RUMINANT NUTRITION

454 Effect of additional zinc, copper, manganese, and cobalt on reproduction and milk production of lactating dairy cows receiving bovine somatotropin. M. H. Campbell*, and J. K. Miller, *The University of Tennessee, Knoxville.*

The objective was to determine if complexed zinc, copper, manganese and cobalt would improve reproductive performance and/or milk and milk component production in lactating dairy cows that started receiving bovine somatotropin in the ninth week of lactation. Holsteins (n = 50) and Jerseys (n = 10) received either the control or the treatment diet from parturition until 154 d of lactation. The treatment diet contained 14.9 ppm Zn as zinc methionine, 5.2 ppm Cu as copper lysine, 8.2 ppm Mn as manganese methionine, and 1.06 ppm Co as cobalt glucoheptonate in addition to the levels included in the control diet. Cows were blocked by breed, lactation number, and presence of retained fetal membranes. The incidence of retained fetal membranes increased days to first estrus (detected via HeatWatch™) in the control cows (54.2 vs 81.0, P =.05) but not the supplemented cows (49.6 vs 44.0, P >.6). Days to first service, days open, days from first service to conception, services per conception, milk production and milk components were not different. Somatic cell counts were similar for both treatments. Treatment effectively reduced days to first estrus when cows were stressed with the presence of retained fetal membranes.

Key Words: Reproduction, Trace Minerals

455 Immune response and performance of heifers supplemented with zinc from an organic and an inorganic source. E. B. Kegley*, D. L. Kreider, K. P. Coffey, S. A. Silzell, and D. L. Galloway, *University of Arkansas, Fayetteville.*

Seventy-five Angus crossbred heifers, were transported 7 h, then used to determine the effects of zinc sulfate or a zinc amino acid complex on their immune response and performance. Heifers (176.4 ± 2.5 kg initial BW) were blocked by breed, stratified by weight, then assigned randomly to 15 groups of five heifers each. Treatments were 1)control (no supplemental Zn), 2) Zn sulfate (360 mg of Zn/d), or 3) Zn amino acid complex (360 mg of Zn/d). Each treatment consisted of five replicates assigned at random to treatment. Heifers were kept in .45 ha mixed bermudagrass and fescue pastures and bermudagrass hay (38 mg Zn/kg) was available ad libitum. Heifers received 1.8 kg/d of a corn and wheat middling supplement, that served as the carrier for the treatments. Gain did not differ (P > .10) on d 14, 28, or 56 among supplemental zinc treatments. Serum Zn concentrations were similar (P > .10) on d 28 and 56 among treatments. On d 28, total white blood cell concentrations and the percentages of neutrophils, lymphocytes, monocytes, eosinophils, and basophils did not differ (P > .10) among supplemental Zn treatments. In vivo cell-mediated immunity was measured on d 70 by determining the response by heifers to an intradermal injection of phytohemagglutinin. Skinfold thickness was measured 0, 4, 8, 12, and 24 h after injection. Heifers fed supplemental zinc had a greater (P < .07) response 24 h after injection. Supplemental zinc from an organic or inorganic source did not affect gain, but may enhance cell mediated immune function of stocker cattle.

Key Words: Beef Cattle, Zinc, Immunity

456 Effects of mineral source on the hoof durability, reproductive, and feedlot performance of heifers. A. E. Wertz[1]*, L. L. Berger[1], R. A. Dvorak[2], and K. A. Jacques[2], *[1]University of Illinois, Urbana and [2]Alltech, Inc., Nicholasville, KY.*

Sixty-one heifers were randomly allotted to three mineral treatments to evaluate the effects of mineral source on reproductive performance, feedlot performance, and hoof durability.Mineral supplements supplied 30 ppm Zn, 40 ppm Mn, 10 ppm Cu, 0.3 ppm Se and 0.1% Mg.Mineral requirements were met with inorganic mineral sources for the Control treatment. TheBioplex® treatment supplied 33% of the Zn, Mn, and Cu, as chelates and Se as sodium selenite. The Bioplex/Sel-Plex® treatment supplied 33% of the Zn, Mn, and Cu, as chelates and Se as selenium yeast. Treatments were initiated 60 d prepartum and continued until trial termination. The trial was terminated when heifers reached market condition. Estrus was based on serum progesterone levels taken at 10 d intervals from 20 d postpartum. Ovary and liver tissue collected at slaughter were analyzed for mineral content. Hoof sheer force was measured to characterize hoof durability. No significant differences in hoof durability or feedlot performance resulted from mineral source. No significant difference in postpartum return to estrus existed as the result mineral of source. Bioplex® and Bioplex/Sel-Plex® heifers returned to estrus an average of 35 d sooner postpartum than Control heifers, however, this difference was not significant. Tissue Cu and Se accumulation was higher ($P<.05$) for the Bioplex/Sel-Plex® heifers relative to the Bioplex® heifers. The chelated mineral source increased tissue accumulation of Cu and Se and may have hastened postpartum return to estrus.

