 kg/d; 2.87, 2.77, 2.70, 2.71 kg/d; 3.10, 3.15, 3.05, 3.03 for diets 1-4, respectively. Fat depth, loin depth, estimated carcass lean, and bone strength were: 21.1, 21.2, 21.4, 21.7 mm; 61.2, 58.2, 59.4, 59.3 mm; 53.0, 52.6, 52.6, 52.4%; 178, 194, 182, 194 kg. ADG and ADFI were unaffected by treatment (P=.14); however, F:G tended (P<.08) to be lower in pigs fed the diets with MBM. Carcasses were not affected by P level or source (P=.11). Bone strength was greater (P<.01) in pigs fed the higher vs lower P levels but was not affected by P source. In summary, the feeding of MBM as a supplemental Ca and P source resulted in similar rates and efficiencies of gain compared with diets containing DCP without producing any negative effects on carcass characteristics or bone mineralization. Thus, MBM can be used as a sole source of supplemental Ca and P for finishing pigs.

Key Words: Pig, Phosphorus, Meat and Bone Meal

175 Effects of magnesium-mica on performance and carcass quality of growing-finishing swine. H. B. Watson*, C. V. Maxwell, B. Z. de Rhodas, J. K. Apple, K. P. Coffey, Z. B. Johnson, and F. W. Pohlman, *University of Arkansas, Fayetteville. AR, U.S.A.*

Magnesium-mica (MM) is utilized primarily in the feed industry as a magnesium source, a pellet binder, and as a carrier for micro premixes. Recent studies with feedlot cattle, however, indicate that MM may have additional nutritional benefits beyond the excellent physical characteristics. The objective of this study was to determine the effect of feeding MM on performance and carcass characteristics of growing-finishing pigs (24 to 106 kg). A total of 120 crossbred gilts and barrows were blocked based on initial BW and penned in groups of five head (8 pens/treatment). Treatments were assigned randomly to pens within each block, and consisted of: 1) a control corn-soybean meal diet devoid of MM, 2) as 1 with 1.25% MM, and 3) as 1 with 2.5% MM. Substitutions in all diets were made at the expense of corn. Experimental diets were fed during the starter (1.10% lysine; 24 to 34 kg), grower (0.95% lysine, 34 to 68 kg) and finisher (0.85% lysine, 68 to 106 kg) periods. Pigs were slaughtered for carcass measurements as block means reached approximately 106 kg. Inclusion of MM in the diet at 1.25 or 2.5% had no deleterious effect on ADG, ADFI, Gain:Feed, or carcass yield. Color scores measured at the 10th rib (using the American color score standard), however, were improved ($P < .01$) with increasing level of MM in the diet. Chi-square analysis of color scores using the Japanese color scoring system indicated that differences existed in color scores due to treatment ($P < .04$). This was primarily due to a decrease in number of carcasses with a score of 1. In addition, cost of gain was decreased with MM in the diet. This study indicates that supplementation of the diet of growing-finishing swine with MM did not have deleterious effects on performance or carcass yields, but improved color score and decreased cost of gain.

Key Words: Magnesium, Color score, Swine

176 Effects of modified tall oil, chromium nicotinate, and L-carnitine on growth and carcass traits of finishing pigs. P. R. O'Quinn*[1], A. T. Waylan[1], R. D. Goodband[1], J. L. Nelssen[1], J. A. Unruh[1], J. C. Woodworth[1], M. D. Tokach[1], and K. Q. Owen[2], [1]*Kansas State University, Manhattan,* [2]*Lonza, Inc., Fair Lawn, NJ.*

Research at Kansas State University has shown improvements in fresh pork color from the combination of chromium nicotinate (CrNic) and L-carnitine and from the combination of modified tall oil (MTO) and elevated levels of vitamin E. Therefore, this study used 80 gilts (initially 45 kg) to examine the effects of MTO, CrNic, and L-carnitine on growth and carcass traits of finishing pigs. Pigs were blocked by weight and ancestry and allotted to one of eight treatments arranged as a 2 x 2 x 2 factorial with main effects of MTO (0 or .5%), CrNic (0 or 50 ppb), and L-carnitine (0 or 50 ppm). The corn-soybean meal diets were fed in two phases: 45 to 73 (1.00% lysine) and 73 to 107 (.75% lysine) kg and contained 3% and 2% soybean oil, respectively. Soybean oil was replaced by MTO in the four diets containing MTO. From 45 to 107 kg, pigs fed MTO had increased ADG (P = .03) and ADFI (P = .10), and pigs fed CrNic had improved G/F (P = .02) when compared to other treatments. There were no main effect interactions (P > .15) for the overall growth trial, and L-carnitine did not affect (P > .40) growth performance. L-carnitine decreased visual color of the longissimus muscle in diets without MTO, but improved color in diets containing MTO (MTO*L-carnitine, P = .10). Dressing percentage was increased by CrNic in diets without MTO, but decreased in diets containing MTO (MTO*CrNic, P = .07). Average backfat and longissimus muscle area were not affected (P > .15) by treatment. There was a CrNic by MTO interaction (P < .05) for belly firmness; CrNic increased firmness in diets without MTO and decreased firmness in diets with MTO. However, MTO increased belly firmness (P < .01) regardless of other factors. These data suggest benefit from adding MTO and/or low levels of CrNic on growth of finishing gilts, but little benefit was seen on carcass traits from adding modified tall oil, chromium nicotinate, or L-carnitine.

Key Words: Modified tall oil, Chromium nicotinate, L-carnitine

177 Effect of dietary chromium-L-methionine on glucose metabolism of growing pigs. E. B. Kegley*[1], T. M. Fakler[2], and C. V. Maxwell[1], [1]*University of Arkansas, Fayetteville,* [2]*Zinpro Corp., Eden Prairie, MN.*

This study evaluated the effect of chromium as chromium-L-methionine (CrMet) on glucose tolerance and insulin sensitivity in pigs. Pigs were fed a control diet or the diet supplemented with 400 μg Cr/kg of diet as CrMet. Twenty-eight crossbred barrows (28.3 $\pm$ 2.23 kg initial BW; 55 to 61 d of age) were stratified by weight and housed in pens (7 pigs/pen; 2 pens/dietary treatment) and fed their respective diets for a period of 36 or 37 days prior to the metabolic challenges and blood sampling. On d 35 and 36, pigs in one pen/dietary treatment were fitted with an indwelling jugular catheter. Approximately 30 h after catheterization, pigs were fasted for 16 h and an intravenous glucose tolerance test followed by an intravenous insulin challenge test was conducted. Pigs fed diets supplemented with CrMet had a faster (P < .03) glucose clearance rate from 10 to 15 min after the glucose infusion (500-mg glucose/kg of BW). Pigs supplemented with CrMet had lower (P < .06) plasma glucose concentrations before and during the glucose tolerance test. Plasma insulin concentrations were lower (P < .02) before glucose infusion for pigs fed the diet supplemented with CrMet. Pigs supplemented with CrMet also had lower (P < .07) insulin:glucose ratios after glucose infusion. There was a dietary treatment by time interaction (P < .02) on glucose concentrations after the insulin infusion (.1 IU insulin/kg of BW). Pigs supplemented with CrMet had lower (P < .05) plasma glucose concentrations from 45 to 120 min after the insulin infusion. The return to basal glucose concentration was slower for pigs fed diets supplemented with CrMet. These data indicate that dietary supplementation of CrMet alters glucose and insulin metabolism in growing pigs.

Key Words: Pigs, Chromium, Glucose Tolerance

178 Dietary chromium tripicolinate increases sow productivity under commercial conditions. C. D. Hagen[1], M. D. Lindemann*[2], and K. W. Purser[3], [1]*Iowa Select Farms, Iowa Falls, IA,* [2]*University of Kentucky, Lexington,* [3]*Prince Agri Products, Inc., Quincy, IL.*

Twelve 4,000-sow units in a common geographic location were selected to examine the effects of supplemental Cr from chromium tripicolinate (CrPic) on productivity of sows in commercial conditions. All units were under the same general management, served by the same feed mill and utilized similar breeding stock, facility design, equipment and animal management practices. Units were randomly allotted to one of the dietary treatments (0 or 200 ppb Cr from CrPic) based on historical litter size during a 3-month pretest period. The month subsequent to the 3-month pretest period was utilized as a start-up month, followed by a 6-month loading period of supplementation, and, then, sow performance was evaluated over a 12-month test period. During the loading period, performance did not differ (P>.13) for the treatment groups. During the test period, the use of supplemental CrPic improved reproductive performance. The statistical evaluation revealed that the percent of sows bred within 7 days postweaning was improved with CrPic addition (90.6 vs 87.8%; P = .08), as were pigs born alive (10.42 vs 10.05; P = .02) and pigs weaned (9.08 vs 8.75; P = .02) per litter. Reductions in wean to first service interval (6.4 vs 5.9 d; P=.20) and in sow death rate (9.4 vs 10.9%; P=.09) with CrPic were also noted. The addition of a parity term to the statistical model revealed standard parity effects on all sow performance parameters but there were no parity X treatment interactions (P >.33). However, because the model took into account the large parity effects, the P-values for the aforementioned traits were also strengthened. P-values for the CrPic effects then became: sows bred within 7 days, P<.001; pigs born live and weaned/litter, P<.001; wean to first service interval, P = .01; and sow mortality, P =.06. In commercial conditions, the use of a biologically available form of Cr can positively affect total sow productivity.

Key Words: Chromium, Pigs, Litter size

179 Effects of dietary lysine intake during lactation on reproductive performance, blood borne metabolites and hormones in primiparous sows. H. Yang*[1], J. E. Pettigrew[2], L. J. Johnston[1], G. C. Shurson[1], J. E. Wheaton[1], M. E. White[1], Y. Koketsu[1], A. F. Sower[1], and J. A. Rathmacher[3], [1]*University of Minnesota, St. Paul,* [2]*Pettigrew Consulting International, Louisiana, MO,* [3]*Iowa State University, Ames.*

Effects of dietary lysine concentrations during lactation on metabolic state, protein metabolism, reproductive hormones and performance were investigated in 36 primiparous sows. Sows were assigned randomly to one of three diets containing .4% (Low), 1.0% (Normal) or 1.6% (High) total lysine from intact protein sources. All diets contained 2.1 Mcal NE/kg and exceeded NRC (1988) requirements for all other nutrients. Actual lysine intakes over an 18-d lactation were 16, 36 and 56 g/d for sows fed Low, Normal, and High, respectively. Increasing lysine intake during lactation did not affect fractional breakdown rate of muscle on d 4 of lactation, but decreased it on d 15 (P < .05). Sows fed Low had a reduced number of LH pulses on d 12 and 18 (P < .05) and serum estradiol (E2) concentration on d 18 of lactation compared to Normal and High. However, LH pulses and E2 concentration were similar between Normal and High (P > .35). Increasing lysine intake increased concentrations of serum urea nitrogen (SUN) and postprandial insulin (P < .05) during lactation, but had no effect on plasma glucose concentration (P > .20). Sows fed High had higher serum IGF-1 on d 6 and 18 than sows fed Normal (P < .05). LH pulses were correlated with serum insulin concentration 25 min after feeding (P < .1) and pre- and postprandial SUN concentration (P < .05). Our results indicate that decreasing lysine intake from Normal to Low increased muscle protein degradation and decreased concentrations of insulin, SUN and estradiol and LH pulsatility; increasing lysine intake above Normal increased insulin, SUN and IGF-1, but did not increase secretion of estradiol and LH. Furthermore, nutritional impacts on reproduction may be mediated in part through associated effects on circulating SUN and insulin.

Key Words: Lysine, Primiparous Sow, Luteinizing Hormone

180 Effects of increased dietary lysine on sow and litter performance. R.E. Musser*, R.D. Goodband, J.L. Nelssen, M.D. Tokach, and S.S. Dritz, *Kansas State University, Manhattan*.

Three hundred and fifty three lactating sows were used to determine the effects of increased dietary lysine on sow and litter performance. At farrowing, sows were assigned to corn-soybean meal lactation diets (no crystalline amino acids) consisting of either 1.0 or 1.3% total lysine. Average sow parity was 2.85 and lactation length was 17 d. Both parity and lactation length were used as covariates in the analysis. Litters were standardized to 10.5 pigs on d 2 of lactation. A treatment by parity interaction was observed with first parity sows fed 1.3% lysine having heavier litter weaning weights than sows fed 1.0% lysine (48.4 vs 44.8 kg respectively; P < .03). Surprisingly, third and fourth parity sows fed 1.3% lysine had decreased litter weaning weights than those fed 1.0% lysine (48.6 vs 52.3 kg respectively; P < .06). No other treatment by parity interactions existed. No differences were observed in the number of pigs weaned (9.7 vs 9.8; P = .61) or pig survivability (93.2 vs 93.5%; P = .77). Sows fed 1.0% lysine consumed less feed the first week of lactation than sows fed 1.3% lysine (4.35 vs 4.54 kg/d; P < .02), with no differences observed during week two or overall (4.85 vs 4.94 kg/d; P = .31). No differences were observed in subsequent reproductive performance for days to estrus (6.0 vs 5.9 d; P = .80), farrowing rate (71.5 vs 76.7%; P = .35), or number of pigs born or born alive (10.5 vs 10.5 ; P = .84) for sows fed either 1.0% or 1.3% lysine. This experiment observed that increasing dietary lysine from 1.0 to 1.3% increased litter weaning weights for parity one sows, but not for older sows. Increasing dietary lysine from 1.0 to 1.3% did not influence subsequent reproductive performance.

Key Words: Lysine, Lactation, Weaning weight

181 Valine is a Limiting Amino Acid in Low- Protein Nursery Diets. I. Mavromichalis*[1], D. M. Webel[1], J. L. Emmert[1], R. L. Moser[2], and D. H. Baker[1], [1]*University of Illinois, Urbana, IL,* [2]*United Feeds, Inc., Sheridan, IN*.

Three trials were carried out with pigs between 5 and 8 wk of age to determine the limiting order of amino acids in a 13.5% CP corn-soybean meal-based diet containing 8% dried whey. The positive-control diet was a 19.2% CP corn-soybean meal-based diet (1.15% Lys), also with 8% dried whey. Amino acid additions to the low-protein, negative-control diet were based on levels needed to accomplish 110% of ideal ratios (to Lys, set at 1.15%). In Exp. 1, addition of an amino acid mixture containing Lys, Trp, Thr, Met, Ile, and Val to the low-protein diet increased (P < .05) gain and gain:feed ratio, and these response traits were not different from those of pigs fed the 19.2% CP positive-control diet. Single deletion of Lys from the supplemental amino acid mixture depressed performance to a greater (P < .05) extent than single deletion of any of the other amino acids. Single deletions of Trp, Thr, Met, or Val decreased (P < .05) performance in a similar but lesser magnitude than the decrease caused by Lys deletion, whereas Ile deletion was without effect. Exp. 2 and 3 were designed to evaluate the limiting order of AA beyond Lys in the low-protein diet. Neither His nor Glu were found to be deficient, and as in Exp. 1, Trp, Thr, Met, or Val deletion from the supplemental amino acid mixture resulted in performance depressions (P < .05) that were similar. These results suggest that Lys is first limiting and Trp, Thr, Met, and (surprisingly) Val are equally second limiting in a reduced protein (13.5% CP) corn-soybean meal-based diet with 8% whey for 10-kg pigs.

Key Words: Low-Protein Diet, Limiting Amino Acids, Valine

182 Effect of variable net energy content of low crude protein, crystalline amino acid-supplemented diets for growing-finishing pigs. K. G. Friesen*[1], B. J. Kerr[2], L.L. Southern[3], and T.D. Bidner[3], [1]*The Pork Group - Tyson Foods, Inc., Springdale, AR,* [2]*Nutri-Quest, Inc., Chesterfield, MO,* [3]*LSU Agricultural Center, Baton Rouge, LA*.

An experiment was conducted to evaluate varying CP and(or) NE levels for pigs. Gilts were allotted on the basis of BW to six treatments with nine reps of 13 gilts each in a RCB. Digestible Lys levels of .96 (25 to 41 kg BW), .75 (41- 59 kg BW), .60 (59 to 82 kg BW), and .48% (82 to 110 kg BW) were fed in the four phase growing-finishing period. The digestible TSAA, Trp, and Thr levels fed at each Lys level were .60, .20, .64; .50, .16, .50; .46, .13, .42; and .41, .10, .34%. The six dietary treatments were three levels of NE within two levels of CP. The high CP diet was formulated to provide all amino acids from intact protein (except crystalline Thr was used in some diets). The low CP diet was formulated to meet the Ile requirement at each phase of growth and crystalline Lys, Thr, Trp, and Met were added. The low CP diet was approximately 4% lower in CP than the high CP diet. The three NE levels (by changing dietary levels of tallow and wheat middlings) at each level of CP were 2,536, 2,474, and 2,412 kcal/kg in Phase 1; 2,585, 2,526, and 2,467 kcal/kg in Phase 2; 2,429, and 2,391, 2,353 kcal/kg in Phase 3; 2,466, 2,421, and 2,376 kcal/kg in Phase 4. Gain was not affected by CP level, but GF was decreased (P<.01) by the low CP level. Gain/feed also was decreased (P<.01) as NE level decreased. Gain/feed was highest in pigs fed the high CP, high NE diet, and GF was lowest in pigs fed the low CP, low NE diet (CP x NE, P<.06). Loin eye area (LEA) was reduced (P<.08) by the low CP diet, but percentage muscling (NPPC), lean gain, and fat free lean (TOBEC; carcass and ham) were not affected by CP. Tenth rib 3/4 fat, lean:fat, total fat (TOBEC) were not affected by diet. Pigs fed the intermediate level of NE had the highest LEA and lean gain (NE quadratic, P<.05). Low protein, amino acid supplemented diets fed throughout the growing-finishing period decreased GF, but they had very little effect on carcass traits of gilts.

Key Words: Pigs, Amino acids, Carcass traits

183 Effects of increasing L-lysine HCl in corn-soybean meal diets on finishing pig growth performance and carcass characteristics. M. De La LLata*, M.D. Tokach, R.D. Goodband, J.L. Nelssen, S.S. Dritz, and J.A. Loughmiller, *Kansas State University, Manhattan*.

One hundred and sixty growing pigs (PIC L326 x C22) with an initial weight of 63 kg were used in a 54 d growth trial to determine the effects of increasing L-lysine HCl in corn-soybean meal based diets for finishing pigs. Treatments consisted of a control diet, (no L-lysine HCl) or .15, .225, and .30% L-lysine HCl replacing the lysine provided by soybean meal. Dietary treatments fed in a grower (60 to 80 kg) and a finisher (80 to 110 kg) phase were formulated to contain .70 and .55% total lysine, respectively. During the grower phase increasing L-lysine HCl from 0, .15 or .225% to .30% decreased ADG (P < .05) and reduced (P < .05) feed efficiency (G:F). During the finishing phase, increasing L-lysine HCl from 0, .15 or .225% to .30% decreased (P < .05) ADG. Feed efficiency was decreased (P < .05) when L-lysine HCl increased from 0 or .15% to .225 or .30%. For the overall experiment increasing L-lysine HCl from 0 or .15% to .225 or .30% decreased (P < .05) feed efficiency (.30, .30, .28 and .26, respectively) and ADG (943, 912, 853 and 853 g, respectively). Carcass characteristics were not affected by dietary treatment, however, backfat depth numerically increased for the .30% L-lysine HCl treatment (15.5, 15.0, 15.0 and 17.1 mm, respectively). Based on the results of this experiment, no more than .15% L-lysine HCl should be added to replace lysine from soybean meal in a corn-soybean meal based diet to avoid deficiencies of other amino acids that limit the growth performance of finishing pigs.

Key Words: Lysine, Corn, Finishing pigs

184 Effect of reducing protein level and adding amino acids on growth performance and carcass characteristics of finishing pigs. H. Liu*, G. L. Allee, J. J. Berkemeyer, K. J. Touchette, J. D. Spencer, and I. B. Kim, *University of Missouri-Columbia*.

A total of 156 high-lean-growth gilts were used in two experiments to evaluate the effect of reducing dietary CP level and adding synthetic amino acids (AA) on growth performance and carcass characteristics of finishing pigs. In Exp. 1, 96 pigs (initially 52.3 kg) were used in a 35 d growth trial to evaluate the effect of reducing CP and adding AA on early-finishing performance. There were 4 treatments in a RCBD design with six replicate pens/treatment containing 4 pigs/pen. The control diet was formulated with corn and soybean meal and 3% added fat to contain .76% true ileal digestible lysine (TDL) and 16.8% CP with no AA added. All the other diets were formulated to contain the same levels of TDL and NE as the control diet by adding variable levels of lys and fat. Protein levels in trt 2 and 3 were reduced by 3 and 4%, respectively, with thr, trp, and met added to the ideal ratio. Trt 4 was similar to trt 3, except ile and val were added to meet the ideal ratio.

In Exp. 1, there were no differences in ADG, ADFI, or feed efficiency (G:F) among different treatments. In Exp. 2, 60 pigs (initially 83.0 kg) were used to evaluate the effect of reducing CP and adding AA on late-finishing performance and carcass characteristics. Treatments of Exp. 2 were similar to treatments in Exp. 1, except that the control diet of Exp. 2 was formulated to contain .59% TDL and 14.4% CP. Each of the four treatments had five replicate pens with 3 pigs/pen. Real-time ultrasound was used to measure the 10th rib backfat depth (BF) and loin-eye area (LEA). In Exp. 2, reducing CP by 4% with no added ile and val reduced G:F (P<.08), compared to the control. There were no differences in ADG, ADFI, BF, or LEA among treatments. These experiments indicate that the CP level of early-finishing pig diet can be reduced up to 4% by adding lys, thr, trp, and met, with no detrimental effect on pig performance. In late-finishing period, if dietary CP level is reduced by 4%, ile and/or val may limit performance.

Key Words: Protein, Amino Acids, Finishing Pigs

185 Crystalline lysine, threonine and methionine supplementation of grain sorghum-based, low protein diets for growing and finishing swine.

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Two trials were conducted to evaluate the effectiveness of crystalline lysine, threonine and methionine supplementation of grain sorghum-based, low protein diets for G-F pigs. Each trial involved a comparison of grain sorghum-based diets formulated with 1) soybean meal (48%) as the supplemental source of amino acids (control) or 2) L-lysine HCl , L-threonine and DL-methionine with enough soybean meal to meet the requirements of the other amino acids (AA). Amino acid supplementation reduced crude protein content of the diets by four percentage units. Both trials were similar and each involved 60 crossbred pigs (5 reps). For both trials, grower diets (.75% estimated digestible lysine) were fed from 36 or 29 kg to 52 or 54 kg avg BW for trials 1 and 2, respectively, finisher 1 (.64% dig lys) to 81 or 84 kg and finisher II (.52% dig lys) to 103 or 113 kg. The grain sorghum utilized was a blend of commercial, low tannin hybrids; a different crop of grain was used in each trial. At the end of both trials, all pigs were scanned to estimate carcass lean content. Overall results over both trials for the control and AA treatments, respectively , were: 1.03 and 1.01 kg ADG (P>.10; SE = .01), 3.00 and 2.99 kg ADF (P>.10; SE = .04), 2.92 and 2.92 F/G (P>.10; SE = .02), 50.4 and 50.3% estimated carcass lean (P>.10; SE = .32), and .374 and .372 kg avg lean gain/d (P>.10; SE = .008). There was no grain crop (trial) x diet effects (P>.10). Results indicated that upon supplementation with crystalline lysine, threonine and methionine, the protein level of grain sorghum based diets can be reduced by four percentage units with very little or no effect on growth performance or carcass lean yield of growing and finishing pigs.

Key Words: Pigs, Amino Acids, Grain Sorghum

186 Effect of feeding low protein diets on performance of growing pigs.

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The objective was to determine the response of growing pigs (50 to 80 kg bw) fed diets equivalent to but limiting in lysine and lower in protein (CP) than a typical corn-soy diet. Forty-eight PIC 327 x C22 gilts were allotted on the basis of weight and backfat depth to one of six diets and penned individually (1.39 m^2/pig). The control diet contained corn and soy (15% CP and .63% true digestable lysine (TDLYS)) as the only amino acid sources. Diet 1 was formulated using synthetic amino acids to lower the CP level to 13% but maintained the 10 essential amino acids at the true digestible levels of the control. Diet 2 was formulated as diet 1 with three dispensable amino acids (DAA) added to achieve N equivalence with the control. Diets 3 and 4 were formulated in the same manner as diets 1 and 2, respectively, to 11% CP. Diet 5 was a corn-soy diet with greater TDLYS (0.81%) to verify that the control was lysine limiting. Pigs fed diet 5 tended (P > .10) to grow faster (1.11 vs 0.99 kg/d), deposit more whole-body protein (148 vs 136 g/d) and less body lipid (280 vs 297 g/d) than control pigs. Pigs fed low CP diets without DAA (diets 1 and 3) had a numerical increase (P < .30) in feed intake compared to control pigs fed the 15% CP diet (3.03 vs 3.15 and 3.37 kg/d). This resulted in a linear increase in body lipid accretion (297 vs 367 vs 406 g/d, P < .06) and in the body lipid:protein ratio (2.18 vs 2.64 vs 3.22, P < .05). The addition of DAA to diets 2 and 4 to make them iso-nitrogenous tended (P < .08) to depress body protein accretion (121 vs 135 g/d) and to elicit greater (P < .26) body lipid (3.33 vs 2.93 lipid:protein ratio) when compared to low CP counterparts. These results indicate that pigs over-consume low CP diets and become fatter. However, feed intake is affected by a factor other than amino acid concentration of low CP diets.