Key Words: Mineral, Reproduction, Hoof Durability

457 Evaluation of nutrient status of immunologically compromised calves from northern Idaho. K. L. Thompson[1]*, R. C. Bull[1], K. M. Byrne[2], J. A. Church[1], J. J. Ney[1], *[1]University of Idaho, Moscow and [2]Washington State University, Pullman.*

Immunologically compromised calves have been reported by feedlot veterinarians when the source of calves is from northern Idaho. A field trial was conducted to determine whether calves originating from this region had a compromised immune system because of certain nutrient deficiencies. Crossbred steer calves averaging 130 kg were selected from seven beef producers (20 calves/herd). Within each herd half of the calves was initially given an orally administered 12.5 g Cu bolus (Schering-Plough) and two Se boluses (10% elemental Se; ICI Australia Operations) and injected with 5 mL of vitamins A, D, and E. At weaning (approximately 120 d later) these calves were retreated with one Cu bolus and 5 mL of vitamins A, D, and E. Remaining calves (10 calves/herd) served as controls without supplemental nutrients. Health care and ranch management were not molified. Serum Cu and Zn and whole blood Se and white cell count were monitored in jugular blood samples at initial and weaning periods. Forage and soil samples were collected on pastures during late summer. Forages were analyzed for CP and NDF and both forage and soil samples were analyzed for Se, Cu, and Zn. Supplemental Se increased whole blood Se ($P < .01$), but .14 vs .12 ppm Se for supplemented vs. control, respectively, but were within normal adequate levels. Supplemental nutrients increased total white cell count ($P < .09$), neutrophils ($P < .07$) and basophils ($P < .01$). Forages were low in Cu, Zn, CP (averaged 6.0%), while soils were high in Fe and Mo and low in Zn and Cu. Lymphocyte function studies were conducted on calves immunized with modified live IBR and PI3 vaccines at weaning. Lymphocytes were harvested, stimulated with concavalin A mitogen and killed bovine herpes virus (BHV). Supplemental nutrients increased lymphocyte BHV response ($P < .07$). Forage Cu, Zn, and CP were all deficient, possibly resulting in a compromised immune system.

Key Words: Beef Calves, Immune, Nutrition

458 Impact of tocopherol form and dosing site on blood serum responses by steers. H. Han, and F. N. Owens, *Oklahoma State University, Stillwater.*

Eight mature ruminally and duodenally cannulated beef steers (510 kg) fed low quality prairie hay were used to determine relative availability of α-tocopherol from ruminally or duodenally dosed α-tocopherol or α-tocopherol acetate. Relative availability was calculated as the increase in serum (jugular or coccygeal vein) concentration between pre-dosing and two weeks after daily dosing. Rest periods of at least 3 weeks followed each experiment. In experiment 1, six steers were dosed ruminally or duodenally with 500 IU tocopherol acetate (dry form) daily for 14 days. Surprisingly, serum tocopherol concentrations were higher (1.05 vs .64 ug/ml; $P < .01$) with ruminally than duodenally dosed acetate, opposite what one would expect from ruminal destruction of tocopherol. In experiment 2, steers were dosed either ruminally or duodenally with 2,000 IU of either tocopherol or tocopherol acetate (both liquids) daily for 14 days. With ruminal dosing, serum response tended to be greater (2.80 vs 2.29 ug/ml) from the acetate than the free alcohol form. However, with duodenal dosing, the serum response was opposite, tending to be greater from the free alcohol than from the acetate form (.79 vs –.43ug/ml). Responses were less from duodenally than ruminally dosed tocopherol. In experiment 3, 2,000 IU of either tocopherol or tocopherol acetate (both liquids) was infused into the duodenum daily for 14 days. Blood serum tocopherol concentrations were higher ($P < .01$) from the free alcohol than the acetate form of tocopherol (0.84 vs 0.27ug/ml). Indeed, serum responses to duodenally infused tocopherol acetate were nil. In conclusion, serum responses indicate that postruminal availability of the acetate form of tocopherol is very low; availability is increased by exposure of the acetate form to ruminal contents. Whether this enhancement in availability of tocopherol acetate in the rumen is due to hydrolysis of the ester, attenuated passage to the small intestine or other factors is not yet known.

Key Words: Tocopherol Acetate, Rumen, Duodenum

459 Effect of feeding gossypol from cottonseed meal and vitamin E to dairy calves. J. Velasquez-Pereira, L. R. McDowell*, C. A. Risco, D. Prichard, N. S. Wilkinson, L. X. Rojas, P. Rabiansky, M. Tiffany, and S. N. Williams, *University of Florida, Gainesville and Hoffmann-La Roche, Nutley, NJ.*