Key Words: Pigs, Low protein, Amino acids

187 Manipulation of swine diets to reduce gaseous emissions from manure that contribute to odor.

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Three experiments were conducted to assess the effects of feeding low protein diets with supplemental amino acids (AA) and the addition of dietary additives on the emission of volatile gasses from swine manure in simulated anaerobic manure pits. Exhaust gas concentrations from each of 12 pits were monitored every 2.4 h for 2-3 wk for NH_3, H_2S, CH_4, and CO_2 using a multi-gas monitoring system. Manure pH and VFA concentrations were determined. In Exp. 1, fortified corn-soybean meal diets containing 16.5, 14.5, 12.5, or 10.5% CP were each fed to 3 pigs (52 kg BW) in metabolism crates for 14 d. The 12.5% CP diet was supplemented with lysine and the 10.5% diet with lysine, threonine, and tryptophan to equal the levels of these AA in the 14.5% CP diet. NH_3 and pH decreased linearly (P<.01) as dietary CP decreased (21.4, 13.8, 13.4, 10.1 ppm; 8.04, 7.75, 7.35, 6.75, respectively). CH_4 tended to increase slightly with decreasing CP (1.56, 1.59, 2.15, 2.25 ppm), but CO_2 was not affected (552, 544, 554, 551 ppm). H_2S was undetectable. VFA levels were not affected by diet, except for trends (P<.15) in butyric and valeric acid (23, 21, 39, 50 and 3, 3, 6, 8 mM). In Exp. 2, 84 pigs (3 reps of 7 pigs, 23 kg) were fed an 18% CP diet without or with *Yucca schidigera* extract (Ultimate Gold, .2%), a microbial product (MicroSource 'S', .05%), or a fructooligosaccharide (inulin, 3%) for 6 d. In Exp. 3, 36 pigs (3 reps of 4 pigs, 33 kg) were fed the 18% CP diet without or with a zeolite (clinoptilolite, 2%) or a 14% CP diet with the 3 AA for 15 d. Zeolite, yucca, inulin, and the microbial product reduced NH_3 emissions by 9, 15, 29, and 38% (P<.10). Although detectable, H_2S emissions were too low for accurate quantification. Inulin tended to increase valeric acid (5 vs 9 mM; P<.10). Feeding the low CP diet reduced NH_3 by 29%. The results indicate that NH_3 emissions from swine manure can be reduced by lowering the dietary CP level or by adding certain additives to the diet.

Key Words: Pig, Manure, Odor

188 Effects of feeding low sulfur starter diets on growth performance of early weaned pigs and odor, hydrogen sulfide, and ammonia emissions in nursery rooms.

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A study was conducted to determine if lowering dietary sulfur levels in a 3-phase nursery diet sequence would reduce odor, hydrogen sulfide (H_2S) and ammonia (NH_4) emissions in nursery rooms while maintaining growth performance of early weaned pigs. A total of 128 pigs from two groups averaging 7 kg in initial body weight and weaned from 15 to 26 d of age were randomly allotted to one of four nursery rooms for a 5-wk feeding period. Each room was mechanically ventilated and contained 2 raised deck nursery pens (1.2 m x 1.2 m) located 0.6 m above solid concrete floors. Pigs received either a typical high-sulfur (HS) or a modified low-sulfur (LS) 3- phase diet sequence. Phase I, II, and III diets were nutritiously similar across treatments except for sulfur level, and were fed from d 1 to 7, 8 to 21, and 22 to 35, respectively. LS diets were achieved by replacing (or partially replacing) dried whey, dicalcium phosphate, copper sulfate, and several sulfate-based trace minerals with lactose and dried skim milk, tricalcium phosphate, zinc oxide, and alternative trace mineral sources, respectively. Analyzed dietary sulfur levels were .32 and .28% (Phase I), .31 and .19% (Phase II), and .26 and .21% (Phase III) for HS and LS, respectively. Manure was allowed to accumulate on the floor during the 5-wk period. Air samples were collected and evaluated by a trained panel using an olfactometer to determine weekly odor detection threshold units (ODU). Weekly H_2S and NH_4 concentrations were measured using a Jerome^{TM} meter and Sensidyne^{TM} tubes, respectively. Weekly and cumulative ADG and ADFI were similar (P >

.10) between treatments. G/F did not differ between HS and LS diets (P > .10) except during Phase II when pigs fed HS had higher G/F than pigs fed LS (P < .10). Average ODU, H_2S, and NH_4 levels tended to increase weekly during the 5-wk feeding period. Feeding LS had no effect on ODU and H2S during wk 1 and 2, but tended to reduce ODU and H2S during wk 3, 4, and 5. Weekly and final NH_4 level was unaffected by dietary treatment. These results suggest that use of alternative reduced sulfur ingredients in starter diets may reduce odor and H_2S emissions in confinement nursery rooms without reducing pig performance.

Key Words: Sulfur, Odor, Hydrogen sulfide

189 Calculated body-N loss or infused alanine-N is not recovered from starved newborn pigs. N.J. Benevenga*, T.W. Rasch, L.G. Haas, B.D. Mickelson, and J.A. Davis, *University of Wisconsin-Madison, Madison, WI.*

Estimating body nitrogen (N) loss by comparative slaughter in newborn pigs starved for 60 h (12-72 h of age) and comparing it to N measured in urine revealed that 30-50% of body-N loss was recovered in urine (FASEB J. 9:A745 1995). In other studies, 4 small pigs (.99±.16 kg) and 4 large pigs (1.86±.16 kg) were given alanine IV with levels stepped every 6 h from 0 to 25, 50 and 75% of fasting heat production followed by infusion of water for 12 h. The recovery of the infused alanine-N in both urinary-N and the expanded body urea-N pool was 73% and 54% in small and large pigs respectively (FASEB J. 10:A472 1996). In these studies, expired ammonia accounted for between .1 and 1.0% of the infused alanine-N. Urinary nitrate-N in piglets starved for 60 h could account for .6% of body-N loss. Because the standard Kjeldahl used to measure total N in the previous studies does not detect oxidized N (nitrite and nitrate), it was modified to include these N compounds. When comparing the two Kjeldahl methods, no methods difference (P≥.05) in body-N or urinary-N in 7 pigs was detected. A closed circuit respiration system was developed so possible gaseous forms of N loss from ^{15}N L-alanine, particularly $^{28}N_2$, $^{29}N_2$ and $^{30}N_2$, could be sampled, identified and measured. Nine pigs were infused IV with either ^{15}N enriched L-alanine (2.5 A.P.) or unenriched alanine (.37 A.P.) for 60 h. After establishing and maintaining an atmosphere of 80% Ar and 20% O_2, no change (P≥.05) in N-containing gases was seen. Studies were carried out with 4 newborn pigs to determine if ^{15}N from L-alanine could be quantitatively recovered in the body, urine or N-gas, by infusing them IV with ^{15}N enriched L-alanine (2.5 A.P.) for 60 h followed by a 12 h water infusion. The average total recovery (mean±S.D.) of the infused ^{15}N was 75.1±3.5% with 41.6±2.8% in the body, 33.5±1.7% in urine and none in N-gas. If N cannot be accounted for, the conclusion from these three approaches cast doubt on the use of N-balance to estimate requirements.

Key Words: Newborn Pig, Body-N, N-loss

190 Effects of corn hybrids fed to growing pigs on nitrogen metabolism. J. L. Snow*[1], L. L. Andersen[2], D. Rozeboom[2], M. Allen[2], and N. L. Trottier[2], [1]*University of Illinois; Urbana, IL,* [2]*Michigan State University; East Lansing, MI.*

Eight barrows (19.11 ± .49 kg, Yorkshire) were arranged in two 4 x 4 Latin squares to investigate the effect of feeding different corn hybrids on nitrogen balance. The test corns were: high oil (HO), isogenic high oil (IHO), waxy (WX), isogenic waxy (IWX), high lysine (HL), yellow dent one (YD1), yellow dent two (YD2). Pigs were fed corn-based diets consisting of 96.87 % test corn. Pigs were allowed adjustment period to diets (5d) followed by five days of total urine and fecal collection. Nitrogen (N) retained was not different between HO vs IHO, WX vs IWX and HL vs YD1 ($P \geq .1$; see table). Nitrogen retention as a percent of N intake and N absorbed was similar between HO vs YD2 and WX vs YD2 ($P \geq .1$), but was different when HL was compared to YD2 ($P \leq .05$). Overall, pigs fed the YD1, HL and HO corns retained numerically more nitrogen consumed and absorbed than all other corns.

Item	HO	IHO	WX	IWX	HL	YD1	YD2
n	4	4	4	4	4	4	7
N retained, g/d	7.92^{af}	6.78^{a}	6.62^{ad}	5.97^{a}	10.05^{af}	11.34^{a}	$4.9\ 9^{d}$
N digestibility, %	83.31^{af}	78.90^{a}	74.04^{ad}	77.80^{b}	81.06^{af}	83.30^{a}	74.12^{d}
N retention, % of intake	49.74^{ad}	45.58^{a}	44.55^{ad}	42.03^{a}	57.22^{af}	62.36^{a}	38.48^{d}
N retention, % of absorbed	59.73^{ad}	57.73^{a}	59.14^{ad}	53.39^{a}	70.75^{af}	75.06^{a}	52.34^{d}

^{a,b} Means in rows with different superscripts are different among these comparisons: HO vs IHO, WX vs IWX, HL vs YD1 ($P \leq .1$) ^{a,c} Means in rows with different superscripts are different among these comparisons: HO vs IHO, WX vs IWX, HL vs YD1 ($P \leq .05$) ^{d,e} Means in rows with different superscripts are different among these comparisons: HO vs YD2, WX vs YD2, HL vs YD2 ($P \leq .1$) ^{d,f} Means in rows with different superscripts are different among these comparisons: HO vs YD2, WX vs YD2, HL vs YD2 ($P \leq .05$)

Key Words: Nitrogen retention, specialty corns, pigs

191 Effect of dietary soy genistein on growth and immune response in pigs during a viral challenge. L.L. Greiner*[1], T.S. Stahly[1], and T.J. Stabel[2], [1]*Iowa State Univeristy, Ames, IA,* [2]*USDA/ARS/National Animal Disease Center, Ames, IA.*

Twelve replications of four littermate pigs from a PRRS negative herd were weaned (10 ± 2 d) and penned individually in isolation chambers. Pigs were randomly allotted within litter to one of four dietary soy genistein concentrations (0, 200, 400, 800 ppm) to quantify the effect of genistein on growth and immune response during a PRRS challenge. Genistein was provided as the soy glycoside, genistin. At 21 ± 2 d of age (4.9 ± 1.4 kg BW), pigs were oral-nasally inoculated with 2 mL of 10^4 PRRS virus strain JA142/mL. Blood was collected every 4 d from d 0 to 24 post-inoculation (PI) and analyzed for serum PPRS virus, gamma-interferon (γ-IFN), and alpha-1-acid glycoprotein (AGP) concentrations. Serum virus and γ-IFN peaked at $10^{5.25}$ virus/mL and 96% protection, respectively, at 4 d PI and then declined steadily. Serum AGP concentration peaked at 12 d PI. Each 10-fold increase in serum virus was associated with a reduction of daily gain of .013 kg in pigs 4 to 8 d PI and .025 kg in pigs 16 to 20 d PI. Serum virus concentration decreased (P<.07) linearly as dietary genistein concentrations increased ($10^{2.46}$, $10^{2.26}$, $10^{2.05}$, $10^{2.14}$ virus per mL of serum) independent of days PI. Serum concentrations of γ-IFN responded quadratically (P<.06) as dietary genistein concentrations increased (28.4, 25.7, 22.8, 30.9% protection). AGP concentrations also increased (P<.01) quadratically; however, the magnitude of the response decreased over time. Increased dietary genistein concentrations resulted in a cubic response (P<.13) in daily pig gain (.246, .287, .252, .228 kg) and a quadratic response (P<.03) in daily feed intake (.317, .360, .349, .289 kg) independent of days PI. These data indicate that the magnitude of the biological responses that occur in pigs infected with PRRS are directly related to the animal's serum virus concentration, and that low concentrations of dietary soy genistein reduce virus concentration and improve body growth in virus challenged pigs.

Key Words: Genistein, Growth, Immune Response

192 Enteric disease challenge effects on pig growth, N balance, and immune indicators. J.A. Loughmiller*, S.S. Dritz, M.D. Tokach, R.D. Goodband, J.L. Nelssen, M. De La Llata, and S.A. Moser, *Kansas State University, Manhattan.*

Pigs (30 ± 1 kg) were used in a 25 d trial to determine the effects of an enteric disease challenge on N balance, growth performance, and immune variables. Pigs (n=21) were challenged on d 8 with Salmonella typhimurium (S), unchallenged and fed ad libitum (A; n=6), or unchallenged and pair-fed the feed intake of a challenged pig (P; n=8). Collection periods were d 4 to 7, 8 to 11, 12 to 15, 16 to 19, and 22 to 25. Blood was collected on d 5, 9, 13, 17, and 23. There was a disease

challenge × time interaction (P < .05) for ADG, due to decreased ADG (P < .01) for S vs A from d 8 to 11 (617 vs 1385 g). Pair-fed pigs had intermediate ADG (949 g), and differed from S (P < .07). Gain/feed was lower for S vs P from d 8 to 11 (.20 vs .62; P < .05). There was a disease challenge × time interaction for retained N (P < .05), indicating reduced lean growth from d 8 to 11 for S (19.6 g/d; P < .01) and P (23.2 g/d; P < .07) vs A (30.1 g/d). From d 8 to 11, N retention, as a percentage of N intake or N absorbed, was worse for S (38.6%, 34.4%) vs A (57.0%, 65.5%; P < .05), and P (51.7%, 58.7%; P < .07). While short-term differences were evident, d 8 to 25 growth performance and N balance were not affected (P > .20), except for increased DM digestibility and decreased fecal N for S vs A (P < .05). There was a disease challenge × time interaction for serum haptoglobin (P < .05), with higher haptoglobin on d 9 and 13 for S vs A, (P < .05) and S vs P on d 13 (P < .05) and 17 (P < .10). On d 13 and 17, serum alpha-1 acid glycoprotein was only higher for S vs A (P < .05). Plasma IGF-I increased from d 4 to 25 (linear, P < .05), and was higher for S vs A on d 17 (P < .10), d 23 (P < .05), and for S vs P (P < .05) on d 17. Results indicate that short-term reductions in N balance and growth performance from an acute disease challenge are due to feed intake reductions and immune response nutrient repartitioning. Because of compensatory gain during recovery, long-term effects were minimal.

Key Words: Pig, Salmonella, N Balance

PHYSIOLOGY

193 The effect of exogenous estradiol-17β ($E_2\beta$) during elongation on placental size at d112 of gestation in the Meishan (M) pig.

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Day 2.5 transferred M embryos are larger, contain more trophectoderm cells and secrete more $E_2\beta$ when gestated in a Yorkshire (Y) as compared to M uterus to d12. Additionally, placentae of M conceptuses are larger when gestated in a Y uterus as compared to a M uterus to d112. Embryonic $E_2\beta$ secretion during elongation on d12-13 is thought to stimulate endometrial secretion of growth factors including IGF-I. This experiment was conducted to determine if exogenous $E_2\beta$ given to straight-bred M females during conceptus elongation would increase placental size of M conceptuses. M females (n=12) were checked twice daily for estrus (0700 and 1900) and bred to a M boar at 0 and 12h after the onset of estrus (d0). Bred females were randomly assigned in equal numbers to receive eight 1 ml injections (im) at 6h intervals starting at 0700 or 1900 (time of day when first in estrus), of sesame oil starting on d12 (Veh), 1mg of $E_2\beta$ in sesame oil starting on d12 (E12), or 1mg of $E_2\beta$ in sesame oil starting on d13 (E13). Pregnant females were then slaughtered on d112 of gestation and ovulation rate, litter size, fetal weight (FW), crown-rump length (CRL), placental weight (PW) and placental surface area were quantified. As there were no differences in any of the measurements between E12 and E13, the $E_2\beta$ groups were combined (E) for analysis. There were no differences between E and Veh treated females in ovulation rate or litter size, which averaged 16.3±.7 and 11.8±.7. FW and CRL were not different (P¿.10) between E and Veh treated females, averaging 802±26 g and 24.3±.3 cm. Placentae were heavier (P<.05) and larger (P<.001) in E treated females than in Veh treated females (175±10 g and 1428±65 cm^2 vs 134±10 g and 978±29 cm^2, respectively). In addition, placental efficiency (as estimated by the FW:PW) was greater (P<.05) in the Veh as compared to E treated females (5.8±.2 vs 4.9±.2). These data demonstrate that the amount of embryonic $E_2\beta$ produced around the time of elongation effects placental size at term.

Key Words: Pig, Placental size, Meishan

194 Estrogen receptor genotype is not associated with placental size in the pig.

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Litter size is positively associated with placental efficiency (PE), defined as a piglet's birth weight to that of its placenta (Wilson, et al., 1998; Proc Midwest Sec ASAS; abstract #170). By selecting progeny with a greater PE, we increased litter size in a single generation in Yorkshire pigs. Although we have evolved an efficient way to match each piglet with its placenta, much time is invested in obtaining these measurements. Allelic polymorphism (A and B) associated with the estrogen receptor gene has been proposed by others (Rothschild et al., 1996; PNAS 93 201-205) as a marker for litter size. It was our objective to determine if there was any association between the estrogen receptor genotype of an individual piglet and its observed PE. The current study analyzed 249 Yorkshire piglets from 32 litters representing animals selected on PE (high and low) as well as unselected controls. Sows were monitored at farrowing, with each piglet's umbilical cord double tagged and cut to allow piglets to be matched with their placentae. Ear tissue was obtained and estrogen receptor genotyping was performed by PCR as described by Short et al. (1997; JAS 75 3138-3142). We confirmed previous data that PE shows significant variation both among (range 2.15 to 8.87) and within (range 2.96 to 8.59) litters. Although there was a positive correlation (r=.58, p<.0001) of piglet birth weight with placental weight, there was no correlation of piglet birth weight with PE. There was however, a strong negative correlation (r=-.62, p<.0001) between placental weight and PE. There was no effect of piglet estrogen receptor genotype on placental weight or PE (p>.50). Further, there was no obvious skew in the genotypes (AA, AB or BB) of animals that were selected on PE compared to unselected controls. Therefore, estrogen receptor genotype gives no insight into a piglet's PE, a trait known to be associated with litter size in the Yorkshire breed.

Key Words: Estrogen receptor gene, Litter size, Placental efficiency

195 Inability of Progesterone to Delay Return to Estrus in 14 d Weaned Sows.

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Segregated early weaning has been instituted to improve growth, efficiency, and health status of weaned pigs. Sow reproductive performance is impaired when sows are weaned at 14 d or less. Greatest limitations are seen in reduced conception rates and subsequent litter size, and an increase in length and variation of wean-to-estrus interval (WEI). The immediate objectives of the present experiment were to determine the effect of a single injection of progesterone (P_4) on the WEI, return of LH pulsatility, and consistency of return to estrus in early-weaned sows. A total of 38 sows were weaned at 9 to 14 d of lactation. Nineteen sows were injected at weaning with 4,000 mg of P_4 dissolved in 8 ml of sesame seed oil and the other 19 sows served as controls and were given an 8-ml sesame seed oil injection. Twenty-three sows were fitted with indwelling jugular catheters and blood collected every 4 hours for 6 d beginning 8 hours after weaning to determine P_4 concentration. Blood samples were also collected at 20-minute intervals for 6 hours beginning the day after weaning for 8 d for LH assays. Sows were checked twice daily for return to estrus with a mature boar starting on day 3 post-weaning. WEI ranged from 3 to 14 d with no significant difference (P>0.05) between treatments. Two sows remained anestrus and were not included in the WEI analysis. The P_4 treated sows had a significantly higher (p<0.01) levels of P_4 (.40 vs 4.77 ng/ml) lasting for approximately 30 hours after weaning. The LH data were analyzed for mean LH, the number of peaks in a 6-hour period, average peak amplitude, and average baseline LH. There were no significant interactions between treatment and time for any of the above parameters. In summary, the single P_4 injection cleared the system too quickly to delay return to estrus. Although P_4 concentrations were elevated in the treated group, no significant change was observed in the LH pulsatility or consistency of return to estrus. Future research is needed to determine the possibility of another delivery mechanism.

Key Words: early wean, wean-estrus-interval, sow

196 Follicular development and atresia during the luteal phase of the estrous cycle in gilts selected for high ovulation rate and controls.

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Follicular development and atresia were characterized during the luteal phase in two genetic lines differing in ovulation rate (RLS, n=62, cross of Relax Select and Litter Size and C, n=45,randomly selected control line). Gilts were assigned randomly within sire for ovary recovery on days 5, 8, 11 and 14 (d 0 = first d of estrus)of the estrous cycle. Ovaries

were evaluated for numbers of CL, small (SF, 2 to 2.9 mm)and medium (M1F, 3 to 4.9 mm; M2F, 5 to 6.9 mm)follicles. Relative percentage rather than follicle numbers of each size category were analyzed statistically. Follicles (20 largest per gilt) with <10% apoptotic (A0) granulosa cells determined by flow cytometry were classified as healthy. RLS gilts ovulated 2.5 more follicles than C gilts at the pretreatment estrus (15.9 vs 13.4 CL, P<.01). The relative % of SF decreased over time in both lines (day, P<.01) but the decline was greater in C than in RLS gilts between d 5 and d 14 (C, 72.6 to 37.6% vs RLS, 57.3 to 40.6%, line x day, P<.05). The relative % of M1F increased over time in both lines(day, P<.01)but the increase was greater in C than in RLS gilts between d 5 and d 14(C, 27.5 to 59.1% vs RLS, 40.9 to 51.1%, line x day, P<.06). The % of M2F increased rapidly in both lines between d 5 and d 8 and then declined to d 14. The decrease was greater (P<.01) in C than in RLS gilts (C, 12.3 to 3.4% vs RLS, 12.1 to 8.3%). The % of healthy follicles in RLS gilts decreased between d 8 and d 11(49.3 to 30.8%) and then increased to d 14(45.8%), whereas the reverse pattern was observed in C gilts(d 8, 31.4%; d 11, 46.4%; d 14, 20.7%; line x day, P<.01). Different patterns of follicular development and atresia in these two genetic lines suggest alteration of the follicular recruitment process during the luteal phase in response to genetic selection for high ovulation rate.≤≤≤

Key Words: Pig, Follicular atresia, Ovulation rate

197 Expression of basic fibroblast growth factor in placental tissues of early pregnant ewes.

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Placental vascular growth is associated with local production of angiogenic factors, including basic fibroblast growth factor (bFGF). We have shown previously that maternal placental (endometrial) vascularity increases two-fold by d 24 after mating in ewes (Reynolds and Redmer, Biol. Reprod. 47:698, 1992). To evaluate the expression of bFGF mRNA and to localize bFGF protein, placental tissues were obtained from early pregnant ewes on d 12, 18, 24, 30, and 40 after mating (n=5 ewes per day). Placental tissues were separated into maternal (caruncular [CAR] and intercaruncular [ICAR], d 12-40) and fetal (fetal membranes [FM], d 18-30; or cotyledonary and intercotyledonary [COT and ICOT], d 40) components, and were then snap- frozen or fixed in Carnoy's solution. Expression of bFGF mRNA was evaluated by ribonuclease protection assay of 20 ug of total cellular RNA; protected RNA hybrids were separated by polyacrylamide gel electrophoresis and were quantified (cpm x 1000) with an Instant Imager. In addition, bFGF protein was immunolocalized in paraffin-embedded tissue sections (6 um) by using an antibody against a human bFGF peptide. Across all days, concentrations of bFGF mRNA were greater (p<.01) for CAR and ICAR (2.8 ± .5 and 1.6 ± .3) compared with FM, COT, or ICOT (.9 ± .3, .6 ± .1, or .8 ± .5). For CAR, bFGF mRNA concentrations decreased (p<0.08) from d 18 to d 40 (4.2 ± 1.2 vs. 1.1 ± .4). The intensity of immunostaining for bFGF protein appeared greater in maternal compared with fetal placenta across all days. In maternal placenta, bFGF protein localized mainly to lumenal and glandular epithelium, and the intensity of staining decreased as gestation advanced. For fetal placenta, bFGF protein localized primarily to chorionic epithelium, and the staining intensity did not change across days. Thus, immunolocalization of bFGF corroborates the bFGF mRNA expression in the same tissues and suggests that bFGF plays a role in placental vascular growth during early pregnacy in ewes.

Key Words: placenta, angiogenesis, sheep

198 Prolactin activation of c-src signaling in mammary epithelial cells via a JAK2 and SHP2 dependent pathway.

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Treatment of mammary epithelial cells (primary bovine cultures or the murine lines NMuMG and HC11) with prolactin resulted in increased activity of the tyrosine kinase c-src, measured by immunoprecipitation of c-src and phosphorylation of the substrate peptide p39cdc24[6-20] (100 ng/ml prolactin giving increases of 4.30.6, 6.20.9 and 5.10.7 fold for the 3 cultures, respectively). To investigate the pathways of c-src activation and its physiological consequences, HC11 and NMuMG cells were stably transfected with dominant negative mutants of c-src, the tyrosine kinase JAK2 and the phosphotyrosine phosphatase SHP2 (DN-Src, DN-JAK2 and DN-SHP2, respectively). DN-JAK2 abolished prolactin-induced activation of c-src and SHP2 (measured by immunoprecipitation and dephosphorylation of phosphorylated src[521-533]). DN-SHP2 had a small effect on prolactin-induced JAK2 kinase activation (measured as phosphorylation of Angiotensin II in JAK2 immunoprecipitates), but completely blocked c-src activation. DN-Src abolished c-src activation by prolactin and reduced expression of beta-casein 50%, as measured by western blot analysis. Prolactin induced activation of EGF transcription, assessed as activity of a reporter gene containing -888 to +25 bp of EGF driving a luciferase reporter, was reduced by 60% by DN-Src. Expression of DN-Src was also associated with a 70% decrease in prolactin-induced tyrosine phosphorylation of the transcription factor STAT3, but had no significant effect on STAT5 phosphorylation. These results indicate that activation of c-src in response to prolactin occurs in a variety of mammary epithelial systems. This activation appears to involve initial activation of JAK2, which activates the phosphatase SHP2. This phosphatase appears to be necessary for activation of c-src by prolactin. Finally, c-src activation appears to play a role in prolactin activation of some, but not all, members of the STAT family of transcription factors, with resultant alterations in prolactin mediated gene expression.

Key Words: Prolactin, Mammary Gland, Signaling

199 The Effect Of Centrifugation Of Stallion Semen With And Without Extender On Pellet Quality and Sperm Cell Motility Up To 72 Hours of Storage.

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This study was conducted to determine the influence of centrifugation on pellet quality and sperm cell motility with and without pre-extension. A total of nine collections were obtained from three Morgan stallions. Ejaculates were obtained utilizing an artificial vagina. From each ejaculate a 30 ml aliquot of semen was divided into three samples of 10 ml each. Sample 1 was not centrifuged and extended in Kenney's Extender (KE). Sample 2 was extended in Kenney's with Modified Tyrodes (KMT), centrifuged, pellet quality evaluated after removal of the supernatant and then extended in KMT. Sample 3 was centrifuged, pellet quality evaluated after removal of the supernatant and then extended with KMT. A pellet score (1-3) was assigned for each sample based on the ease of removal of the supernatant from the sperm pellet. A score of 1 indicated difficult removal of the supernatant from the pellet. A score of 3 indicated easy removal. Pre-extension of semen prior to centrifugation reduced pellet quality (1.3 vs. 2.7). Percent motile cells were determined at 0, 24, 48, and 72 hours post treatment. Centrifugation significantly (P<.01) decreased sperm cell motility at time 0. There were no significant differences between treatments at 24 hours post treatment. However, centrifugation significantly (P<.01) increased sperm cell motility at 48 and 72 hours post treatment. This study suggests that centrifugation of stallion semen may have beneficial effects on sperm cell motility if semen is stored 48 hours or longer. Furthermore, centrifugation of raw semen resulted in a firmer sperm pellet, decreasing the loss of sperm cells when the supernatant is removed.

Key Words: Semen, Centrifugation, Stallion

200 Effect of lactation length and exogenous progesterone/estradiol-17β on embryo survival in multiparous sows.

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Thirty-six second parity, high lean, European sows were randomly allotted to be either early weaned (EW; 13.0 d lactation; n=26) or conventionally weaned (CW; 31.0 d lactation; n=10) in a 2 × 2 factorial. Sows were mated via AI at the first postweaning estrus and sows from each lactation length were treated daily at 1200 on d 14-20 postmating with 2 ml i.m. injections of either 25 mg progesterone and 1.25 μg estradiol-17β (P_4/E_2; n=17) or the vehicle minus the steroids (CTRL; n=17). Sows were slaughtered at d 29.3 ± .3 of gestation to assess ovulation rate and embryo survival. There were no interactions between the lactation length and hormone treatment. The percentage of sows open, open due to cystic ovaries and anestrus for the EW and CW sows were 29.2 vs 10.0%; 16.6 vs 0.0%; and 7.7 vs 0.0%, respectively. The weaning-to-estrus interval tended to be longer for EW than CW sows (5.5 vs 4.6 d; P < .10). Ovulation rate was not affected by lactation length (EW vs CW; 19.9 vs 21.3; P > .35). The total number of embryos (live + dead)

and the number of live embryos were reduced in EW sows as compared to CW sows (13.1 vs 17.9; P < .02 and 11.6 vs 16.1; P < .02). P_4/E_2 increased the total number of embryos present and tended to increase the number of live embryos as compared to the CTRL treatment (18.0 vs 13.1; P < .02 and 15.3 vs 12.3; P < .08). CW sows had a significant increase in the percentage of corpora lutea (CL) represented by embryos (% E) and in the percentage of CL represented by live embryos (% ES) compared to EW sows (83.5 vs 66.6%; P < .05 and 79.4 vs 59.6%; P < .03). Hormone (P_4/E_2) treated sows had increased % E compared to CTRL sows (84.1 vs 66.0%; P < .04), but % ES was not increased significantly (76.8 vs 62.3%; P < .11). These data highlight the impact of short lactations on sow rebreeding performance and embryo survival. Treatment with exogenous P_4/E_2 during implantation may moderately increase the number of embryos surviving to d 30 of gestation.

Key Words: Lactation Length, Embryo Survival, Steroid Therapy

201 Effect of lactation length on postweaning progesterone and estradiol-17β profiles in multiparous sows.

B. A. Belstra, B. T. Richert, M. A. Diekman, J. W. Frank, D. C. Kendall, and W. L. Singleton, *Purdue University, West Lafayette, IN.*

The hypothesis that short lactation lengths alter steroid hormone profiles during early gestation and decrease embryo survival was tested using eighteen second parity, high lean, European sows. Sows were either early weaned (EW; 13.4 ± .6 d lactation; n=9) or conventionally weaned (CW; 31.3 ± 1.3 d lactation; n=9) and mated via AI at the first postweaning estrus. Serum samples were collected via jugular venipuncture at weaning, every other day until d 24-26 of gestation and at slaughter (29.3 ± .2 d). Progesterone (P_4), estradiol-17β (E_2) and estrone sulfate (E_1S) concentrations in serum were determined by radioimmunoassay. Progesterone and E_2 concentrations from d -6 to d 26 of gestation were not different between weaning treatments at any time point (P = .13). The time relative to predicted ovulation that serum P_4 and E_2 concentrations peaked (d 12 and d -2, respectively) was not different for CW vs EW sows. Peak P_4 and E_2 concentrations were not different for CW vs EW sows (34.0 vs 32.2 ng/ml; P = .73 and 23.9 vs 21.1 pg/ml; P = .60). Serum E_1S concentrations were numerically greater in CW sows than EW sows from d 16 to 30 and significantly greater at d 20 and 24 (2.1 vs 1.1; P < .04 and 9.0 vs 3.9 ng/ml; P = .05). E_1S concentrations adjusted for the number of live embryos (LE) at slaughter were numerically greater, but not significantly, from d 16 to 30 for CW vs EW sows. The change in E_1S concentration from d 16 to 24, adjusted for LE, was greater in CW than EW sows (7.2 vs 4.1 ng/ml; P < .02). These data indicate that a lactation length as short as 10-15 days does not result in significant changes in postweaning and early gestation P_4 and E_2 profiles. The increased levels of E_1S in CW vs EW sows after adjustment for live embryo number may suggest greater size or viability of the placenta of CW sows embryos. These data do not support the hypothesis that altered steroid profiles are responsible for the increased embryonic death observed in early weaned sows.

Key Words: Lactation Length, Progesterone, Estradiol

202 In vitro meiotic competnece of oocytes collected from porcine antral follicles.

G. A. Perry*, R. S. Prather, and M. F. Smith, *University of Missouri-Columbia, Columbia, Missouri/USA.*

In vitro embryo production is limited by a small pool of oocytes per ovary that are capable of undergoing nuclear and cytoplasmic maturation. Culture of preantral and early antral follicles may provide a larger source of oocytes capable of maturation and subsequent fertilization and embryonic development. The objective was to determine the effect of antral follicle diameter on in vitro meiotic competence of porcine oocytes. Ovaries were collected from prepuberal gilts at a local abattoir. Cumulus-oocyte complexes (COCs) were collected from antral follicles having the following diameters: 1) .4-.6 mm, 2) .7 .9 mm, 3) 1-2 mm, and 4) 3-6 mm (3 replicates of 30 COCs per size class). The COCs were cultured in oocyte maturation medium with (0 to 22h) and subsequently without (22 to 44 h) gonadotropins. Following culture, cumulus cells were removed and stage of meiotic competence was determined by orcein staining. Oocyte diameter increased ($P<.05$) with each follicular size class (133.9, 144.1, 148.4, and 151.1 μm, respectively). Cumulus expansion (CE) at 44 h was greater ($P<.05$) for COCs collected from larger follicles (1-2 mm = 98.8%; 3-6 mm = 97.7%) compared to smaller follicles (.4-.6 = 11.1%; .7-.9 = 23.5%). The proportion of oocytes that underwent germinal vesicle breakdown (GVB) was lower ($P<.05$) for oocytes collected from smaller (.4-.6 = 5.1%; .7-.9 = 21.3%) compared to larger follicles (1-2 mm = 98.8%; 3-6 mm = 97.7%). Similarly, the proportion of oocytes that progressed to metaphase II (MII) was dramatically lower ($P<.05$) for oocytes collected from smaller (.4-.6 mm = 0%; .7-.9 mm = 1.3%) compared to larger (1-2 mm = 57.1%; 3-6 mm = 84.9%) follicles. Although GVB was similar for oocytes collected from 1-2 mm and 3-6 mm follicles, the percentage of oocytes at MII was greater ($P<.05$) for oocytes collected from 3-6mm follicles. In summary, porcine oocytes collected from early antral follicles ($\leq$.9 mm follicular diameter; $\leq$144 μm oocyte diameter) had reduced ability to achieve CE, GVB, and MII compared to oocytes from larger follicles.

Key Words: Follicle, Oocyte, Meiosis

203 Insulin-like growth factor-I (IGF-I) response to ovarian follicle ablation in beef cattle.

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In previous studies, treatment with growth hormone stimulated bovine ovarian follicular development while cattle selected for natural twin ovulations had higher circulating concentrations of IGF-I. The present objective was to determine the relationship between IGF-I and FSH during the initiation of ovarian follicular development by follicle ablation. All follicles $\geq$ 5 mm in diameter were ablated transvaginally in 24 cyclic crossbred cows on d 7 or 8 of the estrous cycle (estrous = d 0). Blood samples were collected at 12-h intervals via a jugular vein cannula beginning just before ablation and continuing for 96 h after ablation. Plasma was collected by centrifugation and samples were stored at -4°C until assayed. IGF-I was measured by RIA subsequent to acid-ethanol extraction; FSH and LH were measured directly using a double-antibody RIA. Circulating concentrations of both IGF-I and FSH were elevated (P < .01) within 12 h after ablation. Peak mean concentration of IGF-I (61.3 ± 5.5 ng/ml) occurred at 24 h after ablation and returned to baseline (47.6 ± 5.5 ng/ml) by 72 h. Peak mean concentration of FSH (70.3 ± 5.7 ng/ml) occurred at 24 h and returned to baseline (31.1 ± 5.7 ng/ml) by 72 h. The correlation between plasma IGF-I and FSH concentrations for the 96-h period was r = .76 (P < .01). Systemic LH concentrations were unaffected (P > .1) by follicle ablation. These results suggest that removal of all medium and large follicles by ablation enhances IGF-I secretion, which may facilitate the initiation of a new ovarian follicular wave by FSH.

Key Words: Cattle, FSH, IGF

204 Response of beef calves to low-dose endotoxin challenge.

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An experiment was conducted to evaluate a low-dose endotoxin challenge model and the induction of endotoxin tolerance in cattle. Eighteen beef calves (initial weight 323 kg) were injected intravenously with 0.2 μg/kg of E. coli 055:B5 endotoxin (Sigma Chemical Company, St. Louis, MO) at 0 and 72 h. Animals were observed for clinical signs of endotoxemia and serial blood samples were collected at 0, 1, 2, 3.5, 4.5, 6, 12, 24, 72, 73, 74, 75.5, 76.5, 78, and 84 h. Most animals exhibited mild to moderate clinical symptoms of endotoxemia (depression, increased respiratory rate, frequent urination, diarrhea) within one hour of the initial injection but appeared normal by 4 h. No animals became severely distressed or required treatment. Clinical symptoms were less evident after the 72 h injection. Calves resumed normal feed consumption when returned to individual pens at the conclusion of the injection / sampling periods. Rectal temperature peaked at 3.5 h (Δ 0.81 C) and returned to initial levels by 4.5 h. Hematological changes characterized by leukopenia, neutropenia, and monocytopenia were consistent at 1 h through 3.5 h and immature neutrophils (bands) appeared in circulation by 4.5 h. Leukogram returned to normal by 6 h except for appearance of bands and occasional neutrophilia and monocytophilia. Tumor necrosis factor (TNF) peaked (Δ 0.31ng/ml, p<.05) at 1 h and returned to baseline levels by 4.5 h. At 3.5 h, bilirubin was elevated (Δ 0.18 mg/dl, p<.05), and at 24 h haptoglobin increased (Δ 10.65 mg/dl, p<.05) and total serum iron decreased (Δ -97.0 mg/dl, p<.05). Changes in measured parameters observed after the 0 h endotoxin injection were either absent or diminished following the 72 h injection, indicating establishment of endotoxin tolerance. Low-dose endotoxin challenge provides an alternative to traditional challenge models, yielding demonstrable effects without undue animal distress and/or mortality. Calves also exhibited

endotoxin tolerance when challenged with a second dose of endotoxin at 72 h.

Key Words: Cattle, Endotoxin, Tolerance

205 Differences in testicular function and structure associated with high or low plasma concentrations of FSH during development in littermate boars. D. D. Lunstra*, T. H. Wise, and J. J. Ford, *USDA, ARS, RLH U.S. Meat Animal Research Center, Clay Center, NE.*

We previously reported that plasma FSH is negatively correlated with mature testicular weight and total sperm production. The objective of this experiment was to define differences in testicular structure, daily sperm production (DSP) and steroidogenic capacity associated with divergent FSH concentrations during development in boars. Seven sires were used to produce seven littermate pairs of 1/2 Meishan x 1/2 White Composite boars by reciprocal crossing of reciprocal backcrosses. Littermates differed (P<.01) in plasma FSH at 4, 5 and 6 mo of age (HiFSH vs LoFSH; 1162 vs 229 ± 77 ng/mL). Blood samples, testicular morphology and *in vitro* steroidogenesis were evaluated at 1 yr of age. LoFSH boars continued to exhibit lower serum FSH (P<.001; 169 vs 702 ± 67 ng/mL) at 1 yr of age. Littermates did not differ in bodyweight, but LoFSH boars had lower serum testosterone (T; P<.01; 2.9 vs 5.9 ± .8 ng/mL) and had larger testes weight (P<.001; 561 vs 273 ± 26 g), epididymal weight (P<.01; 138 vs 92 ± 9 g) and total DSP (P<.001; 16.9 vs 6.7 ± 1.2 x 10^9) than HiFSH boars. Testes of boars with LoFSH had smaller volume percentage interstitial tissue (P<.001; 29 vs 42 ± 2%), volume percentage Leydig cells (P<.001; 15 vs 29 ± 1%) and average Leydig cell size (P<.01; 2102 vs 3219 ± 105 μm^3) than HiFSH boars. LoFSH boars had a greater number of Leydig cells (P<.001; 36.7 vs 23.8 ± 2.1 x 10^9), but LoFSH and HiFSH boars did not differ in total mass of Leydig cells per paired testes (P=.38; 77.7 vs 72.2 ± 4.4 g). Production of T *in vitro* per gram of testis (P<.02) and per 106 Leydig cells (P<.03) was lower for LoFSH boars, but T production per paired testes did not differ (P=.23) between LoFSH and HiFSH boars. In these littermate boars, divergence in FSH concentrations during development was associated with altered development and function of both the Leydig cells and seminiferous tubules.

Key Words: Swine, Testosterone, Leydig

206 The impact of pregnancy on small intestinal and hepatic tissue growth and energy use in beef heifers. A. N. Scheaffer*[1], J. S. Caton[1], M. L. Bauer[1], D. A. Redmer[1], and L. P. Reynolds[1], [1]*North Dakota State University.*

Beef heifers (24 mo; 384 ± 11 kg BW; 45 pregnant [PR]; 24 non-pregnant [NP]) were grouped in common pens and fed corn silage and hay-based diets formulated to provide .45 kg of ADG in NP cows. PR heifers were slaughtered on d 0, 40, 80, 120, 160, 200, 235, and 270 of gestation, and NP heifers were slaughtered on d 40, 120, 200, and 270 of the study. Intestinal and hepatic tissues were analyzed for protein, DNA, RNA concentrations (mg/g of fresh tissue), and *in vitro* oxygen use. For ileum, DNA, which provides an estimate of cell number per unit of tissue, revealed an interaction ($P = .09$) between pregnancy and day; PR and NP declined linearly with time but NP increased on d 270 ($P = .09$). For PR, hepatic DNA responded quadratically ($P = .01$), initially declining and then increasing as time progressed, whereas hepatic DNA of NP remained constant. For duodenum, the ratio of protein:DNA (Ptn:DNA), an estimate of cell size, increased linearly in PR ($P = .02$) and quadratically in NP ($P = .08$). Ileal Ptn:DNA showed a linear increase ($P = .01$) in PR, but NP was less (21.63 vs 17.73; $P = .04$) at d 120. Hepatic Ptn:DNA was not impacted by pregnancy or day. Energy use (kcal/day), calculated from in vitro oxygen use, of duodenum and jejunum increased linearly ($P \leq .02$) for both PR and NP. PR and NP ileal energy use increased linearly ($P \leq .01$), but PR was less throughout gestation ($P = .07$) than NP. The summation of duodenal, jejunal, and ileal tissue (small intestine; SI) energy use was less for PR compared with NP throughout gestation ($P = .08$). For the liver, PR and NP energy use increased linearly ($P = .01$ and .02), and NP was greater than PR at d 40 and 200 ($P = .07$ and .05). These data indicate that the SI and liver of PR expend energy differently than those of NP, at certain periods during gestation. This response can partially be explained by differences in growth and energy use of the liver and SI of PR and NP heifers.

Key Words: Pregnant heifers, Oxygen consumption, intestine

207 Effect of intravenous iron and folic acid on uterine protein secretion during early pregnancy. J. L. Vallet*, R. K. Christenson, H. G. Klemcke, and P. L. Pearson, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.*

The influence of increased substrate (iron, folic acid) on uteroferrin (UF) and folate binding protein (FBP) secretion was determined. White crossbred gilts were mated after at least one estrous cycle of normal length. Jugular catheters were inserted on d 9 of pregnancy, and from d 10 to d 14 of pregnancy, gilts received daily intravenous infusions of either (1) 20 mL .9% saline, (2) 1 mg alpha-tocopherol in 20 mL saline, (3) 100 mg Fe Citrate and 1 mg alpha-tocopherol in 20 mL saline or (4) 500 μg tetrahydrofolate and 1 mg alpha-tocopherol in 20 mL saline. The antioxidant alpha-tocopherol was included in the treatments because iron compounds are strong oxidizers and tetrahydrofolate is easily oxidized. On d 15, gilts were slaughtered and the reproductive tract was flushed with 20 mL .9% saline per uterine horn. Conceptuses recovered were evaluated for stage of development (somite stage). Uterine flushings were assayed for total protein, retinol binding protein (RBP), acid phosphatase (AP, a measure of UF), and FBP. Alpha-tocopherol treatment increased (P<.05) both total protein (284.3 ± 27.1 vs 185.4 ± 30.3 mg, respectively) and total RBP 17.8 ± 1.6 vs 12.6 ± 1.8 mg, respectively) compared to saline alone. Tetrahydrofolate treatment decreased (P=.05) total protein (203.2 ± 27.1 vs 284.3 ± 27.1 mg) and total AP (710.7 ± 74.4 vs 929.7 ± 74.4 μmole/Pi/min) compared to alpha-tocopherol treatment. No treatment differences were detected for somite stage of embryo or for total FBP. Uterine protein data were further analyzed using total protein as a covariate. No effect of any of the treatments on AP, RBP or FBP was detected. Thus, intravenous iron and tetrahydrofolate do not increase the amount of UF and FBP, respectively, in the uterine lumen on d 15 of pregnancy. These data suggest that the amount of UF and FBP secreted by the endometrium during pregnancy is relatively unaffected by substrate availability and instead is governed by local (e.g., intrauterine) control mechanisms.

Key Words: Endometrium, Uteroferrin, Folate binding protein

208 Effect of incubation temperature on in vitro maturation of pig oocytes: subsequent fertilization and development. L. R. Abeydeera*, W. H. Wang, R. S. Prather, and B. N. Day, *University of Missouri, Columbia, MO.*

In vivo, mature ovarian follicles of pigs are cooler than the stroma (35 vs 37-39°C) and suggests that low temperature may influence the meiotic progression and cytoplasmic maturation of oocytes (Hunter et al., Human Reprod, 1997; 12:95-100). Present study examined the effect of low temperature during pig oocyte culture on nuclear maturation, fertilization and subsequent development. In exp. 1, oocytes were cultured at 35 or 39°C for 44 h in a protein-free medium (Abeydeera et al,. Biol Reprod 1998; 58:1316-1320) containing EGF to examine the nuclear maturation. In exp. 2, oocytes were cultured at 35°C for 44 or 68 h to examine nuclear maturation. In exp. 3, oocytes matured for 44 or 68 h at 39°C and for 68 h at 35°C were co-incubated with spermatozoa for 5-6 h. Putative embryos were transferred into NCSU 23 medium+0.4% BSA. At 12 h after insemination, some oocytes were fixed to examine fertilization rate and the remaining oocytes were examined at 48 and 144 h for cleavage and blastocyst formation rate, respectively. Compared to 39°C, culture of oocytes at 35°C for 44 h reduced (p<0.05) the metaphase II (M II) rate (73 vs 11%). However, extension of culture time to 68 h at 35°C increased (p<0.05) the M II rate (7 vs 58%). In exp. 3, compared to other groups, fewer (p<0.05) oocytes reached M II stage when oocytes were cultured at 35°C for 68 h (69-79 vs 49%). However, extension of the culture period to 68 h at 39°C stimulated the spontaneous activation of oocytes (28%). No difference in cleavage rates were observed among different groups. Compared to oocytes matured for 44 h at 39°C (31%), the proportion of blastocysts obtained was low (p<0.05) for oocytes matured at 35 or 39°C for 68 h (13 and 3%, respectively). The results indicate that lower culture temperature can delay nuclear maturation of pig oocytes. However, extension of culture time can stimulate nuclear maturation and these oocytes are capable of fertilization and development to the blastocyst stage at moderate rates.

Key Words: Pig oocytes, Maturation, Temperature

209 Concentrations of milk components change dynamically throughout the early secretory period in Jersey cows. G. Bobe* and G. L. Lindberg, *Iowa State University, Ames, IA/USA*.

Our objective was to quantify the concentrations of milk fat, lactose, and individual milk proteins during the early secretory period in Jersey cows. Composite milk samples were collected from 21 Jersey cows of the Iowa State University Teaching herd between February and July at 0, 12, 24, 30, 38, 46, 54, 62, 80, and 88 hours postpartum, and at days 4, 5, 6, 8, 10, 14, 22, and 38 postpartum. The milk samples were analyzed for total fat, lactose, and protein concentrations by infrared, for total protein nitrogen, noncasein nitrogen, and nonprotein nitrogen concentrations by Kjeldahl analysis, and for α_{S1}-CN, β-CN, κ-CN, α_{S2}-CN, α-LA, and β-LG concentrations by reversed-phase HPLC. The data were analyzed using PROC MIXED in SAS. The statistical model included time postpartum, length of gestation, parity, milk yield, calving season, and the interactions of time postpartum with length of gestation, parity, milk yield, and calving season all as fixed effects, and cow and residual as random effects. The concentrations of all milk components were significantly affect by time postpartum ($P<0.01$). The concentrations of fat and lactose in milk were greatest at day 5 with 5.64 g/l and at day 38 postpartum with 5.00 g/l, respectively. The concentrations of all individual milk proteins were greatest immediately after parturition; in particular for β-LG with 13.05 g/l, and for whey proteins other than α-LA and β-LG with 54.34 g/l, and decreased exponentially till 40 h postpartum to 4.12 g/l for β-LG and to 8.45 g/l for whey proteins other than α-LA and β-LG. Colostrum provides the only source for nutrients and immunity in the neonatal calf, which makes the concentrations of milk components a limiting factor for the nutrition and immunity in the neonatal calf. We conclude from our observations that the high total protein concentration in colostrum influence the nutritional status of the suckling calf, and that whey proteins other than α-LA have important biological functions in the neonatal calf.

Key Words: Colostrum, Milk Proteins

210 Effects of oral administration of concentrated equine serum to newborn foals on immunoglobulin G levels. C.J. Hammer*, H.D. Tyler, and P.A. Miller, *Iowa State University, Ames, IA 50011*.

Thirteen newborn foals of Quarter Horse breeding were used to determine if oral administration of concentrated equine serum raises IgG levels in foals allowed to naturally suckle colostrum. Foals were alternately assigned either to receive 300 ml of an oral equine IgG product or to serve as a control. Foals receiving the IgG product were given 150 ml orally at 10 h and 12 h after birth. All foals were allowed to nurse from their dam *ad libitum*. Jugular blood samples were obtained at 10 h and 24 h post parturition for IgG determination. Colostrum samples from the dam were also obtained at 10 h post parturition. Serum samples were analyzed for IgG using a commercially available radial immunodiffusion kit. There was no significant difference in serum IgG levels from foals in the control or treatment group at 24 h of age (1488 mg/dl vs. 1596 mg/dl; $p>.34$). There was also no difference between control and treated foals in the rate of IgG absorption from 10 h and 24 h after birth ($p>.32$). In conclusion, oral administration of equine IgG at 10 h and 12 h to foals capable of ingesting quality colostrum does not significantly raise serum IgG levels.

Key Words: Foal, Immunoglobulin, Colostrum

211 Calving season, length of gestation, parity, and milk yield affect the composition of colostrum in lactating Jesey cows. G. Bobe* and G. L. Lindberg, *Iowa State University, Ames, IA/USA*.