Newborn male Holstein calves were used to test the effect of feeding 400 mg free gossypol/kg and to determine if vitamin E could counteract gossypol toxicity. The treatments were as follow: **CON**: SBM based starter; **GOS**: CSM based starter; **G+2E**: CSM based starter + 2,000 IU vitamin E · $calf^{-1}$ · d^{-1}; **G+4E**: CSM based starter + 4,000 IU vitamin E · $calf^{-1}$ · d^{-1}. Vitamin E improved ($P < .05$) weight gain and feed intake over CON calves. Plasma gossypol concentrations were higher ($P < .05$) in calves receiving CSM than CON calves; however, there were no differences among animals receiving the three CSM diets. Hemoglobin and hematocrit were decreased ($P < .05$) in GOS calves, and vitamin E supplementation counteracted ($P < .05$) this effect. Plasma α-tocopherol concentration was not affected ($P > .1$) by gossypol intake and followed the supplementation pattern. During the experimental period, 10 calves died, 6 from the GOS and 2 each from G+2E and G+4E. Necropsy findings from 8 of 10 calves were suggestive of gossypol toxicity. Histopathological examination revealed centrilobular necrosis in the liver and atrophy and vacuolation of cardiocytes. Feeding gossypol from CSM caused death of some calves with gossypol related toxicity signs. Gossypol did not decrease plasma α-tocopherol; however, vitamin E supplementation increased performance and may have conferred some protection against gossypol toxicity.

Key Words: Gossypol, Vitamin, Calves

460 Effects of vitamin D_3 supplementation of beef steers on longissimus muscle tenderness. S. S. Swanek*, J. B. Morgan, F. N. Owens, H. G. Dolezal, and D. R. Gill, *Oklahoma State University, Stillwater.*

Two studies were conducted to evaluate the effects of supplemental vitamin D_3 on Warner-Bratzler shear values (WBS) of longissimus muscle from feedlot beef steers. Longissimus muscle steaks (2.54 cm thick) were aged for 7, 14 or 21 d and then frozen. Steaks were thawed and broiled to a internal temperature of 70°C, allowed to cool to 20°C, and eight 1.27 cm core samples were obtained and sheared. In Exp. 1, 118 steers (529 kg mean weight) from two trials were supplemented with 0 or 5 million IU of vitamin D_3 per day for 5 d immediately prior to slaughter. Vitamin D_3 supplementation resulted in lower WBS values after 7 d of postmortem aging (4.38 vs 4.71 kg; $P < .05$); no differences were observed at 14 d (3.86 vs 4.04 kg; $P = .22$) or 21 d of postmortem aging (3.59 vs 3.58 kg; $P = .95$). In Exp. 2, 44 steers (571 kg mean weight) from two studies were supplemented with 0 or 7.5 million IU of vitamin D_3 per day for 10 d immediately prior to slaughter. Supplementation lowered WBS at 7d (4.21 vs 5.15 kg; $P < .05$), 14 d (3.82 vs 4.40 kg; $P < .10$), and 21 d of postmortem aging (3.51 vs 4.04 kg; $P < .05$). Plasma calcium concentration at slaughter tended to be greater (10.4 vs 9.3 mg/dl; $P < .10$) and plasma magnesium was lower (1.46 vs 1.98 meq/l; $P < .01$) for steers that received supplemental vitamin D_3 in Exp. 1. Presumably, an increase in activity of proteases associated with the calpain system during aging is responsible for the increased meat tenderness.

Key Words: Vitamin D_3, Calcium, Tenderness

461 Wet corn gluten feed use in North Dakota: Roughage source in grower diets, evaluation of dietary level, and the influence of corn, barley, and hull-less oats in finishing diets. D. V. Dhuyvetter[1], R. M. Collins[2], J. S. Caton[3]*, M. Kapphahn[3], C. Schauer[3], and M. Marchello[3], *[1]Farmland Industries, Inc., Kansas City, MO, [2]Spearfish, SD, and [3]Department of Animal and Range Sciences, North Dakota State University, Fargo.*

The efficacy of feeding cattle wet corn gluten feed (WCGF) in southeastern North Dakota was evaluated under growing and finishing conditions for fall-fed calves. One hundred forty-four Charolais (96 hd) and Red Angus (48 hd) crossbred steers were stratified by breed and initial weight, then allotted randomly (6 $hd^{-.1}$ 4 $rep^{-.1}$ trt^{-1}) to experimental diets for the growing and finishing periods. Steers (248 ± 22 kg) were fed 84 d for the growing period using isocaloric (1.67 and 1.05 Mcal/kg NEm and NEg, respectively) WCGF/forage based combinations (WCGF + wheat straw (WS); WS + corn (WSC); WS + alfalfa (WSA); WSA + corn (WSAC); and WCGF + alfalfa (A)) in the diets. Next, steers (339 ± 16 kg) were fed finishing diets for 140 d using isocaloric (1.91 and 1.28 Mcal/kg NEm and NEg, respectively) WCGF/grain combinations (0, 28, 56, 85% WCGF, diet DM), with dry rolled corn as the base grain, and substitutions with barley (28B) and hull-less oats (28HLO) for corn in the 28% WCGF dietary treatment. Performance and carcass data were statistically analyzed using a randomized complete block design, with pen and animal as the experimental unit, respectively. Cumulative 56-d grower performance was (7.4, 1.3, .17; 7.0, 1.2, .17; 6.9, 1.2, .17; 7.2, 1.2, .17; 7.2, 1.1, .16; DMI (kg), ADG (kg), and G/F, for WS, WSC, WSA, WSAC, A, respectively) unaffected ($P > .15$) by forage combination. Cumulative finishing performance and carcass characteristics were summarized in the table below. These data suggest that WCGF can be an effective feed source for cattle fed under similar conditions in North Dakota.