The composition of milk from dairy cows varies more in the colostral period than in other periods of the lactation. The objective of this study was to determine factors that influence the variation of milk composition of Jersey cows, and, specifically, of the individual milk proteins during the colostral period. Composite milk samples were collected from 21 Jersey cows of the Iowa State University Teaching herd between February and July at 0, 12, 24, 30, 38, 46, 54, 62, 80, and 88 hours postpartum, and at days 4, 5, 6, 8, 10, 14, 22, and 38 postpartum. The milk samples were analyzed for total fat, lactose, and protein concentrations by infrared, for total protein nitrogen, noncasein nitrogen, and nonprotein nitrogen concentrations by Kjeldahl analysis, and for α_{S1}-CN, β-CN, κ-CN, α_{S2}-CN, α-LA, and β-LG concentrations by reversed-phase HPLC. The statistical model included time postpartum, calving season, length of gestation, parity, milk yield, and the interactions of time postpartum with calving season, length of gestation, parity, and milk yield all as fixed effects, and cow and residual as random effects. Calving season, length of gestation, parity, and milk yield had all significant interactions with time postpartum ($P<0.01$). Cows that calved between February and April had in comparison to cows that calved in May and June at 0 hours postpartum lower lactose concentrations (2.20 g/l vs 3.80 g/l) and greater total protein concentrations (19.02 g/l vs 12.60 g/l), in particular of whey proteins other than α-LA and β-LG (74.84 g/l vs 36.13 g/l). The maturation of colostrum to normal milk was slower in cows that calved before the predicted calving date than in cows that calved after the predicted calving date. Heifers had greater fat and lower total protein concentrations in colostrum than multiparous cows. Cows that had lower milk yields in the current lactation had greater lactose and total protein concentrations, in particular of whey proteins other than α-LA and β-LG, in colostrum than cows that had greater milk yields in the current lactations. We conclude that length of gestation, parity, milk yield, and calving season affect the composition of colostrum in lactating Jersey cows.

Key Words: Colostrum, Milk Proteins

212 Factors affecting timing of ovulation in weaned sows. C.J. Bracken*, W.R. Lamberson, M.C. Lucy, and T.J. Safranski, *University of Missouri, Columbia, MO, USA*.

The objective of this study was to determine factors affecting time of ovulation in sows after weaning. Transrectal ultrasound was used to measure follicular development at day 3 post weaning in 146 sows in a commercial herd. Images of both ovaries of each sow were recorded on videotape. The videotape was reviewed to determine the number and diameter of follicles present. 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 for 6 days. 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. Sows exhibiting estrus within 7 d post-weaning were designated on-time (OT) and sows exhibiting estrus after 7 d were designated late (LT). Parity (P), number of pigs weaned (WND), lactation length (LL), predominant follicle size (small, 3-4 mm; medium, 5-6 mm; or large, $\geq$ 7 mm), total d 3 follicular volume (FV) and body condition score (BCS) were fitted to models with the dependent variables interval from weaning to onset of estrus and interval from weaning to ovulation (WO). Onset of estrus averaged 6.80 d after weaning with a range of 4 to 17 d and a standard deviation of 3.36 d. The OT sows had a greater FV than LT sows (2012.41 ± 105.20 mm^3 vs. 1304.66 ± 190.31 mm^3; $P<.05$). Average WO was 178.22 h with a range of 104.5 to 408.0 h and a standard deviation of 63.71 h. The WO decreased with increasing P, LL, and FV ($P<.05$). There was a tendency for longer WO for very low BCS sows compared to better conditioned sows (BCS 1 = 215.13 ± 17.54 h vs. BCS 2 = 175.66 ± 11.01 h; BCS 3 = 194.98 ± 11.85 h; and BCS 4 = 175.97 ± 35.29 h; $P=.1047$). We conclude that parity, lactation length, total d 3 follicular volume, and body condition score may be important determinants of time of ovulation and useful inputs for models designed to predict the optimum time for insemination.

Key Words: ultrasound, ovulation, sows

213 Correlation of processing temperature to feeder calf performance and health. T.R. Falkner, J.S. Drouillard, G.L. Stokka, A.S. Flake, D.A. Blasi, and G.L. Kuhl, *Kansas State University, Manhattan, KS*.

The ability of rectal temperature taken at arrival processing to predict future health and performance of stressed beef calves was determined. Several data sets were analyzed and all revealed a processing temperature greater than 39.7 °C to be significantly associated ($p<.05$) with increased morbidity from bovine respiratory disease (BRD) and reduced animal performance, even when animals with elevated rectal temperatures received antibiotic therapy. Bull calves had higher average processing temperatures than steers (39.6 °C vs. 39.0 °C, $p<.05$), tended to have increased risk for BRD ($p<.10$), and numerically reduced 28-d

performance. Moderately stressed heifer calves rested overnight before processing in small groups were chosen for more detailed analysis. Data from 498 heifers (initial weight 225 kg) was stratified based on processing temperature groupings of Normal (<38.7 °C), Slight Elevation (38.7-39.2 °C), Moderate Elevation (39.3-39.7 °C), and Febrile (>39.7 °C). Morbidity and ADG (28-d and 56-d) for the groupings were determined.

There was a negative linear correlation (p<.05) between processing temperature and animal performance across the temperature groupings, independent of morbidity. Taken under the proper conditions, rectal temperature of stressed beef calves is useful to predict both BRD risk and future animal performance.

Processing temperature(°C)	**<38.7**	**38.7-39.2**	**39.3-39.7**	**>39.7**
Percent Morbidity	27.7^a	25.6^a	33.5^a	47.8^b
Deads included				
–28 day ADG, kg	1.85^a	1.49^b	1.46^b	0.35^c
–56 day ADG, kg	1.63^a	1.44^b	1.35^b	0.75^c
Deads excluded				
–28 day ADG, kg	1.85^a	1.59^b	1.46^c	1.40^c
–56 day ADG, kg	1.63^a	1.51^b	1.40^c	1.32^c

^{abc}means with no common superscript differ (p<.05)

Key Words: Cattle, Receiving, Temperature

RUMINANT NUTRITION AND FORAGES

214 Effects of implant strategy during the stocker period on feedlot performance of commercial crossbred steers.

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Seventy two crossbred steers (average BW 248 kg)were used to determine the effect of implant strategy during the stocker phase on feedlot performance. On January 14, 1998, steers were weighed, assigned to an implant regime, and allowed to graze dormant native range for 77 d at Bushland, TX. The implant treatments were no implant (CONTROL, n=36) and Revalor-G® (IMPLANTED, n=36). At the end of the grazing period, steers were relocated to the Texas Agricultural Experiment Station feedlot facility, weighed, dewormed with Ivomec ®, implanted with Sinovex-S®, and housed in 6 pens with pinpointer feeders to measure individual feed intakes. Steers were weighed at 28 d intervals throughout the finishing period. The steers were adapted to a finishing diet containing 80% steam rolled corn, 10% cottonseed hulls, and 10% protein-mineral supplement. Steers were reimplanted on d 83 of the finishing period with Revalor-S®. Steers were slaughtered on d 130 when 50% or more were estimated to have reached USDA Choice quality grade. Carcass traits were measured by trained evaluators. During the grazing period, ADG was higher (P=.0008) for the IMPLANTED than for the CONTROL steers (.57 vs .43 kg/d). During the feedlot phase, ADG was not different (P=.4848) between the IMPLANTED and CONTROL steers (1.90 vs 1.94 kg/d). Average daily feed intake was not different (P=.3823) between the IMPLANTED and the CONTROL steers (12.1 vs 11.8 kg/d). Feed to gain ratio tended (P=.1037) to be lower for the CONTROL steers (6.15) than for the IMPLANTED steers (6.39). Hot carcass weight (367 kg), marbling score (small 10), USDA quality grade (Choice-), backfat thickness (14.48 mm), ribeye area (88.23 cm^2), KPH (2.05), and USDA yield grade (3.03) were not different (P=.2963) between the IMPLANTED and the CONTROL steers. These results suggest that cattle gaining approximately .5 kg/d during the stocker phase can be implanted without affecting feedlot performance or carcass quality.

Key Words: Steers, Implant, Feedlot performance

215 Energy value of field peas (*Pisum sativum*) in lamb finishing diets.

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One hundred lambs were allotted to 20 pens in a randomized complete block design to determine the energy value of field peas (*Pisum sativum*) and their effect on feedlot performance and carcass characteristics. Four diets were fed where peas replaced corn at 0, 15, 30, or 45% of the diet. The diet contained 75% dry rolled corn or peas, 10% alfalfa hay, 5% concentrated separator by-product, and 10% supplement. Diets were formulated to contain a minimum of 15% CP, .7% Ca, .36% P, 1.22% K, 1.74 Ca:P and 28 mg lasolacid/kg. Diets also contained .2% blood meal and .8% feather meal to ensure that metabolizable protein did not limit gain. Lambs were blocked by weight and sex and allotted randomly to one of four treatments (5 pens/treatment). Initial and final weights were an average of two consecutive day weights. Performance measurements (n = 5) included ADG, DMI, and feed efficiency (G/F). There was a cubic response to DMI ($P = .02$). Ram lambs (3 pens/treatment) were slaughtered on d 89. Carcass characteristics (n = 3) included hot carcass weight (HCW), leg score, conformation score, flank streaking, marbling, color score, ribeye area, fat thickness, body wall thickness, yield grade, and dressing percentage. There was a quadratic response to flank streaking ($P = .10$), all other characteristics were not affected by treatment ($P > .18$). Based on lamb performance, there was a linear increase ($P = .10$) in dietary NE_m and NE_g. Calculated NE_m and NE_g of peas were 2.82 and 2.12 Mcal/kg, respectively. Field peas have an NE_g 24% greater than corn when fed to feedlot lambs.

	%	Peas	(DM	basis)		Contrast		
Item	0	15	30	45	SEM	Lin	Quad	Cub
In Wt,kg	33.5	34.2	32.8	35.0	1.3	.61	.56	.32
Fnl Wt, kg	61.3	64.3	62.7	65.6	1.6	.14	.99	.24
ADG, kg/d	.31	.34	.34	.35	.02	.25	.63	.65
DMI, kg/d	1.59	1.66	1.55	1.62	.03	.97	.99	.02
G/F	.197	.205	.218	.213	.01	.22	.52	.63
HCW, kg	32.2	32.9	31.4	34.3	1.4	.47	.44	.32
NE_m,Mcal/kg	2.08	2.16	2.22	2.25	.07	.10	.73	.95
NE_g,Mcal/kg	1.41	1.48	1.54	1.56	.06	.10	.69	.90

Key Words: Field pea, Finishing, Lamb

216 Effects of ruminally protected choline and dietary fat on blood metabolites of finishing heifers.

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On d 90 of a 120-d finishing study, blood was collected from 318 finishing heifers that were being utilized to study performance effects of dietary additions of ruminally protected choline and tallow. Heifers were blocked according to previous nutritional regimen (full-fed or ad-libitum fed) and allotted to one of 12 treatments. Pens contained 11 to 15 heifers each. Two pens, one within each block, were assigned to each treatment. Heifers were fed a finishing diet based on steam-flaked and dry-rolled corn (12.5% CP, 8% alfalfa on DM basis). Treatments were arranged as a 3 x 4 factorial, with the factors being three levels of added tallow (0, 2, or 4%) and four levels of encapsulated choline (0, 20, 40 or 60 g/d product, estimated to supply 0, 5, 10, or 15 g/d available choline; Balchem Corp., Slate Hill, NY). Blood was collected via jugular vein puncture at 2 h post-feeding. Urea and insulin levels were not significantly affected by either tallow or choline supplementation. Supplementation of tallow led to linear increases in NEFA (P=.11), cholesterol (P<.01), triglyceride (P<.05), and total amino acid (P<.05) concentrations. Choline supplementation led to quadratic responses for triglycerides (P=.15) and total amino acids (P=.08). Choline at either 20 or 40 g/d increased triglycerides and total amino acids, but 60 g/d choline decreased concentrations of both. Glucose levels tended to decrease (linear, P=.14) with addition of choline. A fat by choline interaction (P<.05) occurred for total amino acids. Total amino acid levels increased with choline addition when fat was not included in the diet but decreased in response to choline when fat was added at 4%. These data illustrate that supplementation with choline or tallow can influence blood metabolites related to energy metabolism.

Key Words: Cattle, Choline, Fat

217 Performance and carcass characteristics of steers on programmed gain finishing systems.

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Two experiments evaluated programmed gain finishing systems on performance and carcass characteristics in finishing steers. In Exp. 1, 160 steer calves (297 kg) were blocked by BW and randomly assigned to 4 treatments; ad libitum access to feed (Trt 1), programmed gain of 1.27

kg/d for 70 d (Trt 2), programmed gain of 1.13 kg/d for 35 d and 1.36 kg/d for 35 d (Trt 3), or programmed gain of 1.13 kg/d for 50 d and 1.36 kg/d for 50 d (Trt 4). The diet consisted of 35% wet corn gluten feed (WCGF), 32.1% dry-rolled corn (DRC), 21.4% high-moisture corn, 7.5% alfalfa hay, and 4% supplement. In Exp. 2, 245 yearling steers (394 kg) were blocked by BW and randomly assigned to 5 treatments; ad libitum access to feed (Trt 1), programmed gain of 1.09 kg/d for 21 (Trt 2) or 42 d (Trt 3), or programmed gain of 1.27 kg/d for 21 (Trt 4) or 42 d (Trt 5). The diet consisted of 49% DRC, 40% WCGF, 8% corn silage, and 3% supplement. For Exp. 1 and 2, intakes required to achieve the programmed rate of gain were calculated using the NRC (1996) computer model and were adjusted every 14 (Exp. 1) or 7 d (Exp. 2). Following the programmed gain phase, steers were allowed ad libitum access to feed until slaughter. In Exp. 1, daily gain was reduced ($P<.05$) in all programmed gain treatments compared with Trt 1. Feed efficiency and carcass traits were similar among all treatments. Steers on Trt 1 were fed for 154 d and steers on Trt's 2, 3, and 4 for 161 d. In Exp. 2, feed efficiency was similar among treatments. Steers on Trt 3 gained slower, had lighter carcasses, and less 12th rib fat compared with other treatments ($P<.10$). Performance and carcass traits were similar among other treatments. Programming gain reduced the total amount of feed consumed in both Exp. 1 ($P<.05$) and Exp. 2 ($P<.10$). Lack of a significant feed efficiency response and numerical reductions in carcass weight precluded any economical advantage from these programmed feeding systems.

Key Words: Beef Cattle, Restricted Feeding, Finishing

218 Influence of pressed beet pulp and desugared molasses on feedlot performance of beef steers.

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One hundred and forty-four crossbred steers (282 ± 23 kg BW) were used to evaluate pressed beet pulp (PBP) and concentrated separator byproduct (CSB; desugared molasses), in growing and finishing diets. A randomized complete block design was used in a 3 × 2 factorial arrangement (PBP and CSB). Grower phase control diet contained 31.5% corn silage, 10% alfalfa hay, 49.5% corn, and 9% supplement (DM basis). PBP replaced 0, 20, or 40% corn and CSB replaced 10% corn and urea (DM basis). Steers were blocked by weight and allotted randomly to treatment. The growing phase lasted 84 d. Initial and final weights were an average of 2-d weights following a 3-d restricted feeding period (1.75% of BW). Following the growing trial, steers were weighed (415 ± 32 kg), re-randomized, and allotted to finisher diets. Finishing control diet included 45% corn, 40% high moisture corn (HMC), 5% brome hay, 5% PBP, and 5% supplement. Experimental design was similar to the growing phase. PBP replaced 5, 12.5, or 20% corn and CSB replaced 10% HMC and supplement (DM basis). Final weights were based on hot carcass weights (62% dress). Steers were slaughtered on d 83 and 98. PBP in growing diets linearly decreased DMI and ADG ($P < .001$). PBP in finishing diets linearly decreased ADG ($P < .001$) and quadratically decreased DMI ($P = .10$). CSB increased DMI in growing and finishing phases($P < .005$). Ration NE_g decreased ($P < .01$) in the growing phase. There was a P × C interaction in the growing phase for NE_g and ADG. Growing phase NE_g of PBP was 94.2% of corn and finishing phase was 81.5% of corn.

Item		%	PBP	:CSB				Contrast		
Growing	0:0	20:0	40:0	0:10	20:10	40:10	SEM	PBP	CSB	P x C
DMI, kg/d	9.77	8.73	8.00	10.23	9.36	8.55	.04	<.001	.003	.86
ADG, kg/d	1.82	1.54	1.42	1.67	1.60	1.45	.18	<.001	.56	.05
NE_g, Mcal/kg	1.34	1.30	1.32	1.19	1.30	1.24	.03	.43	.006	.05
Finishing	5:0	12.5:0	20:0	5:10	12.5:10	20:10				
DMI, kg/d	11.0	11.0	10.3	11.6	11.9	11.1	.23	.01	.002	.88
ADG, kg/d	1.77	1.67	1.51	1.76	1.71	1.50	.06	<.001	.41	.91
NE_g, Mcal/kg	1.53	1.50	1.47	1.51	1.50	1.36	.05	.08	.28	.41

Key Words: Pressed beet pulp, Desugared molasses, Cattle

219 Comparison of methods for calculating energy values from feed analyses.

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Energy (TDN) values for feeds often are calculated from ADF, e.g., (1) TDN=87.84 -7*ADF and NE_{lac}= 1.996-0.0126*ADF which equates to (2) TDN= 45.55 -0.514*ADF. Published equations (3 & 4) from Ohio State in 1984 (Conrad et al., J. Dairy Sci. 67:427) and 1997 (Weiss, Silage:Field to Feedbunk Conference, Hershey, PA) sum the digested components individually and thus respond to differences in non-fibrous feed components. To test their validity, TDN values calculated using these equations were compared with TDN values for 113 feeds (all forages plus corn grain) listed in NRC tables for Beef (1996) and Dairy (1989) cattle. Regression of calculated values against NRC values for equations 1, 2, 3, and 4 revealed intercepts of 28.6, 42.8, 16.0, and 8.7, all being greater (P<.02) than 0, with slopes of .57, .42, .66, and .83. Higher intercepts and lower slopes indicate that equations 1, 2, and 3 provide less robust estimates of TDN. To detect potential bias, TDN differences between calculated and tabular values for individual feeds were regressed against nutrient composition of feeds. TDN values for feeds richer in fat were underestimated (P<.002) by 1.2% for every 1% added fat by equations 1 and 2; TDN of feeds richer in lignin were overestimated by equations 1 and 2 but underestimated by equations 3 and 4. Equations 3 and 4 underestimated TDN of higher protein feeds, possibly due to an extra-caloric effect of protein. Of these, equation 4, as modified below, was the most precise: TDN=0.98*(100-NDF-CP-ASH-FAT)+(0.984-0.0016NDF)*CP +2.7*(EE-1)+0.75*(NDF-LIGNIN)*(1-(LIGNIN/NDF)$\hat{0}$.667)-7. This equation includes adjustments for higher acid detergent insoluble N of forages than grains, higher gross and net energy of triglycerides (ether extract minus 1 for pigments and sterols), and lignification of fiber. Net energy values for beef can be calculated from ME (ME=4.409*TDN*.82) and NRC (1996) relationships (NE_m=1.37*ME -0.138*ME$\hat{2}$ -0.0105*ME$\hat{3}$ -1.12; NE_g=1.42*ME -0.174*ME$\hat{2}$ +0.0122*ME$\hat{3}$ -1.65) and for dairy cattle fed at 3X maintenance (NE_{lac}=0.0245*TDN-0.12).

Key Words: Feed composition, Energy, TDN

220 Effects of virginiamycin or monensin and tylosin on ruminal fermentation characteristics in steers fed diets based on dry-rolled corn with or without wet corn gluten feed.

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Six ruminally cannulated Holstein steers (BW 345 kg) were used in a 6 x 6 Latin square design to evaluate a 2 x 3 factorial arrangement of dietary and antibiotic treatments on ruminal fermentation. 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 daily, at 12 h intervals, approximately 2.4% of empty BW. Each period consisted of an 18 d adaptation followed by 2 d of ruminal fluid collections at 0, 2, 4, 6, 8, and 10 h following the morning feeding. Ruminal samples were analyzed for pH, fermentation products (lactate, ammonia, VFA), and ciliated protozoal counts. Ruminal pH was lower (P < .05) in steers fed CORN+SBM than steers fed CORN+CGF (5.77 vs 5.99). CORN+SBM fed steers had higher (P < .10) ruminal concentrations of total VFA (111.2 vs 96.3 mM), propionate (33.4 vs 26.0 mM), butyrate (18.0 vs 13.8 mM), and valerate (2.1 vs 1.8 mM). The acetate:propionate ratio was lower in steers fed CORN+SBM (P < .05) than in steers fed CORN+CGF (1.8 vs 2.2). Lactate and ammonia concentrations were unaffected by diet type. Inclusion of V or MT had no effect on ruminal pH, VFA, lactate, ammonia, and ciliates concentrations. V reduced (P < .01) concentration and molar proportion of isovalerate compared to MT and C. Steers fed CGF had higher total ciliate counts than steers fed CORN+SBM ($8.6x10^5$ vs $.61x10^5$/g; P < .01). The increase in total counts was due to greater *Entodinium sp. Isotricha sp* and *Polyplastron sp* were higher in steers fed CORN+SBM than in steers fed CORN+CGF (281 vs 32/g and 13 vs 2/g, respectively; P < .05). Wet corn gluten feed appeared to have a stabilizing effect on ruminal fermentation as evidenced by higher ruminal pH, lower VFA concentrations, and higher ciliated protozoal populations.

Key Words: Cattle, Antibiotic, Ruminal fermentation

221 Influences of delaying initial implant or re-implant date on production characteristics and carcass traits of steers fed high grain content diets.

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Performance and carcass characteristics were evaluated when an initial low dosage estradiol- trenbolone acetate implant used as part of a re-implant program (revalor-g d1 and revalor-s d35, RI35; revalor-g d1 and revalor-s d70, RI70) was compared to either an initial full dosage E2-TBA implant (revalor-s d1, D1) or a delayed use of revalor-s (revalor-s d35, DI35; revalor-s d70, DI70). Steers (n=480) approximately 10 months of age were sorted into light (307 1.8 kg) and heavy (332 2.5 kg) groups and allotted to 24 pens of 10 steers. Adaptation to a 92% concentrate diet (1.37 Mcal NEg/kg) occurred over 24 d of the 144 d trial. Treatment differences were tested by orthogonal contrasts of: no implant vs implants (No vs I); delayed implant vs re-implant (DI35, DI70 vs RI35, RI70); implant d 35 vs d 70 (DI35, RI35 vs DI70, RI70); delayed implant vs initial revalor-s (DI35, DI70 vs D1); re-implant vs initial revalor-s (RI35, RI70 vs D1). During 1 to 35 d, ADG and gain efficiency (G/F) were greater ($P < .02$) for steers that had been implanted RI35,RI70 (2.05 kg) and D1 (2.04 kg) than not implanted DI35,DI70 (1.86 kg). During 36 to 70 d, ADG of implanted steers was greater, No vs I (1.22 vs 1.37 kg; $P < .04$) and DI35, RI35 vs DI70, RI70 (1.50 vs 1.25 kg; $P < .01$). Steers given revalor-s improved G/F for d 35 vs d 70 (.152 vs .124; $P < .01$). Steers implanted on d 70 had increased ADG during 71 to 105 d ($P < .03$). Among implant treatments DMI was lower ($P < .05$) for delayed strategies during most interim periods. Cumulative ADG was increased by implanting (No vs I, 1.28 vs 1.49; $P < .01$) and by implanting on d 1 (DI35,DI70 vs RI35,RI70; 1.45 vs 1.52; $P < .01$). Cumulative G/F did not differ ($P > .10$) among implant treatments. Differences were not observed in marbling score (5.38 .092) or yield grade (3.32 .058). There were no differences ($P > .15$) in distribution of population of Choice (72%), Select (28%) or tough carcasses. Tenderness measured in 12th rib slices was slightly higher when revalor-s was used on d 1 ($P < .05$). Performance was slightly improved by using a RI strategy compared to either DI or D1 strategy. Implanting was not detrimental to any carcass traits in this study. No distinct advantages were clear for a specific implant strategy under these production constraints.

Key Words: Implants, Beef, Feedlot

222 Effects of inoculation with either *Propionibacterium* strain P-63 alone or combined with *Lactobacillus acidophilus* strain LA53545 on performance of feedlot cattle.

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Effects of microbial inoculants on performance during adaptation to a feedlot diet and throughout a 120-d feeding period were tested using 75 newly weaned calves (317 kg). Five calves in each of five pens received either 1) no inoculum, 2) *Propionibacterium* strain P-63 at a daily rate of 3.0 X 10^{11} cfu/hd and 3) *Propionibacterium* strain P-63 (1.0 X 10^{9} cfu/hd daily) plus *Lactobacillus acidophilus* strain 53545 (1.0 X 10^{8} cfu/hd daily). Inoculants were thoroughly mixed into the ration daily. During a 14-d pre-trial receiving period, calves were fed a 50% concentrate diet plus their allotted inoculum. On d 0, feed was withheld for 24 hr; on d 1 and thereafter, calves were given ad libitum access to a 90% concentrate ionophore- and antibiotic-free diet. To increase the potential for acidosis, cracked wheat replaced 75% of the ground corn in the diet from d 1 to d 10. Calves were monitored for overt signs of acidosis; no cases warranted treatment. During these 10 days, inoculation did not alter DMI, but both ADG and feed efficiency were improved ($P < .04$; $P < .02$) for calves receiving the combination inoculum as compared to calves receiving P-63 alone or no inoculum (1.63 vs 1.11 and .93 kg; 4.5 vs 7.3 and 8.2). Subsequently, this weight gain advantage diminished, but the feed efficiency advantage for calves receiving the combination inoculum remained superior ($P < .04$) through day 27, was detected again from day 84 to 119, and for the total 120-d trial (4.97 vs 5.32 and 5.17, carcass weight basis). Carcass characteristics were not altered though calves fed the combination inoculant had numerically fewer liver abscesses at harvest (0 vs 8% and 8%). Benefits in ADG during adaptation to the high concentrate diet and in feed efficiency for the total trial suggest that the combination inoculant (*Propionibacterium* plus *Lactobacillus acidophilus*) reduced the incidence or severity of acidosis.