Response	0	28	56	85	28B	28HLO	SE	P^a
DMI, kg[b,d]	8.9	10.2	10.1	9.3	9.6	9.5	.17	.01
ADG, kg	1.5	1.6	1.7	1.4	1.6	1.6	.04	.01
G/F[b,c,d]	.17	.16	.17	.16	.17	.17	.004	.05
HCW, kg[b,e]	349	361	363	343	349	354	4.68	.02
YG[d,e]	2.8	2.8	3.1	2.6	2.6	2.6	.14	.03

[a]Overall F-test.
[b,c,d,e]Polynomial contrasts were, 28B v 28, 28HLO v 28, and cubic, and quadratic level effects, respectively ($P < .10$).

Key Words: Wet Corn Gluten Feed, Cattle, Concentrate

462 Wet corn gluten feed use in North Dakota: Evaluation of dietary level, and the influence of corn and barley in finishing diets on digestion coefficients. C. S. Schauer[1]*, D. V. Dhuyvetter[2], R. M. Collins[3], J. S. Caton[1], R. Weis[1], and V. Burke[1], *[1]Department of Animal and Range Sciences, North Dakota State University, Fargo, [2]Farmland Industries, Inc., Kansas City, MO, and [3]Spearfish, SD.*

The efficacy of feeding cattle wet corn gluten feed (WCGF) in southeastern North Dakota was evaluated for finishing diets. Five Angus × Hereford crossbred steers (496 ± 36 kg) fitted with indwelling ruminal, duodenal, and ileal cannulas were arranged in a 5 × 5 Latin square experiment. Treatments (1.91 and 1.28 Mcal/kg NEm and NEg, respectively) were WCGF/grain combinations (0, 28, 56, 85% WCGF, diet DM), with dry rolled corn as the base grain. Barley was substituted for corn to formulate a 28% WCGF/barley dietary treatment (28B). Animals were fed (1.3% BW) once daily at 0700 h. Each period (19 d) allowed for 5 d collection of fecal, duodenal and ileal digesta samples. Flow rate was determined using chromic oxide (12g/d) as an external marker. Site of digestion data were analyzed using appropriate terms for a 5 × 5 Latin square design. As was expected, total OM intake was similar ($P>.10$) while N intake increased ($P<.10$) with advancing WCGF treatment. Total tract digestion of OM and N were unaffected ($P>.10$) by treatment. Total tract and ruminal NDF digestion tended ($P<.16$) to be lower in WCGF diets when compared with 0 WCGF diets. Ruminal OM digestion was highest ($P<.10$) in 0 WCGF diets while other treatments had similar ruminal OM digestion coefficients. Ruminal OM digestion in steers fed 28B was similar ($P>.10$) to those fed 28 WCGF and lower than 0 WCGF fed steers. No other differences ($P>.10$) were observed in digestion of OM, NDF, or N. These data suggest including WCGF in grain based diets has minimal effects on total tract digestion. Some differences in ruminal and intestinal digestion were observed. Additional work evaluating WCGF and barley combinations would further define the usefulness of WCGF in finishing diets.

Key Words: Wet Corn Gluten Feed, Cattle, Metabolism

463 The effects of alkaline hydrogen peroxide treatment on the composition, rate and extent of degradation of sunflower heads, stalks and hulls. J. Lehmkuhler* and M. S. Kerley, *University of Missouri, Columbia.*

The objective of this study was to assess the value of postharvest sunflower residue after treatment with an alkaline hydrogen peroxide solution. The head, stalk and hull were treated with a 1% hydrogen peroxide solution at a pH of 11.5 for approximately 24 hours. Compositional changes in NDF, ADF, ADL, CP and percent recovery were observed. Treatment of sunflower heads resulted in a significant decrease ($P<.0001$) in %ADL (13.25 vs. 2.41) and CP (9.87 vs. 2.77) while %NDF and %ADF increased ($P<.0001$). Treatment did not significantly change %ADL for stalks or hulls ($P<.34$ and $P<.11$ respectively), however, CP, NDF and ADF were significantly altered ($P<.0001$) for both plant components. Two steers with ruminal cannulas were utilized to determine the extent and rate of ruminal degradation of treated and non-treated head, stalk and hull. Samples were incubated for 0, 3, 6, 9, 12, 18, 24, 36, 48 and 96 hours. Rates of degradation were analyzed by graphing the natural log of the percent potentially degradable fraction for the incubation periods 3 through 24 hours against time. The differences between slopes were then analyzed using a paired t-test analysis. Treatment significantly ($P<0.1$) increased the rate of degradation for all three components with the hulls having the greatest response in rate of degradation (2.00 vs. 4.54 %/hour for non-treated and treated respectively). The head portion of the sunflower plant had the highest rate of degradation (2.36 and 4.76 %/hour) over the other components for both treatments while the stalks tended to have the lowest rates (1.87 and 3.54 %/hour). This study reveals that sunflower heads are a highly digestible, medium quality feedstuff that could potentially be utilized by ruminants and that grazing sunflower residues could be used to extend grazing periods.

Key Words: Sunflower Digestibility, Ruminant, Chemical Treatment

464 Poultry litter and molasses for growing Holstein bulls. H. Morales-Treviño*, E. Gutierrez-Ornelas, A. J. Tapia-Villarreal, T. J. Klopfenstein, and R. Gonzalez-Gonzalez, *Universidad Autonoma de Nuevo Leó, Facultad de Agronomia.*

Twenty samples of poultry litter (PL) collected from 15 broiler farms were used to measure variation in DM, OM, NDF, ADF, CP and in vitro OM digestibility (IVOMD). High variations were found among different PL for all the measurements (g/kg): 860±2.7 DM; 808±5.6 OM; 153±12.0 ADF; 318.8±36.1 NDF 307±21.7 CP; 713.5±41.9 IVOMD. In a 84d-growing trial, PL was included at three levels (0, 15 and 30 %) using 33 Holstein bulls(219 Kg.). Eleven bulls were assigned to each diet in a completely randomized design including the initial body weight (BW) as covariable. Average daily gain (1.17, 1.27 y 1.17 Kg) and feed conversion (6.00, 5.78 y 6.46) were not affected (P>.05) by level of PL. Dry matter intake increased linearly (P<.01) 24 g/day for each percentage unit of PL included in the diet. Likewise, DMI as g/Kg. $BW^{.75}$ was increased 0.32. Cost of gain was reduced 18.4 % (P<.05) even when DM intake was increased with the PL. In a second trial, cane molasses was included at three levels (9, 18 y 27 %) in a 112d-growing trial using 31 Holstein bulls (240.26 ± 59 Kg.), the three diets had 18 % of PL. Eleven bulls were assigned to each diet and the data analyzed as trial 1. Molasses did not affect (P>.05), daily gain (1.41, 1.40 y 1.28 Kg.), feed intake (7.76, 7.82 y 7.42 kg) and feed conversion (5.56, 5.65 y 5.82). It is possible to use up to 30% of PL and 27 % of molasses in the growing diets without reduce bull performance.

Key Words: Holstein Bulls, Poultry Litter, Molasses

465 Selected fractionate composition and digestibility of an extruded diet containing food waste fed to sheep. P. M. Walker, S .A. Wertz, and T. J. Marten*, *Illinois State University, Normal.*

Twenty four Suffolk wethers, 8-10 mo. old and weighing 43.5 – 70.2 kg. mean = 59.0±7.0 kg were randomly allotted to metabolism crates to determine the apparent digestible energy, protein, ether extract and fiber fractionates of an extruded feed mixture (EF) containing pulped food waste (FW), soybean hulls (SBH) and rolled shelled corn (C). FW, as referred to in this abstract, refers to post-consumer plate scrapings containing uneaten food and waste paper products such as napkins, cups, etc. and pre-consumer unserved prepared foods, both of which have been processed through a waste pulper. FW:SBH:C were mixed in a 40: 55:5 ratio on a wet wt. basis prior to extruding. EF was fed at 2.8% of body weight for 30d with total fecal collection the last 7 days. Gross energy was determined on all samples with an adiabatic bomb colorimeter. FW was found to contain 43.7±7.7% DM, 14.6±7.9% ADF, 9.7±9.0% cellulose 4.5±3.2% ADL, 28.1±7.3% CP and 17.2±3.9% ether extract. EF was found to contain 84.2±2.0% DM, 33.5±5.2% ADF, 28.9±6.9% cellulose, 3.7±1.8% ADL, 16.4±1.6% CP and 4.4±.5% ether extract. Apparent digestible energy of EF was determined to be 3.22 Mcal:kg. Apparent digestibility coefficients were 54.5 % DM, 42.6% ADF, 49.0% cellulose, 60.3% protein, 76.2% ether extract. Extruded feed containing food waste has the potential to make a highly acceptable feedstuff capable of supporting production.

Key Words: Digestibility, Foodwaste, Extruded

466 In vitro ammonia concentrations of corn and sorghum as influenced by the degree of processing and nitrogen source and level. M. S. Brown[1], M. L. Galyean[2], G. C. Duff[1]*, D. M. Hallford[1], and S. A. Soto-Navarro[1], *[1]New Mexico State University, Las Cruces and [2]West Texas A&M University, Canyon.*