Key Words: Acidosis, *Propionibacterium*, *Lactobacillus*

223 Effect of Interseeding Legumes into Endophyte-Infected Tall Fescue Pastures on Forage Production and Steer Performance.

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Grazing and subsequent finishing performance of steers that grazed high-endophyte tall fescue pastures interseeded with lespedeza, ladino clover, or red clover were evaluated during 1995, 1996, and 1997. Initial weights of steers grazed in 1995, 1996, and 1997 were 314.4, 238.3, and 234.5 kg, respectively. Nine 2.02-ha established 'Kentucky 31' tall fescue pastures with more than 65% endophyte infection were used in a randomized complete block design containing three replications per legume treatment. Pastures were seeded with legumes each year in late February or early March. Five mixed-breed steers were randomly allotted to each pasture on March 31, 1995, April 24, 1996, and April 1,1997 and grazed continuously for 200, 168, and 220 days, respectively. All steers were fed .91 kg of ground grain sorghum per head daily during the grazing phase. At the end of the grazing phase, steers were transported to a feedlot facility and fed a finishing diet for 164, 139, and 154 days in 1995, 1996, and 1997, respectively. Legume cover, available forage dry matter, grazing steer performance, subsequent feedlot performance, and carcass parameters were measured. Forage availability was similar between legume treatments. Legume coverage was highest for lespedeza in 1995 and 1996 and ladino clover in 1997. Year and legume treatment had significant ($P<.01$) effects on grazing gain. There was also a significant ($P<.01$) year by treatment interaction on gain during the grazing phase. Gains by steers grazing lespedeza, ladino clover, and red clover treatments were .54, .53, and .48 kg/day in 1995; .63, .63, and .56 kg/day in 1996; and .62, .85, and .66 kg/day in 1997. Grazing gains between legume treatments were not significantly ($P>.05$) different during 1995 and 1996. In 1997, steers grazing ladino clover pastures gained 37.1% more ($P<.01$) and 28.8% more ($P<.01$), respectively, than those grazing lespedeza and red clover pastures. Gains by steers grazing red clover and lespedeza pastures were not significantly ($P>.05$) different. Legume treatment during the grazing phase had no significant ($P>.05$) effect on finishing performance or carcass parameters. Overall gains from the beginning of the grazing phase through the end of the finishing phase were similar between legume treatments.

Key Words: Tall fescue, Legumes, Grazing

224 Feeding raw soybeans in finishing cattle diets.

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Two feeding trials were conducted to determine the value of raw soybeans in finishing cattle diets. A completely random design was used with pen as the experimental unit. Diets in each feeding trial were formulated to be iso-nitrogenous and -ether extract, including a minimum of .6% urea and 2.5% beef tallow (DM basis). In Trial 1, 220 crossbred steers (pens = 22; initial BW = 372 kg 2.4) were fed for 139 d. The 95% concentrate diets were supplemented with urea and beef tallow (UREA); soybean meal and beef tallow (SBM); or dry rolled soybeans and beef tallow (DRB). Daily BW gains (1.4 kg .03) were similar among treatments ($P > .22$) but there was a tendency for UREA fed steers to grow slightly slower than steers fed the other treatments. As the days on feed progressed there was a tendency for DMI of UREA fed steers to be less than SBM or DRB fed steers. Over the entire feeding period, the UREA fed steers consumed about .4 kg/d less ($P < .11$) than SBM or DRB fed steers (DM basis). No differences in gain to feed ratios ($P = .84$), hot carcass weight ($P > .21$), back fat ($P > .76$), and marbling scores ($P > .66$) were noted. In Trial 2, 242 crossbred heifers (pens = 22; initial BW = 314 kg 2.6) were fed for 164 d. Treatments were similar to Trial 1 with differing basal diet starch sources. ADG was similar between SBM and DRB treatments (1.4 kg/d .03) and both were greater ($P > .11$) than UREA (1.3 kg/d .04). Heifers fed SBM and DRB treatments had greater ($P < .06$) daily DMI (8.1 kg/d .11) than the UREA fed heifers (7.7 kg/d .12). Gain to feed ratios were similar for all treatments (.17; SEM = .004). No difference in hot carcass weight ($P > .12$) and back fat ($P > .87$) were noted. UREA fed heifers had lower marbling scores ($P < .01$) and percent internal carcass fat ($P < .07$) than SBM and

DRB fed heifers. Our data indicated that dry rolled soybeans can be successfully included in finishing cattle diets. In cattle finishing diets, the value ($/kg) of raw soybeans as a feed ingredient is (.8 x cost of 44% SBM, $/kg) + (.2 x cost of fancy bleachable tallow, $/kg).

Key Words: Beef cattle, Soybeans, Feedlot

225 Soybean solubles for finishing cattle. J. S. Drouillard*, C. K. Schoenholz, R. D. Hunter, and T. A. Nutsch, *Kansas State University, Manhattan*.

Eighty yearling Angus x Hereford steers (327 kg initial BW) were fed in individual pens for 107 d to compare soybean meal (SBM; 7.85% N) and soybean solubles (SOL; 3.34% N, 62.1% carbohydrate) as supplements for finishing rations. Steers were stratified by weight and allotted to each of 10 treatments, with eight replicates per group. Basal diets contained 7% alfalfa hay, 1% urea, 33 g/T Rumensin®,11 g/T Tylan®, and either steam-flaked corn, or a 70:30 mixture of high-moisture and dry-rolled corn. Diets were supplemented with 0, 2, or 4% (dry basis) of either SBM or SOL, and were fed once daily ad libitum. Orts were collected, dried, and weighed weekly. Steers received a single Revalor-S® implant at the beginning of the experiment. With respect to gain efficiency, regression coefficients revealed a two- to three-fold greater response to SBM and SOL when included in steam-flaked corn diets as compared to high-moisture/dry rolled corn diets. Carcass weights increased (P=.07), ADG increased (P<.05), and efficiency was improved (P<.01) in response to SBM supplementation in flaked diets, but not in high-moisture/dry-rolled diets. Dry matter intake was higher (P<.05) when SOL was added to high-moisture/dry-rolled corn diets. Comparatively, responses to SBM and SOL were in proportion to the amount of protein supplied by each supplement. Carcass quality traits were largely unaffected by grain processing method or supplement type and level. Soy solubles can be utilized effectively as a feed ingredient in beef cattle finishing rations.

Key Words: Soybean Solubles, Cattle, Finishing

226 Effects of supplementing limit-fed, wheat middling-based diets with either soybean meal or non-enzymatically browned soybean meal on growing steer performance. C. M. Coetzer*, J. S. Drouillard, E. Coetzer, and R. H. Wessels, *Kansas State University, Manhattan*.

Seventy two individually fed Angus x Hereford steers (300 kg) were used to evaluate the effects of supplementing limit-fed, wheat middling-based diets with either soybean meal (SBM) or non-enzymatically browned soybean meal (NEBSBM) on growing steer performance. Steers were stratified by weight and randomly allotted, within strata, to one of six treatments. The CP content of a wheat middling-based control diet (16.7 CP%) was increased by 1.9 and 3.8 percentage units using SBM or NEBSBM. A limit-fed, rolled corn-based diet (16.7 CP%) also was included. Steers were fed once daily for 70 days at 2.25% of BW. Data were analyzed by regression using supplementation level as a continuous variable, nested within supplement source (SBM or NEBSBM). Average daily gain and efficiency increased linearly with increasing level of NEBSBM (P<0.05; ADG=1.13 + 0.048(increase in %CP); gain to feed=0.16 + 0.006(increase in %CP)). Dry matter intake, ADG and efficiency did not change with increasing level of SBM. Steers fed the wheat middling diets had lower ADG and efficiency compared to those fed the corn control diet. Supplementation with NEBSBM, but not SBM, improved performance of growing steers fed restricted amounts of wheat middling-based diets. These data suggest that UIP may be first limiting in high-concentrate, limit-fed growing diets composed of wheat middlings.

Key Words: Cattle, Wheat Middlings, Undegraded Intake Protein

227 Impact of feedlot tenure on live weight gain, carcass measures, and economic value of steers. J.T. Wagner*, D.R. Gill, and F.N. Owens, *Oklahoma State University*.

Large frame, mixed breed steers (n=467, 360 kg) were allotted randomly to 24 feedlot pens; six pens were harvested after 117, 131, 145, and 159 days on feed. All steers were implanted on d 0 with zeranol; steers were reimplanted with 120 mg of trenbolone actetate and 24 mg of estradiol 90 d prior to harvest date. Live average daily gain and feed to gain ratios were not significantly different between harvest dates. Carcass weight, dressing percent, and KPH increased linearly (P<.01) and quadratically (P<.01) with days fed. Overall maturity scores and marbling scores increased linearly (P<.01) with days fed; percentage of carcasses qualifying for low and premium choice increased linearly (P<.05 and P<.01) over time. Calculated yield grade (YG) increased linearly (P<.01) and percentage YG 4.5 or greater increased linearly (P<.01) and quadratically (P<.01) with days fed. Linear, quadratic, and cubic (P<01) time effects on ribeye area were detected. To estimate economic return, cattle were priced on a live and on a grid basis. Discounts for YG were not applied until calculated YG reached 4.5 to account for the meat grader's bias. For the four harvest dates, YG of 4 or 5 were assigned by USDA meat graders to 1, 0, 5, and 4 carcasses while calculated YG exceeded 4.5 for 1, 3, 8, and 20. Cattle were priced on a live and grid basis and economic returns were estimated for the various feeding periods. When marketed on a live weight basis, net return tended to increase (P=.10) in a linear trend as days fed increased. When using the grid for marketing, net return showed a linear increase (P<.01) with days fed. Longer feeding times were rewarded more by grid or carcass pricing than by live weight pricing due to the increased dressing percentage and a favorable balance between quality grade premiums and yield grade discounts.

Key Words: Steers, Carcass Characteristics, Serial Harvest

228 Evaluation of corn steep liquor as a replacement for corn and supplement in a cattle finishing diet. A. Trenkle*, *Iowa State University, Ames, Iowa U.S.*.

Coproducts of corn processing industries have been shown to have high value as feeds for cattle. Corn gluten feed contains corn bran with corn steep liquor. The purpose of this experiment was to evaluate as a feed for cattle a combination of corn steep liquor and stillage from a wet corn milling and ethanol plant. Thirty-six crossbred yearling steers with an average weight of 380 kg were allotted at random to six pens. Three pens were assigned at random to a control or steep diet in a 143-day study. The control and steep diets contained on a dry basis 79.0 & 75.4% corn, 12.0 & 12.0% alfalfa pellets, 5.0 & 1.0% soybean meal, 0.70 & 0.33% urea, 2.0 & 0% molasses, and 0 & 10.0% steep, respectively. The steep was delivered in several batches and contained on average 48% dry matter and 33.5% crude protein (dry basis). The following results were observed: 1.41 & 1.51 kg/d gain, 9.4 & 9.4 kg feed DM intake/d, 6.62 & 6.23 feed/gain, 363 & 363 kg hot carcass weight, 6.8 & 5.6 cm fat cover (P < .10), 94.2 & 95.5 cm2 ribeye area, 78 & 65% USDA Choice, and 431 & 369 marbling score (400 = small0, P < .05). The results indicate that steep liquor has a high value as a feed for finishing cattle when fed at 10% of the diet dry matter. Most of the value of the steep was as an alternative source of energy and protein.

Key Words: Cattle, Steep liquor, Feed

229 The effects of dietary cation-anion balance and varying calcium concentrations in the diet on the serum calcium of feedlot steers. M. J. Vahlenkamp*, A. G. Estefan, E. M. Whitley, and L. W. Greene, *Texas Agricultural Experiment Station, Amarillo, TX*..

Previous research shows that high cellular Ca levels at slaughter increase tenderness. A study was conducted with 12 crossbred steers to develop feeding strategies to increase circulating Ca levels. Steers were fed in a single pen equipped with Calen gate feeders and used in a 4 X 4 Latin square design experiment. Dietary treatments were two dietary cation-anion (DCAB) diets (-30 and +5 meq/100g) and two Ca feeding strategies in a 2 X 2 factorial arrangement. The Ca feeding strategies were .45 % Ca throughout each 28 d period or .45 % Ca for 7 d, followed by .1 % Ca for 14 d and then .9 % Ca for 7 d during each period. The diet contained steam rolled corn (75.9 %), cottonseed hulls (15.4 %), and a protein-mineral supplement (8.7 %). Serum samples were taken on d 1, 14, 21, 22, 24, 26, and 28, and ruminal fluid pH was collected on d 14 and 28 for each of the last three feeding periods. Steers fed -30 DCAB diets had a lower ruminal pH on d 28 (P<.05) when compared to steers fed +5 DCAB (5.6347 vs 6.0229, respectively), and tended to have lower ruminal fluid pH on d 14 (P= .059). In addition, average daily feed intake was 22.9 % greater on d 1-7, 38.5 % greater on d 8-21, and 34.2 % greater on d 22-28 (P<.05) for steers fed the +5 DCAB diet compared to the 30 DCAB diet. Serum P was greater on d 14 (P<.05) for steers fed the -30 DCAB compared to those fed the +5 diet (10.256

vs 8.712 mg/dl). Serum Ca was greater (P<.05) on d 28 for steers fed +5 DCAB compared to those fed 30 DCAB (9.216 vs 7.205 mg/dl). Steers fed the alternating levels of Ca had a higher serum Ca (8.866 vs 7.555 mg/dl) on d 28 compared to those fed .45 % Ca throughout the period. The results of this study indicate that feeding a 30 DCAB may alter the acid-base balance of the animal causing subclinical acidosis. The findings also indicate that alternating Ca levels over the last 28 d of the finishing period may help to increase the serum Ca levels of feedlot steers.

Key Words: Tenderness, Calcium, Dietary Cation-Anion Balance

230 Effect of different Ca:P ratios in lamb diets on absorption and retention of phosphorus.

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Rations containing wide Ca:P ratios have frequently reported to reduce amount of P absorbed. However, there are also reports, in which no adverse effects have been found. To find out whether diets with wide Ca:P ratios affect P absorption and retention in lambs, an experiment was conducted. Fifteen lambs (avg wt 30 kg) were assigned randomly to one of three treatments, differing only in the Ca:P ratio: T 1, 2.5:1; T 2, 5.6:1; and T 3, 9:1. Lambs from T 1 were individually fed for 14 d with .908 kg of a diet consisting of chopped switch grass hay (.22% P, .57% Ca, and 10.9% CP), and lambs from T 2 and T 3 were offered the same diet, plus supplementation of limestone in order to reach the respective Ca:P ratios. Lambs were placed in metabolic creates, fitted with fecal collecting bags, and total fecal and urine collections were made for 3 d. Samples were processed for DM, P, Ca, and in vivo dry matter digestibility and P retention were calculated. Data were analyzed statistically by analyses of variance and orthogonal contrasts. Urinary excretion of P was insignificant in all treatments (5.5, 6, and 6.1mg/d.lamb for T 1, T 2, and T 3, respectively). As a result apparent absorption of P and P retention were similar. Amount of P retained in the body was not different (P > .05) among treatments (T 1, 13.5; T 2, 18.3; and T 3, 18.7 mg/d.kg BW). However, Ca retention increased (P = .0001) with increasing Ca intake (T 1, 38; T 2, 76; and T 3, 146 mg/d.kg BW). Feeding growing lambs with diets containing Ca:P ratios of 5.6 and 9 had no negative effects on absorption and retention of P, on the contrary, increases in Ca retention and a tendency to increase P absorption were found, presumably due to the great demand of Ca and P of lambs, along with a low P and Ca intake in lambs of T 1. However, the coefficient of dry matter digestibility was lower (P = .007) in lambs from T 3 (48.4%) than lambs from T 1 and T 2 (53.5 and 52.0%).

Key Words: Lambs, Ca:P ratios, Phosphorus

231 Effects of the inclusion of different levels of iron in lamb diets on absorption and retention of phosphorus.

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It has been reported that diets containing high levels of iron (Fe) cause a reduction in phosphorus (P) absorption in cattle. However, most of the studies carried out in Fe-P interaction, have used Fe concentrations that are well above those usually found in forages. An experiment was conducted to evaluate the effects of high Fe diets on the absorption and retention of P in lambs. Fifteen lambs (avg wt 33 kg) were assigned randomly to three treatments, differing only in the concentration of Fe in diet; T 1 (100 ppm), T 2 (350 ppm) and T 3 (600 ppm). Diet of T 1 consisted of chopped switchgrass hay, and diets of T 2 and T 3, the same grass, plus supplementation of ferrous sulfate to reach Fe concentrations of 350 and 600 ppm, respectively. Lambs were individually fed in the experimental period for two weeks. The last three days of the experimental period, total fecal and urine collections were made, and representative samples were taken. Feed and fecal samples were processed for DM, ash, P, and Ca, and in vivo dry matter digestibility, apparent P and Ca absorption and net P and Ca body retention were calculated. Data were processed statistically by analyses of variance and orthogonal contrasts. Coefficients of apparent absorption of P (T 1, 3.86; T 2, .21 and T 3, 6.43%) and in vivo dry matter digestibility (T 1, 48.1; T 2, 49.1 and T 3, 50.9%) were not different (P > .05) among treatments. Likewise, urinary P retention (.21, .21, and .10 mg/d.kg BW) and net body retention of P (1.7. 0, and 2.8 mg/d.kg BW) and Ca (-16.3, -4.2, and .14 mg/d.kg BW) in T 1, T 2, and T 3, respectively, were not different (P > .05). Daily intakes of Ca and P were considered deficient for growing lambs and produced negative Ca balances and low P retention in lambs. Different than expected, diets containing 350 and 600 ppm of Fe had no negative effects on absorption and retention of P and Ca in growing lambs consuming a low Ca and P diet.

Key Words: Iron, Lambs, Phosphorus

232 Effect of cooked molasses blocks containing different protein levels on performance of heifers fed prairie hay with or without supplemental alfalfa.

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Crossbred heifers (310 kg; n = 175; 30 pens) were used in a randomized block design. Treatments were arranged in a 2 x 3 factorial with the factors being alfalfa supplementation (0 or 2.0 kg/d alfalfa DM; 2.97% N and 59.7% NDF) and cooked molasses block (CMB) supplementation (none, CMB containing 12% CP [CMB12], and CMB containing 30% CP [CMB30]). Heifers had ad libitum access to prairie hay (.83% N, 73.2% NDF) and salt. The experiment was 89 d with heifers fed CMB the final 84 d. During d 5 to 19, heifers had ad libitum access to CMB. Thereafter, access to CMB was restricted to 4 h daily. Digestibilities of diets were measured for 3 replicates during d 80 to 83 by collecting total fecal output by scraping pens daily. There were no significant interactions between alfalfa and CMB for intake or gain. Forage intake was increased 49% by alfalfa (8.35 vs 5.60 kg/d). Gains were increased from a loss of .18 kg/d to a gain of .43 kg/d by alfalfa. Intake of CMB was lower when alfalfa was supplemented (.34 vs .44 kg/d). Heifers fed CMB30 (.21 kg/d) gained more weight (P<.05) than those fed CMB12 (.11 kg/d) or no CMB (.05 kg/d). Heifers fed CMB30 (7.31 kg/d) ate more (P<.05) forage than those fed CMB12 (6.69 kg/d), with heifers fed no CMB (6.92 kg/d) being intermediate. Intake of CMB was greater for CMB30 (.42 kg/d) than for CMB12 (.37 kg/d). A significant interaction between forage and CMB was observed for DM digestion. For heifers not receiving alfalfa, supplementation with either CMB increased (P<.05) DM digestibility (from 38 to 43%). However, when alfalfa was supplemented, CMB numerically decreased DM digestibility (from 52 to 50%). Alfalfa supplementation increased DM digestibility (from 41.4 to 50.3%). Digestibilities for heifers fed CMB12 were similar to those for heifers fed CMB30, but gains were better for CMB30 than CMB12. Thus, differences in forage intake may account for much of the difference between CMB when performance criteria are evaluated.

Key Words: Cattle, Forage, Supplementation

233 Feeding value of field pea forage and grain for growing beef heifers.

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Two experiments were used to evaluate the feeding value of field pea forage and grain in growing beef heifers. In Exp 1, four pens of heifer calves (n=80; BW=298.2±3.5 kg) were assigned randomly to one of two dietary treatments. Basal diet consisted of corn silage (31% DM), corn grain (11%) and mineral supplements (3%). Dietary treatments contained either oat (43%) and mixed alfalfa/grass (12%) hay or oat/pea intercropped hay (55%). Diets were formulated to contain 10.3% CP and were fed for 63 d. Neither final BW (366.7±1.8 kg; P=.61) nor ADG (1.09±.058 kg; P=.51) were affected by dietary treatment. Although heifers fed oat/pea hay consumed less DM (13.4 vs 13.8±.05 kg/d; P<.03), FE (.0797±.0044; P=.74) was not different between dietary treatments. In Exp 2, heifer calves (n=96; BW=361.4±3.3 kg) were blocked by weight (n=3), allotted randomly by block into 12 pens, and assigned one of four dietary treatments. Diets were formulated to contain 12.4% CP and consisted of a hay, corn grain (19% DM), soybean meal (5%) and mineral supplements (2%). In addition to a lower quality grass hay (37%), dietary treatments contained either oat (37%) or oat/pea intercropped (37%) hay. A third and fourth treatment included alfalfa hay (15%) or pea grain (13%) as a replacement for soybean meal in the oat hay treatment. Grass hay or corn grain were also reduced in treatments 3 and 4, respectively, to maintain forage to concentrate ratios. Heifers were fed for 84 d. There was a tendency for final BW (SEM=1.6 kg; P=.08) to be affected by dietary treatment; however, ADG (SEM=.023 kg/d; P=.24) was not affected by dietary treatment (402.4 kg, .51 kg/d; 409.1 kg, .54 kg/d; 407.2 kg, .53 kg/d;

and 409.1 kg, .59 kg/d for oat, oat/pea, alfalfa, and pea grain treatments, respectively). Dry matter intake (8.7±.044 kg/d; P=.57) and FE (0.0624±.0027; P=.25) were not affected by dietary treatment. These data suggest that oat/pea intercropped hay has an energy content similar to oat hay and that pea forage or grain can be used to replace other more traditional protein supplements in growing beef heifer diets.

Key Words: Field pea, Oat, Heifers

234 Using Arsoy as a protein supplement in growing cattle diets.

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Crossbred beef heifers (n = 196) were used in a 98-d drylot study to evaluate Arsoy as a protein supplement for growing cattle. Arsoy is obtained as the main by-product from processing dehulled, defatted soybeans to make soy protein isolate. A basal diet of corn silage/corn stover was fed with one of three protein supplements: soybean meal (CON; 6.8% of diet DM), Arsoy (ARSOY; 13% of diet DM) and soybean meal plus high moisture corn (HMC; 6.8% SBM plus 6.2% HMC of diet DM). Initial BW was 227, 218, and 223 kg for CON, ARSOY, and HMC treatments. Additionally, BW were recorded on d 49 and 98 of the trial. Daily gain (1.1 .05 kg/d) for cattle fed CON or ARSOY was similar during the first half of the trial while heifers fed HMC gained slightly faster (1.2 .05 kg/d; P < .12) during the same weigh period. During the later half of the trial, ADG did not differ between treatments (CON = 1.0 kg/d; ARSOY = 1.0 kg/d; HMC = 1.0 kg/d; SE = .05, P > .95). These data indicate that Arsoy can be used in diets to satisfy protein requirements of beef heifers expected to gain about one kg/d. Daily DMI was similar (P > .28) among treatments during the first 49 d on feed (6.9 .50 kg/d). However, daily DMI was greater (P < .01) for heifers fed HMC (9.2 kg/d) than for those fed either CON or ARSOY (8.5, 8.3 kg/d, respectively) during the last 49 d. Daily DMI for the entire 98 d was greater (P < .03) for heifers fed HMC (8.2 kg/d) than for heifers fed either CON (7.7 kg/d) or ARSOY (7.4 kg/d). Gain to feed ratio was slightly lower (P < .09) for heifers fed CON (.156) than those fed either ARSOY (.173) or HMC (.175) during the first 49 d. However, during the last 49 d the gain to feed ratio was similar across treatments (P > .26). Feed efficiency for the entire 98 d were CON, .137; ARSOY, .146; HMC, .138 (SE = .004) with no differences (P =.22) noted between treatments. Results suggest that Arsoy can be useful in formulating growing diets for beef cattle.