Ruminal fluid from two heifers (384±2 kg) fed an 85% concentrate diet at 1.7% of BW was used to determine effects of processing and N source and level on in vitro ammonia concentrations (NH_3). A buffer:water mixture (25:75) was used to allow changes in pH. In Exp. 1 (2×4 factorial), treatments were unprocessed corn and sorghum (**UP**) and each grain steam-flaked to bulk densities (**BD**) of .38, .33, and .28 kg/L (**C38**, **B33**, **A28**, respectively). Treatments in Exp. 2 (2×2×3 factorial) were **UP** and **A28** corn or sorghum supplemented with 0, 5, or 10 mg N/culture provided by urea (**U**) or casein hydrolysate (**CH**). In Exp. 1, NH_3 of corn was less (*P*<.10) than sorghum at 8 h. Ammonia of **UP** was greater (*P*<.02) than NH_3 for the average of **C38**, **B33**, and **A28**. As **BD** decreased at 4, 8, and 12 h, NH_3 decreased linearly (*P*<.05). At 1 h, NH_3 increased quadratically (*P*<.01) with increasing N level. At 2 h, **A28-CH**, **A28-U**, and **UP-CH** increased NH_3 quadratically (*P*<.07), whereas NH_3 of **UP-U** increased linearly (*P*<.001) with increasing N level. At 4 h, **A28-CH** and **UP-CH** increased NH_3 quadratically (*P*<.01), whereas NH_3 of **A28-U** and **UP-U** increased linearly (*P*<.01) with N level. At 8, 12, 18, and 24 h, **CH** and **U** increased NH_3 linearly (*P*<.001), but the magnitude was greater (*P*<.001) for **U** than for **CH**. At 1 h, NH_3 of **UP-CH** increased linearly (*P*<.02), whereas **UP-U**, **A28-CH**, and **A28-U** responded quadratically (*P*<.001) with increasing N level. At 2 h, NH_3 of **A28-U** increased linearly (*P*<.03), and the remaining treatments increased NH_3 quadratically (*P*<.001) with N level. At 4 and 8 h, NH_3 continued to increase quadratically to a greater extent for **U** than **CH** with increasing N level. At 12, 18, and 24 h, NH_3 of all sorghum treatments increased linearly (*P*<.001), whereas **U**-supplemented cultures exceeded **CH**. Use of ammonia by corn cultures decreased earlier than sorghum, and increasing degree of processing increased ammonia use.

Key Words: Steam Flaking, Grain Processing, Ammonia

467 In vitro pH changes of corn and sorghum as influenced by the degree of processing and nitrogen source and level. M. S. Brown[1], M. L. Galyean[2]*, G. C. Duff[1], D. M. Hallford[1], and S. A. Soto-Navarro[1], *[1]New Mexico State University, Las Cruces and [2]West Texas A&M University, Canyon.*

Ruminal fluid from two heifers (384±2 kg) fed an 85% concentrate diet at 1.7% of BW was used to determine effects of processing and N source and level on in vitro pH changes. A buffer: water mixture (25:75) was used to allow changes in pH. In Exp. 1 (2×4 factorial), treatments were unprocessed corn and sorghum (**UP**) and each grain steam-flaked to bulk densities (**BD**) of .38, .33, and .28 kg/L (**C38**, **B33**, **A28**, respectively). Treatments in Exp. 2 (2×2×3 factorial) were **UP** and **A28** corn or sorghum supplemented with 0, 5, or 10 mg of N/culture provided by urea (**U**) or casein hydrolysate (**CH**). In Exp. 1, culture pH was less for corn (*P*<.10) than sorghum (5.54 vs 5.65) at 8 h, but not different at other times. Culture pH did not differ with **BD** up to 4 h, but pH of **UP** was greater (*P*<.02) than **C38**, **B33**, and **A28** at 8, 12, 18, and 24 h and decreased linearly (*P*<.04) with decreasing **BD** at 12, 18, and 24 h. In Exp. 2, changes in pH of corn followed a similar pattern to sorghum. The **UP** corn generally had a higher pH (*P*<.001) than **A28** at 2 h and later, and **U** supplementation increased pH (*P*<.002) at 1 through 18 h. Increasing N level increased pH quadratically (*P*<.05) at 1 and 2 h, and linearly at 4, 8, 18, and 24 h, with a greater increase for **U** than **CH**. As N level increased at 12 h, pH of **A28-CH** linearly increased the least (*P*<.001), followed by **UP-CH**, **A28-U**, and **UP-U** corn. Changes in pH of sorghum reflected a N source × N level interaction (*P*<.05) at 4 and 8 h. A higher pH (*P*<.02) for **UP** than for **A28** sorghum was noted at 2, 12, 18, and 24 h. Supplementation of **U** increased pH (*P*<.02) greater than **CH** at 1, 2, 12, and 18 h, but sources did not differ at 24 h. Increasing N level linearly increased (*P*<.01) pH at all incubation times, but to a greater extent (*P*<.03) for **UP-U** and **A28-U** than for **UP-CH** and **A28-CH** at 4 and 8 h. Both **U** and **CH** increased pH in vitro, but pH with **U** was consistently higher than with **CH**.

Key Words: Steam Flaking, Grain Processing, Acidity

468 Effect of grain sorghum particle size on digestion parameters and performance of growing steers. T. J. Kessen*, D. D. Simms, G. L. Kuhl, and J. S. Drouillard, *Kansas State University, Manhattan.*

A 73-d growing study utilizing 203 steers (309 kg) and a digestion trial were conducted to determine the effects of grain sorghum particle size on rumen fermentation, ration digestibility, and growing steer performance. Particle sizes in both trials were approximately 2000, 1500, and 1000 microns for the coarse (CR), medium (MR), and fine rolled (FR) grain sorghum treatments, respectively. Rolled corn at about 2000 microns was included as a positive control. Rations consisted of 35–37% dry grain plus ground alfalfa hay and supplement. Apparent DM, NDF, and starch digestibilities increased linearly ($P < .02$) with decreasing sorghum particle size. Rumen pH, NH_3, total VFA concentrations, and acetate to propionate ratio were unaffected by grain type or particle size. Steer performance in the growing trial is shown in the table.