Key Words: Beef Cattle, Soybean By-products, Protein Supplementation

235 Performance of cows and calves grazing fescue and fed zeolite.

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Certain zeolites have been shown to bind tall fescue toxins in vitro. Sixty-four fall-calving cows (438 kg BW) with suckling calves (135 kg BW) were used in a 56-d study to determine the effects of feeding zeolite on growth and serum prolactin levels of cow/calf pairs grazing *Neotyphodium coenophialum* - infected tall fescue pastures. Cows with suckling calves were weighed full on January 12 and 16, stratified by age, breed, and weight, and assigned randomly to one of eight groups. The groups were assigned randomly to one of eight stockpiled fescue pastures (5.0 - 5.9 ha each) and to one of three supplemental treatments that were fed Monday - Friday. All groups of cow/calf pairs were fed .9 kg/hd of rice bran; two groups of cows received no supplemental zeolite (Control), three groups were fed .14 kg/hd of zeolite (.14Z), and three groups were fed .27 kg/hd zeolite (.27Z) at each feeding. Zeolite was top-dressed on the rice bran. Milk production was estimated on February 13 by the weigh-suckle-weigh technique. Blood samples were collected from both cows and calves via jugular venapuncture on February 12, and March 13 for determination of serum prolactin concentrations. Groups of cattle were rotated through the eight pastures at 14-d intervals to minimize the effect of pasture variability. Group of animals was considered the experimental unit for all reported data, but the experimental model included effects of treatment, cow age, breed, and sex of calf. No treatment differences were observed (P > .10) for cow weight change (15, 11, 13 kg), body condition score change (0, .1, .1), milk production (2.7, 3.4, 3.6 kg), or serum prolactin levels from cows fed Control, .14Z or .27Z diets, respectively. Likewise, calf gain did not differ (47.4, 48.6, 46.7 kg; P > .10) among cattle fed Control, .14Z, and .27Z diets, respectively. Therefore, zeolite does not appear to positively impact production by cows grazing endophyte-infected fescue pastures in the winter.

Key Words: Cattle, Zeolite, *Neotyphodium coenophialum*

236 Effect of hybrid on quality of grain sorghum stubble components.

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Stubble from twelve grain sorghum hybrids was harvested to evaluate differences in forage quality characteristics as affected by hybrid. Hybrids were selected from the southeastern Kansas Grain Sorghum Performance Test and grouped (yieldscore) on the basis of their consistent high, medium, and low grain yield indexes (four hybrids/yieldscore group). Stubble was separated into stalk and leaf fractions. Individual stubble fractions were analyzed for ADF, NDF, acid detergent insoluble N, neutral detergent insoluble N (NDIN), and total N. Cell soluble N was estimated as total N minus NDIN. No year by yieldscore interactions were observed. Concentrations of NDF and ADF for both plant parts were lower (P < .05) in yr 1 than in yr 2. Cell soluble N, total N and NDIN were greater (P < .05) in yr 1 than in yr 2 for both the stalk and leaf fractions. Cell soluble N, expressed as a percentage of total N, was lower (P < .05) in the leaf fraction in yr 1 than in yr 2. Stalk portions in yr 1 had higher cell soluble N and lower NDIN concentrations (P < .05) when expressed as a percentage of total stalk N. On a DM basis, cell soluble N and NDIN concentrations in the leaf were highest in the low yieldscore hybrids and lowest in the high yieldscore hybrids (P < .05). Total leaf N concentrations were greatest (P < .05) in the low yieldscore group. Hybrids with medium yieldscores had higher N concentrations in the stalk than did the hybrids in the high yieldscore class (P < .05). Concentrations of NDIN were highest for the low yieldscore hybrids and lowest in the medium yieldscore class (P < .05). As a percentage of total stalk N, the medium yieldscore hybrids had a greater percentage of total N in the cell soluble fraction and the lower percentage in the NDF residue (P < .05) than did the other yieldscore groups. Forage quality characteristics varied markedly across years. Concentrations of NDF and ADF were not affected by yieldscore grouping.

Key Words: Grain sorghum, Nitrogen, Fiber

237 Effect of increasing supplemental soybean meal on intake and digestion by beef steers and performance by beef cows consuming low-quality tallgrass-prairie forage.

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Two experiments were conducted to determine the effect of increasing supplemental soybean meal (SBM) on intake, digestion, and performance of beef cattle consuming low-quality forage. In Exp. 1, 20 ruminally fistulated beef steers (369 kg) were assigned to one of five treatments; control (forage only) and .08, .16, .33, and .50% BW/d of supplemental SBM (DM basis). Steers had ad libitum access to tallgrass-prairie hay (5.3% CP; 49% DIP). Forage organic matter intake (OMI) increased (cubic, P = .01) in response to supplemental SBM, but exhibited little additional response when supplementation exceeded .16% BW/d. In contrast, total OMI exhibited an additional increase at the highest level of supplementation. Organic matter digestibility (OMD) and NDF digestibility responded in a quadratic (P = .02) manner. The concomitant rises in total OMI and OMD resulted in an increase (cubic, P = .03) in total digestible OMI, with the largest proportional response observed when the initial level of supplement was fed. In Exp. 2, 120 spring-calving Hereford × Angus cows (BW = 518 kg; body condition (BC) = 5.3) grazing winter, tallgrass-prairie forage were assigned to one of three pastures and one of eight treatments. The supplemental SBM (DM basis) was fed at rates of .08, .12, .16, .20, .24, .32, .40, and .48% BW/d from December 2, 1996 until the beginning of the calving season (2/10/97). Cows were treated similarly thereafter. Cow BW and BC increased (quadratic, P < .01) in response to supplemental SBM, but exhibited little additional response when supplementation exceeded .3% BW/d. Below this level, cows lost about .5 units of BC for every .1% BW decrease in the amount of supplemental SBM fed. Supplemental SBM had a positive effect on forage use and performance of cattle consuming

low-quality forage, although the magnitude of response diminished at higher levels of supplementation.

Key Words: Beef Cattle, Forage, Intake

238 Frequency of protein supplementation on net portal and hepatic flux of nitrogenous compounds in mature ewes consuming bromegrass hay.

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Objective was to determine the effect of frequency of supplementation of highly degradable protein sources on net nutrient flux across the portal-drained viscera (PDV) and liver of mature ewes consuming forage ad libitum. Indwelling catheters were implanted into a mesenteric artery, mesenteric vein, portal vein, and hepatic vein of each of 16 mature, cross-bred ewes. Ewes were fed ground, bromegrass hay (1.35% N, 45.6% C) ad libitum, in individual pens (1.2 × 1.2 m). Four ewes received 180 g of Supplement 1 (50:50 corn starch: molasses) daily (T1), four ewes received 185 g of Supplement 2 (33.3% corn starch, 36.7% molasses, 27.3% soybean meal, and 2.7% urea), daily (T2). Eight ewes received 200 g of Supplement 3 (10.0% molasses, 81.9% soybean meal and 8.1% urea) on 1 d followed 2 d on Supplement 1 (T3). Sampling protocol provided three observation periods on each of the four ewes assigned to T1 and T2 (0-24 h after supplementation) and one observation on each of eight ewes for each of three 24-h intervals after protein supplementation (0-24 h, d 1; 24-48h, d 2; and 48-72 h, d 3). On sampling days, a priming dose (15 mL of 5% para-aminohippurate, PAH) was followed by constant infusion (.8 mL/min) into the mesenteric venous catheter. Blood samples were taken immediately before feeding and at 2-h intervals from the arterial, portal venous, and hepatic venous catheters. Samples were analyzed for hemoglobin, oxygen saturation, PAH, ammonia N, urea N, and alpha-amino N (AAN), and net flux data were calculated. Data were analyzed by split-plot analyses of variance. Portal, hepatic arterial, and hepatic venous blood flows (125, 18, and 144 L/h) were similar among T and d ($P > .10$), but differed due to hour ($P < .01$). Significant h × T × d interactions were observed for oxygen uptake of PDV, ammonia release by PDV and uptake by liver, and hepatic release of urea N. Similarly, h × d and h × T interactions were observed for AAN release by PDV and uptake by liver ($P < .05$). However, overall means for none of these traits differed ($P > .10$) among T. These results suggest the frequency of protein supplementation affected the pattern but not the net flux of nutrients over the 3-d period.

Key Words: Protein, Forage, Nutrient Flux

239 Extra-requirement supplementation of Ca and P to lactating beef cows wintered on fescue stubble hay.

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The true absorption of Ca and P in cool season grasses has been reported to be as low as 20 and 46%, respectively, both of which differ markedly from values used by NRC in developing nutrient requirements. Dietary Ca and P would need to be increased by approximately 20% above NRC to correct for these lower values, hence the rationale for this study. Three fall-calving (FC) and two spring-calving (SC) herds of 23, 25, 34, 30 or 33 cows each were wintered in southeastern KS on fescue stubble hay. All were Amerifax x Angus, Maine x Angus or Maine x Shorthorn and assumed to be of superior milking ability. In December, FC were assigned body condition scores (BCS) and sorted into two treatment groups per herd by sex and age of calf (average, 54 d). Sorghum grain-cottonseed meal supplements were fortified to create total dietary Ca and P intakes at: 1) 100% of NRC (CNTRL), or 2) 120% of NRC (XCaP). Both were fed at .91 kg/cow/d every other day for 62 d. In February, SC were assigned BCS and gate cut into two treatment groups per herd. Supplements identical to those fed to FC were fed at the same level and frequency to SC for 72 d (average, 33 d prepartum and 39 d postpartum). Upon termination of supplemental feeding, all cows were assigned BCS, and calves were weighed as a group. Conception was determined by palpation of FC and SC the following May and October. Data from FC and SC were pooled and analyzed as a randomized block design. Results for CNTRL and XCaP were: final BCS, 5.1 and 5.2; loss in BCS, .6 and .6; final calf weight, 105 and 109 kg; calf weight per d of age, 1.43 and 1.48 kg; and conception, 93 and 95%, respectively. No treatment differences were found. However, calf performance tended to be improved ($P<.14$) by the higher level of Ca and P.

Key Words: Beef Cows, Fescue, Ca and P Availability

240 Corn versus sorghum distillers grains for lactating dairy cows.

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Twelve Holstein cows (4 primiparous; 98±9 days in milk) were assigned randomly within parity to one of four diets in replicated 4 by 4 Latin squares with 4-wk periods to measure DMI, milk production and composition. Four ruminally fistulated cows were assigned to the same diets to measure NDF digestion, ruminal pH, and VFA. Treatments were 1)dry corn distillers grains, 2) wet corn distillers grains, 3) dry sorghum distillers grains, and 4) wet sorghum distillers grains. Diets contained 15% of the distillers grains, 50% of a 1:1 mixture of alfalfa and corn silages, 24.3% ground corn, and 9.1% soybean meal. There was no effect ($P\geq0.10$) of diet on DMI (25.4 kg/d), 4% fat-corrected milk production (32.1 kg/d), or milk composition (3.6% fat, 3.3% protein, 4.7% lactose), ruminal pH (6.45), or acetate to propionate ratio (2.19). Efficiency of 4% fat-corrected milk production (FCM/DMI) averaged 1.28 for all diets. Apparent extent of NDF digestion, measured in vitro, was similar for all distillers grains (42.3%). Likewise, total tract NDF digestibility was similar among diets and averaged 63.2%. Corn and sorghum distillers grains, whether in the wet or dry form, result in nearly equivalent performance when fed to lactating dairy cattle in early lactation.

Key Words: corn, sorghum, distillers grains

241 Effect of brown-midrib corn silage on lactation performance by dairy cows.

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Twenty-six multiparous Holstein cows averaging 120 DIM at trial initiation were randomly assigned to either control corn silage (grain hybrid; CCS) or brown-midrib corn silage (BMR) in a cross-over design with 8 wk periods to evaluate effects of BMR on intake, digestion, and milk yield and composition. Silages were harvested at milkline stage of maturity at .95 cm theoretical length of cut without rolling and stored in an upright stave silo. Average DM contents for CCS and BMR were 36.3% and 34.0%, respectively. Diet CCS contained 47% forage:53% corn-soy concentrate and diet BMR contained 60% forage:40% corn-soy concentrate formulated to provide 18% CP in TMR (DM basis). Dietary forage was either 67% CCS or BMR corn silage and 33% alfalfa silage (DM basis). Dry matter intake was not different ($P>.10$) between treatments and averaged 28.4 kg/d. Milk production was lower ($P<.001$) for BMR diet (43.1 vs. 44.5 kg/d). Milk fat percentage and yield were higher ($P<.001$ and $P<.02$,respectively) for BMR diet (3.46% and 1.48 kg/d) than for CCS diet (3.18% and 1.40 kg/d). Milk protein percentage and yield were lower ($P<.001$) for BMR diet (3.20% and 1.35 kg/d) than for CCS diet (3.27% and 1.43 kg/d). Body weight change was not different ($P>.10$) between treatments and averaged .55 kg/d. Twenty-four h ruminal *In situ* DM disappearance was higher ($P<.001$) for BMR (62.4%) than for CCS (58.4%) corn silage. Higher ruminal digestion of BMR allowed for similar DM intake and higher milk fat percentage and yield on a high forage diet relative to CCS on a lower forage diet, but milk protein percentage and yield were lower for BMR diet.

Key Words: Corn silage, Brown midrib, Dairy cows

242 Effect of brown midrib sorghum on lactational performance of dairy cows.

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Brown midrib sorghum has reduced lignin concentration and altered lignin composition when compared with normal genotypes which results in increased cell wall digestibility. Following a 2-wk covariate period, thirty Holstein cows (15 multiparous; 109±10 days in milk) were grouped by age and previous milk production and assigned to one of three diets in a continuous 10-wk lactation study to measure DMI, milk production, and rumination activity. Diets contained 53% forage and 47% of a concentrate mixture comprised of soybean meal, ground corn, and whole cottonseed. All diets contained 17.5% alfalfa silage and 35.3% of either normal sorghum silage, brown midrib sorghum silage, or corn

silage. Despite similar DMI (24.5 kg/d; 4.20% of BW), milk production was significantly greater (P $\leq$0.05) for brown midrib sorghum (36.0 kg/d) than for normal sorghum (33.8 kg/d), and similar to corn silage (34.6 kg/d). Milk composition did not vary among diets (3.57% fat, 3.03% protein, 5.02% lactose). Efficiency of 4% fat-corrected milk production (FCM/DMI) was greatest (P$\leq$0.05) for the brown midrib diet (1.36) and similar for the corn and normal sorghum silage diets (1.31). Chewing activity did not vary among treatments. In vitro extent of NDF digestion at 30 h was significantly greater (P$\leq$0.05) for the brown midrib sorghum (49.2%) versus normal sorghum (40.1%), but rate of NDF digestion was similar (0.059/h). Even though DMI and rate of NDF digestion were not different between brown midrib and normal sorghum, apparent extent of fiber digestion was consistently greater for brown midrib sorghum and it resulted in milk production similar to corn silage.

Key Words: brown midrib, sorghum, dairy cows

243 Evaluation of corn distillers grains versus a blend of protein supplements with or without ruminally protected amino acids for lactating cows.

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In a replicated 44 Latin square design with 4 wk per period, 12 multiparous Holstein cows averaging 83 d postpartum were used to compare corn distillers grains (CDG) versus a blend (BLEND) of other protein sources with CDG (fish meal and soybean meal), and to determine the effectiveness of ruminally protected lysine and methionine (RPLM) in improving the utilization of CDG as a protein supplement for lactating cows. All diets contained 30% corn silage, 20% alfalfa hay, and 50% of the respective concentrate mixture. Array of amino acids (AA) available for absorption when fed the BLEND diet was more desirable than for CDG diet according to Milk Protein Score and Cornell Net Carbohydrate and Protein systems. Dry matter intakes were similar ($P >$ 0.40) among all diets. Milk yields (32.6, 31.7, 32.8, and 32.8 kg/d for cows fed CDG, CDG+RPLM, BLEND, and BLEND+RPLM) were similar ($P > 0.27$) for cows fed all diets. Milk fat yields and percentages (3.72, 3.76, 3.67, and 3.63) were unaffected ($P > 0.21$) by diet but milk protein percentages (3.23, 3.26, 3.25, and 3.26) tended ($P < 0.14$) to be higher when fed RPLM. Concentrations of various proteins in milk were similar for all diets although various caseins and whey proteins synthesized in the mammary gland tended ($P < 0.04$ to 0.13) to be affected by dietary protein source. Lysine, Met and Phe were indicated as the most limiting AA for all diets according to AA extraction efficiency and transfer efficiency. Methionine status was apparently improved by RPLM supplementation; Lys status was improved by the BLEND diets. Milk yield and composition when fed CDG were not further increased by feeding blends of protein sources or RPLM; however, such dietary changes improved Lys and Met status of the cows.

Key Words: Corn Distillers Grains, Ruminally Protected Amino Acids, Lactating Cows

244 Dry matter intake and milk production by lactating cows fed hydrolyzed poultry feathermeal and bloodmeal.

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Forty-two early lactation Holstein cows were used in a 105-day lactation study. Effect of protein source(SBM or feathermeal/bloodmeal)Fth/BM, dietary CP percentage, and diet rumen undegradable protein (RUP)content on DM intake, and milk production was measured. Multiparous and primiparous cows (3:1 ratio) were assigned at calving to 5 treatments in a completely randomized block design with a 3 week covariate adjustment period. Diets were(DM basis), 25% alfalfa silage,15 % corn silage,10% mixed-hay, and high moisture corn + supplement. Treatments were: 1.) 14 % CP, 4.1 % RUP as % of DM; 2.) 18 % CP, 6.2 % RUP (SBM/Expeller SBM); or 3.), 4.), 5.) 16% CP (Low, Medium, High RUP, 5.6, 6.2, and 6.8% RUP (Fth/BM) respectively. Undegraded protein of 16 % CP diets was increased by replacement of SBM with increasing amounts of a mixture of Fth/BM (3:1 N-basis)and corn. All diets contained .35% urea and cows were fed once daily for ad libitum consumption. Body weight and BCS were recorded at two-week intervals. Mean BW (572 + SE 20 kg) and BCS (2.66 + SE .2) were not different (P>.10) between treatments. Intake of DM and milk yield was numerically greater for cows fed 14 or 18% CP diets supplemented with SBM protein (25.5, 33.2 and 22.9, 30.5 $\pm$ SE 1.3, 1.7 kg/d) than for cows fed 16% CP diets supplemented with Fth/BM (22.5, 24.8; 20.3, 23.4; and 21.1, 25.0 $\pm$ SE 1.3, 1.7 kg/d). In summary, for cows fed diets supplemented only with SBM protein, DM intake and milk yield was not influenced by diet CP content. For cows fed Fth/BM supplements intake was greater for low inclusion than medium or high levels of feather and blood meal addition. Due to confounding effects of protein source and CP %, no statistically valid conclusions can be drawn from comparison of response to diets with all SBM protein and response to the three levels of replacement with the animal protein mixture. Further studies comparing intake and milk production in cows fed diets of the same CP % containing poultry feather and bloodmeal at the medium and high levels are warrented to examine effects on DM intake and efficiency of N utilization.

Key Words: Feathermeal, Protein, Intake

245 Enhanced ruminal degradation of whole cottonseeds and EasiFlo^{TM} as influenced by yeast culture in situ.

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In order to improve handling characteristics, a new cottonseed product (EasiFlo) was developed by Cotton Incorporated. This cornstarch-coated cottonseed flows freely and can easily be augered through traditional grain handling equipment. To examine its utilization by rumen microorganisms, regular fuzzy cottonseeds and EasiFlo were compared for their ruminal degradation, with or without yeast culture supplementation, using in situ Dacron bag technique. Four non-lactating Jersey cows with ruminal cannulas were used in this study. Cows were fed a 75:25 forage to concentrate diet twice a day (7.3 kg mixed hay and 2.3 kg grain mix on an as fed basis). Two cows received an additional 56 g of Diamond V XP Yeast Culture daily. Two in situ runs were conducted in each cow. Within each run, duplicate Dacron bags were pre-incubated in 39 C water for 15 min, then suspended in the rumen of cows for 2, 4, 8, 12, 16, 24, 48 and 72 h. Ruminal utilization of cottonseeds was improved by the cornstarch coating and was further improved when yeast culture was supplemented into the diet. Cows receiving yeast culture in their diet significantly (P < 0.05) improved DM disappearance by 8.7%. EasiFlo improved (P < 0.05) ruminal DM disappearance by 65% compared to regular cottonseeds. This is partially explained by the coating material (cornstarch) that is readily available to the rumen microorganisms. Ruminal disappearance of NDF and ADF were greater (P < 0.05) in EasiFlo by 23 and 27%, respectively, when compared with regular fuzzy cottonseeds. Yeast culture improved (P < 0.05) ruminal NDF and ADF degradation of both cottonseeds averaged by 25 and 29%, respectively. The results showed a nutritional advantage for EasiFlo compared to fuzzy cottonseeds in addition to the easiness of handling. Both the addition of yeast culture to the diet of cattle and the use of the EasiFlo treatment resulted in greater digestibility of whole cottonseeds by ruminants. Yeast culture and EasiFlo have additive effects so the use of both could result in improved ruminal availability of whole cottonseeds.

Key Words: Yeast Culture, Cottonseed, In Situ

246 Improvement of utilization of whole kernel corn in cattle diet by yeast culture.

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Four non-lactating Jersey cows with rumen cannulars were used to examine the influence of feeding Diamond V XP Yeast Culture on the number of undigested corn kernels excreted in the feces of cows. Cows were fed 7.3 kg mixed hay and 1.4 kg grain mix daily. Two cows were offered an additional 56 g of yeast culture daily. Cows received 1300 whole corn kernels through rumen cannula 1 h after morning feeding from d 1 through d 7. After allowing 3 days of adaptation and stabilization period, total feces from all cows were collected daily from d 4 through d 8 and whole and partial corn kernels were recovered and counted. Ten in situ bags containing 20 kernels per bag were placed in the rumen of each cow on d 6. Five bags were collected in 24 h and the other five were collected in 48 h to measure 24 h and 48 h ruminal disappearance of DM from whole corn. Individual corn kernels were examined carefully and only the intact kernels were used for testing. The number of corn kernels excreted in the feces were reduced (P < 0.05)

significantly by feeding yeast culture. Twenty four percent less corn kernels were excreted from cows fed yeast culture (776/1300) compared with control cows (962/1299). There was no difference in partial corn excretion between treatment. Feeding yeast culture increased ($P < 0.05$) ruminal DM disappearance of corn kernels during 24 h and 48 h incubation with the effect of yeast culture being greater at 48 h incubation. Ruminal degradation of whole corn DM was increased by 3.3% at 24 h incubation and 14.8% at 48 h incubation when yeast culture was fed to the cows. The results of the study indicated that feeding yeast culture not only reduces the fecal excretion of corn kernels but also improves the utilization of diets containing whole corn (corn silage, high moisture corn, etc.).

Key Words: Yeast Culture, Corn Kernel, Fecal Excretion

247 Crude Protein Requirements of Ruminal Bacteria.

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A single-phase continuous culture system with .09/hr dilution rate was used to determine the effect of ruminal degradable protein (RDP) level on microbial nitrogen production and microbial growth efficiency. The basal diet was corn (3.0% RDP on a DM basis). Casein was used to formulate four RDP levels (6.0, 9.0, 12.0, and 15.0% RDP on a DM basis). Two culture runs were conducted with two fermenters allocated to each of the five RDP levels per run. True digestibility of DM and OM were not affected by the RDP levels. Digestibility of crude protein (CP) was linearly increased ($P < .01$) as the RDP levels increased. As RDP increased, daily microbial nitrogen production (DMNP, g/day) increased ($P< .14$) quadratically. Microbial efficiency (MOEFF), expressed as grams bacteria nitrogen per kilogram organic matter fermented (OM_f), showed a quadratic increase ($P< .11$). The MOEFF was maximized at 8.6% RDP on an OM fermented basis. The theoretical RDP requirement to maximize nonstructural carbohydrate (NSC) bacteria was 9.4% RDP on an OM fermented basis. This level of RDP is lower than currently fed in many diets. We hypothesized from this research that slower growth rates, as would occur in the rumen, would decrease RDP requirement by the bacteria in the rumen even further, if proteolysis occurred at rates similar to polysaccharide hydrolysis.

Key Words: RDP, Continuous culture, Microbial efficiency

248 Performance of calves fed texturized calf starter or modified-soy milk replacer that has been extruded into dry, micro pellet form.

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Starter diets were evaluated in Holstein bull calves being fed a common calf milk replacer (22% protein, 20% fat) to evaluate performance, scour data and electrolyte/antibiotic cost. Forty-eight calves (44.7 kg) were randomly assigned according to body weight and blood gamma globulin concentration to one of two calf starter treatments (conventional texturized or dry extruded milk replacer micro pellet). Calves were individually housed in crates and fed twice daily. Weight gains, milk replacer DM consumption, calf starter DM consumption, feed efficiency, scour scores (1-4 scale; 1=normal; 2=loose; 3=water separation; 4=3 with severe dehydration), duration of scours, and electrolyte/medication costs were calculated weekly and for the total 5 week period. Conventional calf starter was offered exclusively in the control group. For the experimental treatment, the extruded milk pellet was fed for the first 3 weeks followed by conventional calf starter. Total weight gain, milk replacer DM consumption, calf starter consumption, feed efficiency, scour score, duration of scours, and electrolyte/medication costs of calves fed the conventional texturized calf starter or the extruded milk pellet were 18.98, 14.02 kg ($p=0.02$); 18.92, 18.35 kg ($p=0.16$); 15.49, 10.49 kg ($p=0.01$); 1.92, 2.39 ($p=0.08$); 1.21, 1.30 ($p=0.13$); 6.05, 7.65 days ($p=0.27$); and 7.50,10.46 ($p=0.07$), respectively. These data indicate that using a modified-soy milk replacer that has been extruded into a dry, micro pellet form had little merit when used as a starter diet.

Key Words: Calves, Starter, Milk Pellet

249 Effects of feeding regimen and days fed on performance and carcass characteristics of feedlot steers.

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Steers (n=107; 309 ± .6 kg) were used in a 2x2 factorial experiment to determine effects of ad libitum (AL) or prescription intake (PI) and days fed (168 vs 203) on performance, carcass characteristics, and gross profits. Steers were allotted to 12 pens and fed a 92% concentrate, 13% CP diet. Steers were implanted with Synovex-S on day 0 and Revalor-S on day 70. Prescription intake steers were fed to gain 1.13 kg/d for the first 78 kg of gain, 1.36 kg/d for the next 124 kg of gain, and were offered feed ad libitum for the final 54 and 103 kg of gain before slaughter for PI-168d and PI-203d, respectively. Overall ADG from d 0-168 was greater ($P < .03$) for AL (1.61 kg/d) vs PI (1.50 kg/d) steers. Feed efficiency was improved ($P < .02$) for PI (.193) vs AL (.183) steers. From d 169-203, PI steers had greater ($P < .06$) ADG (1.60 vs 1.38 kg/d); greater DMI (10.5 vs 9.4 kg/d); and similar ($P = .38$) feed efficiency (.152 vs .147) compared with AL steers. Total DMI was greater($P < .01$) for AL vs PI steers (1465, 1832, 1313, and 1674 for AL-168d, AL-203d, PI-168d, and PI-203d, respectively). Hot carcass weight was greater ($P < .01$) for AL vs PI steers (354, 387, 336, and 373 kg for AL-168, AL-203, PI-168, and PI-203, respectively). Feeding regimen did not affect ($P > .11$) yield grade, but was lower ($P < .02$) for steers fed 168 (2.95) vs 203 (3.54) days. Percentage choice was greater ($P < .05$) for AL vs PI steers (74, 81, 48, and 67% choice for AL-168d, AL-203d, PI-168d, and PI-203d, respectively). Gross profit per steer was $15.05 greater for AL than PI steers when fed for 168 days and $1.65 greater for PI than AL steers when fed for 203 days. Increasing days fed from 168 to 203 increased gross profits $46.30 for PI steers and $29.06 for AL steers. Increasing days fed increased percentage choice 40% for PI and 9% for AL steers.

Key Words: Feedlot steers, Prescription intake, Days fed

250 Effects of Rumensin Level and Bunk Management Strategy on Finshing Steers.

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Eight ruminally fistulated, yearling steers were used in two concurrent 4x4 Latin squares to evaluate dietary Rumensin level and bunk management strategy on DMI and ruminal pH. Steers were adapted to a 92.5% concentrate diet, containing equal parts (DMB) of high moisture corn and dry-rolled corn, using four diets (45, 35, 25, 15% alfalfa). Squares were different bunk management strategies: 24-h, continuous feed access (CONT) or feed access from 08:00 to 22:00, clean bunk management (CBM). Periods were 35-d: 23-d Rumensin level adaptation and 12-d of continuous intake and pH monitoring (7-d pre-challenge, 1-d challenge, and 4-d post-challenge). Steers were challenged on d-31 by feeding 125% of d-30 intake, 4-h late. Within each square, Rumensin was fed at 0 (0), 30 (30), 30 changed to 40 on d-31 (30/40), and 40 g/t (40). During the trial, average DMI was similar for Rumensin levels and bunk management strategies. During the pre-challenge period, Rumensin reduced ($P < .05$) average meal size. The CBM steers had faster ($P < .01$) intake rates, consumed larger ($P = .05$) meals, ate fewer ($P < .01$) meals/d, spent less ($P < .05$) time eating/d, and had an increased ($P < .01$) ruminal pH variance. During the challenge, CBM steers had a faster ($P < .01$) intake rate and a greater ruminal pH variance ($P < .01$) and change ($P = .10$). During the post-challenge period, Rumensin level x bunk management strategy interactions ($P < .10$) were observed for average meal size, pH change and variance. Main effects during the post-challenge period, indicate that Rumensin tended to reduce ($P = .12$) intake rate, and increase ($P = .06$) the number of meals/d. The CBM steers had faster ($P < .01$) intake rates, and decreased ($P < .01$) meals/d, compared with CONT. Rumensin affected consumption favorably for controlling acidosis, while cattle managed using CBM appear to be at a greater risk for acidosis compared with CONT.

Key Words: Rumensin, Bunk Management, Acidosis

251 Influence of feeding brown midrib corn silage during the growth phase on performance of feedlot steers. K. E. Tjardes*[1], D. D. Buskirk[1], M. S. Allen[1], L. D. Bourquin[1], H. D. Ritchie[1], and S. R. Rust[1], [1]*Michigan State University, East Lansing, MI.*

One hundred twenty-eight weanling beef steers (245 ± 13 kg) were used to determine the effects of feeding brown midrib (*bm3*; BMR) corn silage on animal performance. Steers were assigned to growth phase diets that contained corn silage from either BMR or the same hybrid without the *bm3* mutation (isogenic normal; CON). Corn silage was the primary ingredient (86.3%) of the growth phase diets. Steers had ad libitum access to growth phase diets for 112 d. After this time, concentrate in both diets was increased until steers were adapted to a common finishing diet (76% high moisture corn, 15% isogenic normal corn silage). Initial, 112-, and 200-d weights were the average of full weights taken on two consecutive days. Body composition was estimated by ultrasound at initiation and 112 d. All cattle were slaughtered after 200 d on feed. Compared to CON, BMR corn silage had lower percentages of NDF (44.0 vs 39.5%), ADF (29.3 vs 22.4%), and ADL (3.7 vs 1.8%). In situ DM disappearance of BMR was 6% greater than CON at 24 h and 10% greater at 48 h of incubation ($P < .05$). Steer ADG (1.01 and 1.02 kg/d for BMR and CON, respectively) and body composition estimates during the growth phase were not affected ($P > .10$) by treatment. Steers receiving BMR diets had greater ($P < .05$) DMI (7.47 and 7.04 kg/d for BMR and CON, respectively) during the growth phase, resulting in poorer ($P < .01$) feed efficiency. Finishing phase ADG of steers, that previously received BMR, was higher ($P < .05$) than those steers that had received CON (1.80 and 1.71 kg/d, respectively), however ADG for the entire feeding period was not different ($P > .10$) between the two treatments (1.35 and 1.33 kg/d for BMR and CON, respectively). Finishing phase DMI, feed efficiency, and carcass measurements were not significantly different. Corn silage containing the *bm3* mutation provided no benefit for growth of beef steers compared to CON in this experiment.

Key Words: Brown midrib-3, In situ, Growing steers

252 Effect of supplementation with cooked molasses blocks on intake and digestion by steers fed forages of differing qualities. J. W. Ringler*, E. C. Titgemeyer, J. S. Drouillard, and R. H. Greenwood, *Kansas State University, Manhattan.*

Previous studies have shown that supplementation of steers with cooked molasses blocks (CMB) containing 30% crude protein (CP) increased intake of prairie hay containing less than 6% CP. This study was to determine how cattle fed forages of medium to high quality respond to CMB supplementation. Responses to block supplementation (30% CP fed at 0.10% BW) were measured for steers fed each of three different hays: 1) brome containing 8.4% CP and 72% NDF, 2) alfalfa containing 19.2% CP and 52% NDF, and 3) brome supplemented daily with 1.93 kg of alfalfa DM (MIX). Eighteen steers (282 kg) were used for two periods. The experimental design was three simultaneous cross-over experiments, with each cross-over utilizing six steers for two periods. Within each cross-over experiment, all six steers received the same forage. In each period, half of the steers received CMB supplementation, and half served as controls. Each period was 18 d with 12 d adaptation and 6 d total collection of feces. Steers were fed supplements once daily with CMB removed after the appropriate amount had been consumed by the steer. Salt (20 g/d) was provided to each steer daily. Forages were available ad libitum with the amount offered daily set as 120% of intake from the previous 5 d. Block intakes averaged .30 kg/d DM and were not different among forages. Forage organic matter (OM) intake was not affected by CMB when brome (4.45 kg/d) or MIX (5.28 kg/d) were fed, but it decreased from 6.99 kg/d to 6.53 kg/d when CMB was supplemented to alfalfa. Digestibility of OM was greater ($P<.05$) for alfalfa (61.0%) than brome (55.7%) or MIX (57.5%) and was not impacted by CMB supplementation. Digestible OM intake was greater ($P<.05$) for alfalfa (4.21 kg/d) than brome (2.55 kg/d) or MIX (3.10 kg/d) and was not greatly impacted by CMB supplementation. In conclusion, CMB supplementation had only small effects on intake and digestion of medium to high quality forages.

Key Words: Cattle, Forage, Supplementation

253 Effect of cattle type and stocking rate on weight gain of steers grazing old world bluestem pastures. C. J. Ackerman*, H. T. Purvis II, G. W. Horn, R. R. Reuter, and J. N. Carter, *Oklahoma State University, Stillwater, OK.*

One-hundred and ninety-three crossbred light weight steers (initial wt: 160 23 kg; LT) and 126 crossbred heavier weight steers (initial weight: 248 13 kg; HW) were used to evaluate the effects of stocking rate on weight gains of steers grazing plains old world bluestem (Bothriochloa ischaemum L. Keng) May 15 through August 31, 1998. Three initial stocking rates were used; light (LHT: 392 kg BW/ha), moderate (MOD: 616 kg BW/ha), and heavy (HEV: 840 kg BW/ha). Diet quality samples for DM, ash, N, NDF, and ADF analysis were collected monthly. Grazing time was measured in August using vibracorders. Performance and intake data were analyzed as a replicated 2 x 3 factorial. No steer type x stocking rate interactions were detected ($P > .10$). Daily gains were greater ($P = .02$) for HW steers (.78 kg/d) than LT steers (.70 kg/d). However, gain/ha (GHA) was greater ($P = .03$) for LT than HW steers (268 vs 203 kg/ha). Steers in the LHT stocking rate had greater ($P < .06$) ADG than steers in the MOD or HEV rates (.79, .72, and .71 kg/d for LHT, MOD, and HEV, respectively). Steers in the MOD and HEV stocking rates had ($P = .68$) similar ADG. Gain/ha was lightest ($P < .05$) for the LHT stocking rate (166 kg/ha) while GHA for the HEV rate (301 kg/ha) was heaviest ($P = .06$) and the MOD rate (240 kg/ha) was intermediate. No differences were detected ($P > .10$) in diet quality variables between LT and HW steers or stocking rates. There was no difference ($P = .34$) in residual forage mass between LT and HW steers, but residual forage mass (7618, 6915, and 4673 kg/ha for LHT, MOD, and HEV, respectively) tended to decrease ($P = .09$) with increasing stocking rate. Grazing time was not different ($P = .43$) between LT and HW steers, however, steers in the HEV stocking rate (11.6 h) tended ($P < .08$) to spend more time grazing than steers in the LHT rate (9.9 h). Results indicate that gain/ha will be greater for lighter weight steers than heavier weight steers if stocking rates are based on units of weight/unit of area.

Key Words: Old World Bluestem, Growing Cattle, Stocking Rate

254 Influence of the novel urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT) on ruminal nitrogen metabolism, diet digestibility, and nitrogen balance in lambs. P. A. Ludden*[1], D. L. Harmon[1], M. S. Plunkett[1], G. B. Huntington[2], B. T. Larson[1], and D. E. Axe[3], [1]*Dept. of Animal Sciences, University of Kentucky,* [2]*Dept. of Animal Sciences, North Carolina State University,* [3]*IMC-Agrico Inc., Bannockburn, IL.*

A lamb metabolism experiment using 28 ruminally cannulated wethers (45.0 ± .9 kg) was conducted to investigate the effects of chronic administration of the novel urease inhibitor N (n-butyl) thiophosphoric triamide (NBPT) on ruminal N metabolism, fermentation, and N balance. The lambs were administered one of seven doses of NBPT [0, .125, .25, .5, 1, 2, or 4 g of NBPT daily). All lambs were offered a common cracked corn/cottonseed hulls-based diet (2% urea) twice daily at 2.5% of initial BW for the duration of the 15 d experiment. Overall, NBPT decreased (linear $P < .0001$; quadratic $P < .001$) ruminal urease activity, resulting in a linear increase ($P < .0001$) in ruminal urea and decrease in ruminal NH_3 N concentrations. However, the detection of an NBPT × day interaction (d 2 vs. d 15; $P < .01$) indicated that depression in urea degradation diminished as the trial progressed. Increasing NBPT linearly decreased ($P < .01$) total VFA concentrations on d 2 of the trial, but had no effect ($P > .10$) on d 15. Also, increasing NBPT had no effect ($P > .10$) on DM or ADF digestibilities, but linearly decreased ($P < .01$) N digestibility. Supplementation with NBPT produced a linear decrease ($P < .01$) in N retention (g/d or % of digested), via linear increases ($P < .01$) in both urinary and fecal N excretion. Although NBPT was capable of short-term inhibition of ruminal urease, the ruminal microflora may be capable of adapting to chronic NBPT administration.

Key Words: Urease Inhibitor, Nitrogen Balance, Sheep

255 Influence of the novel urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT) and dietary urea concentration on ruminal nitrogen metabolism, diet digestibility, and nitrogen balance in lambs. P. A. Ludden*[1], D. L. Harmon[1], M. S. Plunkett[1], G. B. Huntington[2], B. T. Larson[1], and D. E. Axe[3], [1]*Dept. of Animal Sciences, University of Kentucky,* [2]*Dept. of Animal Sciences, North Carolina State University,* [3]*IMC-Agrico, Inc., Bannockburn, IL.*

Two lamb metabolism experiments were conducted to investigate the effects of chronic administration of the novel urease inhibitor N (n-butyl) thiophosphoric triamide (NBPT) on ruminal N metabolism, fermentation, and N balance at two dietary urea concentrations. In Exp. 1, 30 ruminally cannulated wethers (46.8 ± .6 kg) were fed one of two basal diets (2.0 or 1.1% dietary urea) at 2.5% of initial BW and dosed with either 0, .25, or 2 g of NBPT daily for the duration of the 15 d trial. No NBPT × dietary urea interactions ($P > .10$) were noted. Increasing NBPT depressed (linear and quadratic $P < .0001$) ruminal urease activity, producing a linear ($P < .0001$) increase in urea N and a linear ($P < .0001$) decrease in NH_3 N in the rumen. An NBPT × day interaction ($P < .05$) was noted for ruminal urea, NH_3 N, and total VFA concentrations; the maximum response to NBPT occurred on d 2 but diminished by d 15 of the trial. Administration of NBPT did not influence ($P > .10$) DM, ADF, or N digestibilities. In Exp. 2, 30 non-cannulated wethers (26.4 ± .7 kg) were subjected to the same treatment regimen as in Exp. 1 for a 14-d N balance trial. Administration of NBPT did not affect ($P > .10$) N digestibility, but quadratically increased ($P < .10$) urinary N excretion, producing a linear decrease ($P < .05$) in N retention. Although NBPT is capable of short-term inhibition of ruminal urease irrespective of dietary urea concentration, the ruminal microflora may be capable of adapting to chronic NBPT administration.

Key Words: Urease Inhibitor, Nitrogen Balance, Sheep

256 Matching dietary protein to feedlot steer requirements: Two-year summary of performance and waste management. G. E. Erickson*, C. T. Milton, and T. J. Klopfenstein, *University of Nebraska, Lincoln, NE.*

Two experiments with calves and two with yearlings were conducted to evaluate the effect of matching dietary rumen degradable (DIP) and undegradable protein (UIP) to requirements on performance and nitrogen mass balance. Degradable intake protein and metabolizable protein requirements were determined using the 1996 NRC model. Twelve pens with six runoff collection basins were used to assess N removal, N balance in the top 15 cm of soil, and N runoff. Calves were fed from November to May (183 d), and yearlings from May to October (132 d). The control diet (CON) was formulated to contain 13.4% CP, 7.5% alfalfa, with only supplemental urea for yearlings, and urea, 1.4% feather meal, and .2% blood meal for the calves. An experimental diet (EXP) formulated to minimize overfeeding of N was 10.5 to 12.0% CP. The EXP was changed every 14 d for calves and every 28 d for yearlings to match changing requirements during the feeding period. Yearling gains and efficiencies were similar across years and gain was not affected (P=.27) by diet, but steers fed EXP had lower (P=.03) DMI which led to improved (P=.01) gain:feed of .158 and .166 for CON and EXP, respectively. For the calf experiments, gain:feed was not affected (P=.52) by diet in yr 1, but was reduced in yr 2 (P=.01) by feeding EXP. Nitrogen excretion was lower (P=.01) for EXP than CON in both calves (177 to 154 $gsteer^{-1}d^{-1}$) and yearlings (223 to 177 $gsteer^{-1}d^{-1}$). Decreasing N excretion decreased N volatilization from 158 to 108 $gsteer^{-1}d^{-1}$ (P=.01) with yearlings, and from 72.7 to 61.8 $gsteer^{-1}d^{-1}$ (P=.32) with calves. Nitrogen volatilization was greater during summer and dependent on N excretion. Because EXP contained more corn bran, OM excretion was increased (P=.01) by EXP in both the calf and yearling experiments. Greater OM excretion by yearlings fed EXP led to greater (P=.01) manure OM and N than CON. These results suggest that formulating to requirements will decrease N excretion and volatilization, without adversely affecting performance.

Key Words: Nitrogen, Requirement, Waste management

257 Effect of supplemental L-carnitine on nitrogen balance and blood metabolites of growing beef steers fed a high-protein, corn-based diet. R. H. Greenwood*, E. C. Titgemeyer, and G. L. Stokka, *Kansas State University, Manhattan.*

Seven Angus-cross steers (216 kg) were used in a 7 x 4 incomplete Latin square experiment to evaluate the effects of supplemental L-carnitine (CARN) on N balance and blood metabolites. Steers were fed the same basal diet (72% rolled corn, 10% alfalfa, 4% blood meal, 4% corn gluten meal; DM basis) at 2.5% of BW. Treatments were 0, .25, .5, 1.0, 1.5, 2.0, and 3.0 g/d of supplemental CARN. Periods were 18 d with 13 d for adaptation and 5 d for collection of feces and urine. Blood was collected 0, 3, and 6 h post-feeding on d 18 of each period. Nitrogen retention was not affected by CARN and averaged 29.3 g/d. Plasma insulin, glucagon, IGF-1, cholesterol, triglycerides, and amino acids were not affected by CARN. Plasma NEFA demonstrated a treatment by collection time interaction ($P < .05$) where pre-feeding NEFA decreased linearly in response to CARN, but at 6 h post-feeding NEFA increased linearly in response to CARN. Supplementing CARN at .5, 1.5, and 3.0 g/d increased plasma glucose relative to control steers (cubic; $P < .05$). Plasma glycerol increased when steers were provided 1.5 or 2.0 g/d of CARN (quadratic; $P < .05$). Supplementation with 1.0 and 1.5 g/d CARN tended to increase plasma urea N (quadratic; $P < .12$). Blood BHBA tended to be increased when steers received intermediate levels of CARN (quadratic; $P < .14$). Across periods, N retention and plasma glucose decreased ($P < .05$), whereas plasma cholesterol, triglycerides, glycerol, and NEFA increased ($P < .05$). These changes indicate that the physiological status of the steers changed over the course of the experiment. Additional responses to CARN may have been affected by the physiological status of the steers. Thus, the use of a Latin square design may have limited our ability to detect treatment responses. In conclusion, CARN supplementation did not alter N balance in our experiment, but it did alter some of the plasma metabolites of steers fed high-protein, corn-based diets.

Key Words: Steers, Carnitine, Nitrogen balance

258 The role of methionine as a methyl group donor in cattle. C. A. Loest*, E. C. Titgemeyer, R. H. Greenwood, and G. St-Jean, *Kansas State University, Manhattan.*

Five ruminally cannulated Holstein steers (156 kg) were used in a 5 x 5 Latin square to evaluate the sparing of methionine (MET) by betaine (BET; source of methyl groups) or cysteine (CYS). Steers were fed 2.4 kg DM/d of a diet high in rumen degradable protein (84% soybean hulls, 7% 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. A single dose of .4 g ^{15}N-glycine was abomasally infused for the measurement of whole body protein turnover by the single-dose urea end-product method. Treatments were abomasal infusion of 1) water (control), 2) 2 g/d additional L-MET, 3) 1.7 g/d L-CYS, 4) 1.6 g/d BET, and 5) 1.7 g/d L-CYS + 1.6 g/d BET. CYS and BET were equal molar to MET. Changes in retained N were due to changes in urinary N. Retained N increased in response to MET (P<.05), demonstrating a deficiency of sulfur AA. Responses to CYS and BET, alone or in combination, were small (P<.16). The low response to CYS indicates that the response to MET was not due to transsulfuration to CYS or that supplemental CYS did not alter flux of MET through transsulfuration. The small response to BET suggests an inefficient replacement of MET. Thus, responses to MET were likely due to a correction of a deficiency of MET per se rather than of methyl groups. The small increase in protein synthesis and numerical decrease in protein degradation in response to MET were contrary to expectations for responses to the supply of a limiting AA. MET increased the efficiency of protein deposition rather than increasing, as expected, both synthesis and degradation.

N (g/d)	Control	MET	CYS	BET	CYS+BET	SEM
Retention	19.7^b	26.6^a	21.0^b	21.0^b	21.4^b	.64
Protein synthesis	88.9	92.8	87.4	91.0	95.4	4.0
Protein degradation	69.3	66.1	66.4	70.0	74.0	4.1
Retention/ synthesis	$.225^b$	$.294^a$	$.242^b$	$.231^b$	$.222^b$	.013

^{a,b}P<.05.

Key Words: Methionine, Betaine, Cattle

259 Phase-feeding for finishing calves: Matching the metabolizable protein requirement throughout the feeding period. R. J. Cooper*, C. T. Milton, and T. J. Klopfenstein, *University of Nebraska, Lincoln*.

A finishing trial was conducted to evaluate the efficacy of phase-feeding a series of finishing diets in order to match but not exceed MP requirements throughout the feeding period. One hundred and fifty crossbred steer calves (266 kg avg initial wt) were randomly assigned to 15 pens and 3 treatments (10 steers per pen, 5 pens per treatment). Treatments consisted of: 1) one finishing diet fed throughout the feeding period which was formulated to match MP requirements at 320 kg BW; 2) one finishing diet fed throughout the feeding period which was formulated to match MP requirements at 430 kg BW; or 3) six finishing diets fed in sequential order to match MP requirements for every 45 kg increment in BW gain. The 1996 Beef NRC model was used to determine the appropriate MP requirements. Finishing diets consisted of approximately 7.5% alfalfa, 46% dry-rolled corn, 21% high moisture corn, 20% wet corn gluten feed, and 5.5% supplement (DM basis). Projected MP balances from 320 kg to 545 kg BW ranged from 0 to 106 g/d for trt 1, -69 to 27 g/d for trt 2, and 0 g/d for trt 3, respectively. Our hypothesis was that treatments 1 and 3 would perform similarly, and both would perform greater than trt 2. Treatment 3 would be most economical because of less UIP supplementation compared to trt 1 and improved performance compared to trt 2. Based on past feeding experience, we projected these steers to consume approximately 10 kg/d and gain 1.68 kg/d. However, due to poor feeding conditions and mud, these calves consumed 9.6 kg/d and only gained 1.47 kg/d. Therefore, projected and actual MP balances were not similar. Actual MP balances from 320 to 545 kg BW ranged from 99 to 165 g/d for trt 1, 4 to 97 g/d for trt 2, and 98 to 40 g/d for trt 3, respectively. Because no MP deficiency occurred, no trt differences were observed in DMI, gain, or feed efficiency ($P > .10$). The undesirable feeding conditions experienced in this trial most likely increased the steers' NEm requirement, resulting in gains lower than projected . Therefore, MP requirements were overpredicted.

Key Words: Beef Cattle, Metabolizable Protein, Finishing

260 Corn bran, solvent-extracted germ meal, and steep liquor/distillers solubles blends for finishing yearlings. D.W. Herold*[1], R.J. Cooper[1], T.J. Klopfenstein[1], C.T. Milton[1], and R.A. Stock[2], [1]*University of Nebraska, Lincoln, NE,* [2]*Cargill Corn Milling, Blair, NE*.

Medium framed yearling steers (280, 355 kg) were fed for 116 d to assess performance associated with either four blends of corn bran (BRAN) and steep liquor/distillers solubles (STEEP), or four blends of BRAN, STEEP, and solvent-extracted germ meal (GERM). Steers were blocked by weight and assigned randomly to one of eight treatments: 1)24%BRAN, 6%STEEP; 2)21%BRAN, 9%STEEP; 3)18%BRAN, 12%STEEP; 4)15%BRAN, 15%STEEP; 5)12%BRAN, 12%GERM, 6%STEEP; 6)10.5%BRAN, 10.5%GERM, 9%STEEP; 7)9%BRAN, 9%GERM, 12%STEEP; and 8)7.5%BRAN, 7.5%GERM, 15%STEEP (% of DM). Adaptation to grain was accomplished in 21 d using 45, 35, 25, and 15% roughage diets. Steers were implanted with Synovex Plus, and fed a diet containing 32.5% high-moisture corn, 22% dry-rolled corn, and 7.5% alfalfa hay once daily. Byproduct blends made up 30% of dietary DM. Interactions (P<.05) occurred for DM intake, ADG and gain to feed when STEEP replaced BRAN or BRAN/GERM. Quadratic (P=.06) and linear (P=.05) responses were observed for DM intake within BRAN and BRAN/GERM treatments, respectively, as dietary STEEP increased. A linear increase (P<.01) in ADG was exhibited for BRAN/GERM diets from 6 (1.9 kg) to 15% (2.2 kg) STEEP. Within BRAN diets, a quadratic response was demonstrated for ADG (P=.01) with 6 (2.0 kg) and 15% (2.0 kg) exhibiting lower means than 9 (2.1 kg) and 12% (2.1 kg) STEEP treatments. A linear increase (P<.05) in gain to feed was observed as STEEP level increased from 6 to 15% in both BRAN (.153 to .161) and BRAN/GERM (.158 to .171) treatments. These data suggest blending GERM with BRAN may enhance efficiency relative to BRAN alone, and both BRAN and BRAN/GERM diets are used more efficiently with higher steep liquor/distillers solubles inclusion.

Key Words: Corn byproducts, Wet corn gluten feed, Finishing

261 Effects of supplemental protein on intake and apparent digestibility of stockpiled bermudagrass hay in beef steers. J.S. Wheeler, D.L. Lalman, and C.A. Lents, *Oklahoma State University, Stillwater, OK/USA*.