Item	Corn	FR	MR	CR	SE
DMI, kg/d	11.6	12.0	12.1	12.2	.09
ADG, kg	1.64	1.67	1.62	1.59	.036
G/F	.140	.138[c]	.132[cd]	.130[d]	.003

Standard errors are for comparisons between grain sorghum treatments.
[cd]($P < .07$).

Steer dry matter intake was not influenced by grain type or particle size. Steers fed FR sorghum gained 9% faster ($P < .03$) than those fed CR during the first 28 d, and tended ($P < .14$) to gain faster over the entire trial. Gains of steers fed MR were intermediate. FR sorghum produced 6% more efficient ($P < .07$) steer gains than CR while MR was intermediate. Feed efficiency of steers fed CR, MR, FR were 93%, 94%, and 99%, respectively, of those fed corn. This research indicates that grain sorghum in high roughage, backgrounding programs should be finely processed to a maximum of 1000 microns geometric mean particle size.

Key Words: Particle Size, Grain Sorghum, Digestibility, Growing Steers

469 Interaction of protein supplementation and corn processing method on site and extent of starch digestion in beef cattle. R. Barajas[1,2],* and R. A. Zinn[1], *[1]University of California, El Centro and [2]EMVZ Universidad A. de Sinaloa, Mexico.*

Four Holstein steers (382 Kg) with cannulas in the rumen and proximal duodenum were used in a 4×4 Latin square. Treatments were: 1) 11% CP diet with 74% dry rolled corn (DRC, density = .57 Kg/L) + .8% urea (U); 2) 15% CP diet with 64% DRC + .8% U + 10% cottonseed meal (CSM); 3) 11% CP diet with 74% steam-flaked corn (SFC, density = .31 Kg/L) + .8% U; and 4) 15% CP diet with 64% SFC + .8% U + 10% CSM. Increasing dietary CP increased nonammonia N (13.4%, $P < .05$), microbial N (6.2%, $P < .01$), and feed N (21%, $P < .10$) supply to the small intestine, although ruminal N efficiency (N flow to the small intestine/ N intake) decreased (15.7%, $P < .01$). Ruminal, postruminal, and total tract starch digestion was not affected ($P > .10$) by dietary CP level. However, ruminal, postruminal and total tract starch digestion was greater (35, 73, and 24%, respectively, $P < .01$) for SFC than for DRC. Steam flaking corn also enhanced ($P < .01$) postruminal and total tract digestion of OM (44 and 21%, respectively) and N (21 and 17%, respectively). The DE value of the diet was 20% greater ($P < .01$) for SFC than for DRC. Given that the DE value of SFC is 4.19 Mcal/kg then the replacement DE value of DRC was 3.30 or 79% the value of SFC. We conclude that increasing protein supply to the small intestine will not enhance the comparative feeding value of dry rolled corn in diets for feedlot cattle.

Key Words: Corn Processing, Protein, Starch

470 The effect of three different slow ammonia release urea/calcium compounds on in vitro ammonia release during fermentation of corn starch. K. J. Sanders, C. R. Richardson, and H.H.R. Titi*, *Texas Tech University, Lubbock.*

Laboratory analyses in rumen fluid were conducted to determine the effects of three slow ammonia release urea/calcium compounds on rumen ammonia concentration. The compounds were processed by three different methods (P1, P2 and P3). All three compounds contained 143.5% CP and consisted of 23-0-0-7 N, P, K and Ca, respectively. The nitrogen source was bound to calcium chloride. The fermentation mediums were formulated to be isonitrogenous at 14% CP using pure corn starch and the respective urea/calcium compound. Rumen fluid from a steer receiving a high concentrate diet was collected, strained through four layers of cheese cloth and mixed with McDougall s buffering solution. Two hundred ml of rumen fluid was dispensed into 250 ml fermentation bottles with 4 g of substrate and incubated for 2, 4, 6 and 8h. No differences ($P > .05$) were found for ammonia concentration after 2h of incubation. Process 1 (P1) had the lowest ammonia concentration, numerically, and P3 had the highest ammonia release . After 4h of incubation, ammonia concentration was lowest numerically for P2 (25.89 mg/dL) than for P1 (27.01 mg/dL) and P3 had the highest ($P < .05$) ammonia concentration for all treatments. Compounds (P2 and P3) were the same in ammonia concentration after 6h of incubation (19.76 and 19.61 mg/dL, respectively) and were higher ($P < .05$) than P1 (13.28 mg/dL). Ammonia concentration after 8h of incubation was higher ($P < .05$) for P1 whereas P2 and P3 had the lowest (9.46, 3.89 and 1.49 mg/dL, respectively). These data suggest that different manufacturing methods to produce slow ammonia release urea/calcium products can change the rate of ammonia release during rumen fermentation of corn starch.