To determine the effect of supplemental protein on intake and digestibility of stockpiled bermudagrass hay (SBH) harvested in early December, 4 crossbred steers (367 3.66) were used in a 4X4 latin square. Steers had ad libitum access to SBH (9% crude protein, (CP); 56% acid detergent fiber, ADF). Treatments were: no supplement (C); .16 g/kg of BW of supplemental CP daily (L); .36 g/kg of BW of supplemental CP daily (M); and .55 g/kg of BW of supplemental CP daily (H). Supplements were a mixture of soybean hulls and soybean meal fed at a rate of .59 kg/day. These supplements were formulated to be isocaloric and provided equal amounts of Ca, P, and K. Each period consisted of 14 days of adaptation followed by 5 days of sampling. Forage organic matter intake was 9.4, 10.7, 11.2, and 11.4 kg/d for C, L, M, and H fed steers, respectively (Linear effect P=.01). Total diet organic matter digestibility was 48.8, 54.8, 55.4, and 57.4 for C, L, M, and H fed steers, respectively (Linear effect P=.08). Total digestible organic matter intake was 4.8, 6.6, 7.0, and 7.1 kg/d for C, L, M, and H fed steers, respectively (Linear effect P=.01). Apparent CP digestibility was 48.8 .04 for C fed steers. Treatment effects were not significant for ADF and NDF digestibility (P>.35). In this stockpiled forage, CP digestibility was low, resulting in a dramatic increase in TDOMI with supplemental protein.

Key Words: Beef Cows, Supplementation, Bermudagrass

262 Effects of supplemental copper on cellular and humoral immune responses and performance of newly weaned calves. M.S. Davis*[1], G.E. Carstens[1], J.C. Branum[1], R.E. Mock[2], and A.B. Johnson[3], [1]*Texas A & M University, College Station, TX,* [2]*Texas Veterinary Medical Diagnostic Laboratory, Amarillo, TX,* [3]*Zinpro Corporation, Eden Prairie, MN*.

To examine the rate of **Cu** repletion on immunocompetence during the early postweaning period, Simmental x Angus calves (liver Cu = 23 ± 4 ppm DM) were randomly assigned to treatments (n = 14) containing 0, 10 and 50 ppm supplemental Cu. The basal diet contained 5.6 ppm Cu and consisted of 50% corn, 25% cottonseed hulls, 5% molasses and 20% supplement. Treatment diets were fed individually for 75 d. Supplemental Cu was a 1:1 mix of $CuSO_4$ and organic Cu (Availa Cu®). Liver biopsies were performed on d 0, 14, 28, 42 and 75. To assess humoral immune responses, calves were immunized with a 4-way modified-live viral vaccine on d 14 and 28, and ovalbumin (**OVA**; 4 mg) on d 47 and 61. Blood samples were collected weekly to measure serum neutralizing antibody titers to the 4 viruses and IgG titers to OVA. Cell-mediated immunity was assessed on d 14, 28, 42 and 54 by measuring skin swelling responses to intradermal injections of phytohemagglutinin (**PHA**) at 0, 6, 12, 24 and 48 h post-PHA. Calves were ship stressed (535 km) on d 42 and 43, and inoculated with IBR virus (1.68×10^8 $TCID_{50}$ units) on d 47. Rectal temperature and DMI responses to these stressors were unaffected by treatment. Overall 75-d ADG and DMI were not affected by Cu treatment and averaged 1.26 ± .05 kg/d and 6.68 ± .79 kg/d, respectively. Treatment differences in liver Cu concentrations were evident ($P \leq .01$) by d 14 (31, 58 and 162 ± 6.2 ppm DM for 0-, 10- and 50-Cu calves respectively) and continued to increase throughout the study. PHA skin swelling responses were not affected by treatment on d 14, but were higher ($P \leq .05$) in 50-Cu vs 0-Cu calves on d 28, 42 and 54. 50-Cu calves had higher ($P \leq .01$) BRSV and OVA titers, but lower ($P \leq .06$) PI3 titers compared to 0-Cu calves. Although the impact on humoral immune responses were inconsistent, these data suggest that repleting Cu-deficient calves at a faster rate may enhance cell-mediated immunity in calves.

Key Words: copper, immunity, calves

263 Weight gain and heat production in light weight mature cows following an increase in feed intake. H. C. Freetly*, J. A. Nienaber, and S. E. Echternkamp, *USDA, ARS, U.S. Meat Animal Research Center*.

The objectives of this study were, first, to determine the effect of increased feeding level on the time required to reach normal reproductive status; second, to determine the effect of increased feeding level on rate of body weight gain; and third, to determine the pattern of adaptation of

heat production to different levels of feed intake. One-hundred twenty-eight mature (7.7 ± .2 yr) nonpregnant, nonlactating MARC III (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer, 1/4 Red Poll) composite cows were penned four cows to a pen and placed on individual feeders. Eight pens of cows were assigned to each treatment. From −46 to d 0 cows on the High-High treatment received 299 kcal ME/kg$^{.75}$ BW$\cdot$d^{-1}, and cows on the other three treatments received 155 kcal ME/kg$^{.75}$ BW$\cdot$d^{-1}. On d 0, feed offered to the Low-High cows was switched to 299 kcal ME/kg$^{.75}$ BW$\cdot$d^{-1}, and feed offered to the Low-Medium cows was switched to 227 kcal ME/kg$^{.75}$ BW$\cdot$d^{-1}. Cows on the Low-Low and High-High treatments continued to be offered the same feed amounts. Cows remained on these fixed-feed intakes for 140 d. At d 0, the percentage of normal estrous cycles (97%) did not differ between cows fed 155 and those fed 299 kcal ME/kg$^{.75}$ BW$\cdot$d^{-1} ($P = 1.00$). After d 0, average daily gains were .56, .81, .57, and .32 ± .02 kg for the High-High, Low-High, Low-Medium, and Low-Low treatments, respectively. Efficiency of weight gain/kg DMI was higher in the Low-High cows (.053 ± .002) than the Low-Medium cows (.046 ± .002), and both were higher than that in the High-High (.036 ± .002) and Low-High (.035 ± .002) treatments ($P < .05$). Heat production (8 cows/treatment) increased in time in the Low-Medium and Low-High treatment, and the pattern of increase fit a third-order polynomial function. Heat production in the High-High decreased in time, and that in the Low-Low did not change. Cumulative heat production in the Low-High treatment was 94% of that in the High-High treatment. This study suggests that increased efficiency in weight gain can be used to defer supplemental feeding cost as long as the reproduction sensitivity of the breed type is not exceeded.

Key Words: Cow, Energy, Reproduction

264 Impact of divergent wheat milling byproducts in supplements on the forage use and performance of beef cattle consuming low-quality, tall-grass prairie forage.

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Two experiments were conducted to evaluate the impact on forage use and performance of incorporating divergent wheat milling byproducts (wheat bran [WB] and second clears [SC]) in a 30% CP supplement. The WB represented a high-fiber byproduct whereas the SC represented a high-starch byproduct. In both experiments three supplements were used in which the byproduct combinations constituted approximately 47-49% of each supplement. The byproduct combinations were: 1) 100% WB; 2) 67% WB, 33% SC; 3) 33% WB, 67% SC. In Exp. 1, ninety Hereford × Angus cows (BW=554 kg) grazing winter, tallgrass-prairie range were fed the treatment supplements (2.27 kg/head daily) from early December until calving (average calving date = 3/11/98). Cumulative body weight and condition changes from trial initiation through calving were not affected by treatment (P≥.34). Cow pregnancy rates as well as calf birth weights, ADG, and ending weights were unaffected by treatment (P≥.11). In Exp. 2, sixteen ruminally fistulated Hereford × Angus steers (BW=484 kg) were blocked by weight and assigned to receive one of the same three supplements or to a negative control (NC; forage only). Steers had ad libitum access to tall-grass prairie hay (76.4% NDF, 3.1% CP) and were fed supplement at the same rate as the cows (relative to body weight) in Exp. 1. Forage OM, NDF, and digestible OM intakes were lower (P<.01) for NC compared with supplemented steers but were not different (P≥.23) among the supplemented steers. Digestion of OM was lower (P=.03) for NC compared with supplemented steers, although no difference (P≥.46) was evident among the supplemented groups. Digestion of NDF was not affected (P=.49) by treatment. Within the context of the amount of supplemental protein offered, changes in the combination of wheat milling byproducts in our supplements did not affect cow performance or intake and digestion of low-quality forage.

Key Words: Forage, Wheat, Byproduct

265 First Limiting Nutrient for Lactating, Spring-Calving Beef Cows Fed Grass Hay.

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Thirty-six British cross beef cows (avg initial wt = 603 kg) were used to determine the first limiting nutrient for lactating, spring-calving beef cows fed grass hay. Cows were individually fed using Calan electronic head gates for 60 d post-partum. Cows were given ad libitum access to hay and intake was measured daily. Cows were stratified by weight and age and assigned randomly to one of four treatments: 1) negative control - no supplement provided, 2) energy supplement based on dried beet pulp (.71 kg/d), 3) degradable intake protein (DIP) supplement based on sunflower meal (.78 kg/d), and 4) DIP + undegradable intake protein (DIP +UIP) supplement based on a combination of sunflower meal, feather meal, and blood meal (.78 kg/d). Sunflower meal was included in the DIP + UIP treatment to balance the rumen degradable protein levels. All supplements contained similar levels of NE. There was no significant treatment effect (P>.10) on cow weight change or body condition score change. No significant differences were detected for milk production (P>.10; measured by a milking machine) or milk composition (P>.10). Furthermore, no differences (P>.10) were detected for calf weight gain. Results indicate that the grass hay used in this experiment was not limiting in energy, DIP, or UIP for lactating, spring-calving beef cows.

	Treatments				
Item	Control	Energy	DIP	DIP + UIP	SEM
DM Intake (%BW)	2.3	2.4	2.3	2.4	0.1
Initial Wt (kg)	602	602	602	605	50.9
Cow Wt Gain (kg)	–8.4	–7.3	–3.9	10.4	22.9
Cow BCS change	–0.7	–0.6	–0.8	–0.7	0.2
Calf Wt gain (kg)	34.9	39.9	37.6	39.0	9.9
Milk Production (kg)					
Initial	6.7	6.8	7.0	8.3	2.6
final	6.8	8.0	8.6	10.5	3.3

Key Words: Undegradable Intake Protein, Supplementation, Cow Performance

266 Effects of supplemental undegradable intake protein (UIP) on the performance of lactating beef cows grazing Oklahoma winter tallgrass prairie.

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Seventy-two lactating Hereford and Hereford x Angus cows grazing Oklahoma winter tallgrass prairie were utilized to determine the effects of increasing supplemental UIP on performance. Following parturiton (February and March; weight = 531 6 kg, BCS = 5.1 .4), cows were blocked by body condition score (BCS) and calving date and randomly assigned to one of four dietary treatments (February thru mid April). Treatments were formulated to provide 281 g of degradable intake protein with increasing amounts of UIP (142, 196, 248, and 301 g respectively). Cows were individually fed 1.36 kg of supplement daily, and body weight and BCS were determined biweekly until the end of supplementation (mid April). Milk production was determined 30 and 45 d postpartum (n = 40) using the weigh-suckle-weigh technique. Concentration of progesterone was quantified weekly in plasma samples to determine interval to first normal luteal function. Weight loss (-65 3 kg) and BCS loss (-.7 .1) were not influenced by treatment. Milk production at 30 and 45 d postpartum was similar for cows on all treatments. Milk production at 30 d postpartum was greater (P < .05) than 45 d (6.4 .2 vs 5.7 .2 kg respectively). The interval to first luteal function was similar (86 4 d) for cows on all treatments. We conclude that increasing supplemental UIP did not influence performance of cows grazing Oklahoma winter tallgrass prairie.

Key Words: Beef Cows, Undegradable Intake Protein, Winter Tallgrass Prairie

267 Conjugated linoleic acid content of milk fat is increased by feeding an animal fat low in linoleic acid.

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Conjugated linoleic acid (CLA), a mixture of isomers of linoleic acid (*cis*- 9, *cis*-12 C18:2) containing conjugated double bonds, has many potential human health benefits. Because CLA is formed in the rumen during biohydrogenation of C18:2, beef and dairy products are the primary sources of CLA in the human diet. An experiment was designed to examine changes in the CLA content of milk fat when cows were fed diets varying in energy source. Nine multiparous cows and nine primiparous cows were used in a replicated 3 X 3 Latin square design with 28-d periods. Treatments were 1) control (35% alfalfa haylage, 25% corn silage, 40% concentrate, DM basis) 2) control + 3% choice white grease, and 3) high grain (15% alfalfa haylage, 25% corn silage, 60% concentrate). Diets 2 and 3 were isocaloric. The choice white grease contained 23% C16:0, 13% C18:0, 40% /italicizecis C18:1, and 7.6 % C18:2. Cows consumed 138, 195 and 168 g C18:2 /d on the control, high fat and high concentrate diets, respectively. Production responses have been presented (J. Anim. Sci. 73(Suppl. 1):103). Briefly, fat decreased (P<.05) DMI compared to the high grain diet, and high energy diets increased (P<.05) milk production. Milk fat content was decreased by the high energy diets (P<.05). The CLA content of the milk fat was .23, .56, and .27 mg/100 mg FA for the control, added fat, and high concentrate diets, respectively. Contrasts comparing control vs. high energy and fat vs. high grain were significant (P<.0001) for the CLA content of milk fat and the amount of CLA produced per day. The CLA content of milk fat was not influenced by parity (P>.05), was correlated negatively with the contents of short and medium chain FA in milk fat (P<.01), and tended to be correlated negatively with milk fat content (P<.07). Milk CLA was correlated positively with the *trans*18:1 content of milk fat (P<.0001) and the intake of C18:2 (P<.0001). Milk fat CLA content is influenced by C18:2 intake regardless of the dietary source.

Key Words: Conjugated linoleic acid, CLA, Milk fat

268 Crop processing and chop length effects on utilization of corn silage by lactating dairy cows.

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Objectives were to evaluate corn silage processing and chop length effects on intake, digestion, and milk yield and composition in dairy cows. Treatment corn silages were either chopped at half milkline stage of maturity at .95 cm theoretical length of cut (TLC) without rolling (CU) or chopped and rolled at .95 cm (FR), 1.45 cm (MR), and 1.90 cm (CR) TLC with a 1 mm roll clearance. Twenty-four multiparous Holstein cows (50-100 DIM at start of trial) were in a replicated 4X4 Latin Square design with 28 d periods; one square was comprised of ruminally-cannulated cows for digestion measurements. Treatment silages were fed in TMR containing 50% forage (67% corn silage and 33% alfalfa silage) formulated to 18% CP (DM basis) using a corn-soy bean meal based concentrate. Silage mean particle lengths were 9.4, 6.7, 8.9, and 9.2 mm for CU, FR, MR, CR, respectively. Dry matter intake and milk yield were higher (P < .05) for rolled silages averaging 25.8 kg/d and 46.0 kg/d, respectively, versus 25.2 kg/d and 44.8 kg/d for CU. Milk fat percentage and yield were higher (P < .05) for rolled silages averaging 3.12% and 1.42 kg/d versus 3.05% and 1.34 kg/d for CU. Intake and milk and component yields were not different (P > .10) bewteen FR and CR. Chewing activity was not different among treatments and averaged 4.0 h/d and 8.0 h/d for eating and ruminating. Macro bag (25 cm X 35 cm) 24-h *In situ* DM disappearance was highest (P < .05) for FR (58.3%) and MR (57.2%) versus 51.0% and 52.9% for CU and CR. Rolling corn silage improved lactation performance. Length of chop effects in rolled silage were minimal.

Key Words: Corn silage, Processing, Dairy cows

269 Extruded-Expelled Cottonseed Meal (Express^{TM}) as a Source of Protein and Fat for Lactating Dairy Cows.

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Twenty-four Holstein cows were used in six 4x4 Latin squares to evaluate the effects of substituting extruded-expelled cottonseed meal (Express^{TM}) for whole cottonseed and solvent soybean meal in diets for lactating cows. No differences were observed in milk and milk components among treatments however, cows fed 2.73 kg Express^{TM} with distillers dried grains tended to consume less dry matter and produce less milk than cows fed 3.63 kg Express^{TM} without distiller dried grains. Complete replacement of whole cottonseed with Express^{TM} reduced plasma urea nitrogen (P<.01) and milk urea nitrogen (P<.05) but had no affect on plasma amino acids. In vitro analysis of Express^{TM} revealed that it contained 74% RUP that was 72% digestible in the small intestines.

Key Words: Extruded Cottonseed, Express TM, Rumen Undegradable Protein

270 Effect of dietary thiamin supplementation on lactation performance by dairy cows.

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Three feeding trials were conducted with mid lactation Holstein cows to evaluate the effect of dietary thiamin supplementation on intake and milk yield and composition. In Trial 1, 28 cows were blocked by parity (16 multi- and 12 primi-parous) and randomly assigned to either placebo (C) or thiamin (T) topdress (57 g per cow per day). The topdress was provided once daily on top of the TMR, and cows remained on their respective topdress for eight weeks. Cows fed T received 150 mg thiamin per day from thiamin mononitrate. Cows on C and T were randomly assigned to either corn-soy bean meal (S) or pelleted corn byproduct (B) TMR containing 55% alfalfa silage (DM basis) in a four week crossover experiment. Milk yield (35.1 vs 31.7 kg/d; P<.09) and DM intake (24.8 vs 23.2 kg/d; P<.06) tended to be higher for T on both S and B. In Trial 2, 20 multiparous cows were in a crossover design with four week periods. Either placebo (C) or thiamin (T) premix (114 g per cow per day) were added to TMR containing 50% forage (2/3rd corn silage:1/3rd alfalfa silage; DM basis). Cows fed T received 300 mg thiamin per day from thiamin mononitrate. Milk (39.5 vs 38.8 kg/d; P<.15) and protein (1.27 vs 1.23 kg/d; P<.09) yield tended to be higher for T. In Trial 3, 16 multiparous cows were in replicated 4X4 Latin Square design with 21 day periods. Main effects in the 2X2 factorial arrangement of treatments were silage processing method and dietary thiamin supplementation. Either placebo (C) or thiamin (T) premix (114 g per cow per day) were added to TMR containing 60% alfalfa silage (DM basis). Cows fed T received 300 mg thiamin per day from thiamin mononitrate. Milk fat% (3.56% vs 3.74%) and yield (1.43 vs 1.51 kg/d) tended to be lower (P<.06) for T. There were trends for improved lactation performance from dietary thiamin supplementation in 2 of 3 trials.

Key Words: Thiamin, Milk production, Dairy cows

271 Use of high oil and high lysine corn in dairy-calf starter diets.

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Two consecutive studies were conducted to evaluate use of high oil (HO;7.6% oil) vs regular dent corn (RDC;4.2%) and high lysine (HL;.38% lysine) vs RDC (.28% lysine) in calf starter diets offered from 3 to 56-d-of-age. A total of 70 calves (av 3-d BW, 42.7 kg) were assigned to both studies. Calves were housed in individual hutches. Calves were fed a 22% CP and 20% fat milk replacer (MR) from 3 d of-age, at 227 g in 1.8 l water twice daily for 25 d and once daily for a further 7 d until weaning at 35 d of-age. In the first study, 30 calves were randomly assigned to receive a complete 17.5% CP diet (DM basis) containing either 50% cracked HO or RDC. Corn type did not affect (P>.05) average daily gain (ADG, .57 kg) and feed DM/gain (2.21 kg) In the second study, 40 calves were assigned to receive a complete 15.3% CP diet (DM basis) containing either 58% cracked HL or RDC with dried distillers grains/SBM (DGSB) or SoyPlus (SP) as main protein sources in a 2 x 2 factorial design. Average DMI (including MR) and ADG from 3 to 56 d were 1.14, .46; 1.19, .55; 1.06, .45; 1.23 and .57 kg for calves fed HL-DGSB, HL-SP, RDC-DGSB and RDC-SP diets, respectively. Calves fed SP diets had higher (P<.01) overall gains, DMI, and lower (P<.04) feed DM/kg gain than those fed DGSB diets. Under the conditions of these studies HO did not enhance calf performance. Calves fed HL corn performed equally as well as those fed RDC. Protein source influenced calf performance regardless of corn type.

Key Words: Corn type, Protein source, Calf performance

272 Effect of dietary protein content on frame growth, blood, metabolites, and nitrogen balance in Holstein heifers. P.C. Hoffman*[1], N.M. Brehn[1], H. Chester-Jones[2], and M. Engstrom[3], [1]*University of Wisconsin, Madison,* [2]*University of Minnesota, Waseca,* [3]*Roche Animal Nutrition and Health*.

Forty Holstein heifers (398 kg) were used in a 121-d growth study to evaluate the effect of dietary protein on heifer growth parameters and blood metabolites. Heifers were blocked by BW and randomly assigned to one of four iso-caloric TMR's (2.36 ME/kg) formulated to contain 9, 11, 13, or 15% CP in the diet DM. Dietary ingredients included corn silage, earless corn silage, shelled corn, SBM, corn gluten feed and starch. Actual CP content in the diets were 8.1, 10.7, 12.7, and 15%, respectively. Dietary protein content did not affect ADG (P>.10). Wither height (P<.01), hip width (P<.01), and girth (P<.04) increased linearly with protein level but there were slight decreases or no change in these measurements for 15% CP. Heifer volume (wither height x length x (girth/3.14)/1000 tended to increase linearly (P<.10) with protein level. Serum protein, albumin, and blood urea nitrogen (N) increased linearly (P<.01) with increasing dietary CP%. In a concurrent metabolism study, eight Holstein heifers (407 kg) were randomly assigned to a replicated 4 x 4 Latin Square and fed similar dietary protein levels and TMR's as in the growth study. The effect of dietary CP% on N-balance and nutrient digestibility were evaluated. The amount of DM fed during three 5-d collection periods was fixed, based on DMI during a preliminary period. Increasing dietary CP% enhanced digestibility of DM, OM, and CP (P<.03). Nitrogen intake, fecal-N, urinary-N, and absorbed-N increased linearly (P<.01) with CP%. Retained-N was not affected (P>.10) by dietary CP. Actual amount of DMI increased linearly (P<.01) with dietary CP level, averaging 7.1, 8, 8.2, and 8.8 kg/d for heifers fed 8.1, 10.7, 12.7 and 15% CP, respectively. The growth study suggested that heifer growth parameters were not enhanced above 13% dietary CP. The metabolism study indicated N retention was not enhanced when diets contained >13% CP.

Key Words: Dietary protein, Dairy heifers, Growth

273 The effects of tannin on milk yield and some blood constituents in dairy cattle. M. A. Kobeisy*[1], J. Boehm[2], and J. Leibetseder[3], [1]*Animal Prod. Dept. Fac. of Agric., Assiut, Egypt,* [2]*Institut of Nutrition, Vet. Med.Univ., Vienna,* [3]*Rector of the Univ. Vet. Med., Vienna, Austria*..

The objectives of this study were to examine the effects of tannin on milking performance, blood metabolities and liver function (AST & ALT enzymes)in dairy cattle. A total number of 16 dairy cwos were allotted according to their milk production into two treatment groups, 8 animals in each. A control group receiving no tannin supplement and a tannin-treated group receiving supplemental dietary hydrolizable tannin, added daily to concentrate at 405 g per cow. All animals were fed a concentrate and roughage diet to cover their requirements for maintenance and production, during a 2 weeks preliminary and 4 weeks experimental periods. Milk yield was recorded daily and blood samples were taken every week for determination of some blood constituents. Dietary tannin increased (P<0.01) milk yield (25.26 vs. 23.09 kg/d). Daily milk yield improved by about 9 %. Serum concentrations of glucose, total protein, albumin and globulin tended to be lower in tannin-treated animals. No significant differences were observed in the levels of AST and ALT enzymes between control and tannin-treated animals. Serum urea-nitrogen slightly increased due to tannin treatment. It was concluded that supplementation of dietary tannins added daily to concentrate at 405 g per cow improved daily milk yield without any deletrious effects on some blood constituents and liver function (Ast and ALT) in dairy cattle.

Key Words: Dairy cattle, tannin, blood

274 The influence of tannin on rumen metabolism using RUSITEC. M. A. Kobeisy*[1], J. Boehm[2], G. Dirl[2], M. Holtershinken[3], and J. Leibetseder[4], [1]*Animal Prod. Dept., Fac. of Agric., Assiut, Egypt,* [2]*Institut of Nutrition, Vet. Med. Univ., Vienna,* [3]*Vet. Med. Univ., Hannover, Germany,* [4]*Rector of the Univ. Vet. Med., Vienna, Austria*.

The objective of this study was to determine the effects of dietary hydrolizable tannin (2.7, 4.0, 5.4 and 8.0 % of DM) on invitro- digestibilities, ammonia -N, pH, gas producton, VFA's in rumen using cattle's rumen liquor in rumen simulation technique (RUSITEC). The feed used was the same in two vessels, 11 g hay and 9 g concentrates. particularly crude protein. The decrease in crude protein digestibility due to 2.7, 4.0, 5.4 and 8.0 % tannin addition were 11.2, 12.2, 8.5 and 21.0 units, respectively. Addition of dietary tannin increased pH values, particularly with 5.4 % tannin (P <0.01). While Redox values did not significantly differ among treatments. Dietary tannin reduced ammonia-N concentrations. Tannin addition decreased concentration of acetic, propionic, I-buteric and N-valeric, while increased the concentration of N-butric in most tannin's levels. However, I-valeric concentration was unaffected. Hexan concentration increased (P<0.01) due to 8% tannin addition. In conclusion, when tannin is included in the diet, particularly high level, the invitro-digestibilities and the end product of fermentation are decreased. To confirm this results, additional studies including in vivo observations are necessary.

Key Words: Tannin, rumen metabolism, RUSITEC