Key Words: Ammonia Concentration, Fermentation, Processing

471 Effects of zinc and manganese concentrations on in vitro urea degradation and prairie hay disappearance. H. M. Arelovich*, F. N. Owens, G. W. Horn, and J. A. Vizcarra, *Oklahoma State University, Stillwater.*

Elevated concentrations of Zn and Mn have been reported to decrease ureolysis. Rates of disappearance of urea and prairie hay (PH) in vitro with various Zn and Mn concentrations were appraised by modifying the in vitro media to contain one of five concentrations of added Zn (0, 215, 430, 645 and 860 ppm) and two of Mn (0 and 4300 ppm) in a triplicated 2 x 5 factorial experiment. Each in vitro tube contained .5 g of PH, 1 mL of Zn and 1 mL of Mn solution (both as the chloride), 1 mL of an urea solution (35g/L), 20 mL of ruminal fluid and 20 mL of McDougall s artificial saliva. Mineral concentrations should equal those provided by daily intakes of 0 to 2.62 g Zn and 0 to 13.10 g Mn. Urea supply would equal 100 g of urea per steer daily. Ruminal fluid obtained from three 540 kg cannulated steers 24 h after the last meal of 7.5 kg of PH plus .5 kg of a supplement (89.5% ground corn, 10 % urea, .5 % NaCl) was mixed and used as a source of inoculum. Tubes were incubated at 39 C for a single-stage 48 h IVDMD. One mL samples were removed from each tube at 0, 60, 120 and 180 min after incubation began. Subsamples were analyzed colorimetrically for residual urea. Incubations were repeated on three different dates with time 0 urea values being used as a covariate for urea degradation. Mean IVDMD of PH, 43.4%, was not affected by mineral concentrations. Mean urea-N decreased over time, being 38.0, 27.6, 16.8 and 15.2 mg/dL (SE= .45) at 0, 60, 120 and 180 min, respectively (linear effect, $P = .0001$); rate of urea degradation was slower at 120 and 180 min. Analyzed within specified time intervals, added Zn linearly decreased ureolysis at 60, 120, and 180 min ($P < .08$; .10 and .02, respectively) although interactions with Mn were apparent ($P < .03$) at 120 and 180 min. Ureolysis was less inhibited by Zn when Mn was supplemented. Results support previous measurements on effect of Zn concentration on in vitro ammonia accumulation.

Key Words: Zinc, Manganese, Ureolysis

472 Effects of level and source of fat on rates of lipolysis and biohydrogenation in vitro. T. M. Beam*, D. D. De Luca, and T. C. Jenkins, *Clemson University, Clemson, SC.*

The objective of this study was to determine how fats varying in fatty acid composition and level of addition affected rates of lipolysis and biohydrogenation by ruminal microbes. In vitro incubations consisted of 2 g substrate, 40 mL ruminal contents from a fistulated cow fed grass hay, and 160 mL buffered medium. All incubations were run anaerobically at 40 C in a water bath. Substrates consisted of bermuda grass hay with no added fat (control), 10% added linoleic acid, or with 5 and 10% added canola oil, soybean oil, and tallow. Samples were taken from each flask at 0 (immediately after addition of ruminal inoculum), 3, 6, 9, 12, 24, and 48 h. Each treatment was run in triplicate. Samples were freeze-dried and analyzed for total fatty acid content by gas chromatography. A separate sample was extracted and neutral lipids isolated by solid phase extraction on amino-propyl columns. Lipolysis was expressed as the disappearance rate of neutral lipid fatty acids determined from the slope of linear regressions relating percent conversion of neutral lipid versus time of incubation (0 to 12 h). Neutral lipid was 80% converted by 12 h with little additional conversion from 12 to 48 h. Biohydrogenation was expressed as the disappearance rate of *cis*18:1 or 18:2 for each treatment which was calculated as the slope of a linear regression relating the natural logarithm of fatty acid concentration (% of total fatty acids corrected for control) versus incubation time (0 to 48 h). Biohydrogenation of 18:2 was similar for 5% tallow, 5% canola, 10% canola, and 5% soybean oil and ranged from 7 to 8%/h. Biohydrogenation for 10% linoleic acid, 10% tallow, and 10% soybean oil ranged from 4 to 5%/h. Biohydrogenation of *cis*18:1 was similar for all fat sources (1 to 2%/h) except 5% canola oil, which was 5%/h. Lipolysis was 5.8%/h (r^2 = .50) for 5% soybean oil, 6.6%/h (r^2 = .75) for 10% soybean oil, 7.3%/h (r^2 = .84) for 5% canola oil, and 9.1%/h (r^2 = .80) for 10% canola oil. These results show that biohydrogenation of 18:2 in ruminal contents is affected more by fat level than by fatty acid composition of added triglycerides. Rates of 18:2 biohydrogenation were generally reduced by higher levels of added fat which could not be attributed to reduced lipolytic rates at the higher level. Biohydrogenation of *cis*18:1 proceeds at a slower rate than biohydrogenation of 18:2 for most levels and sources of added fat.

Key Words: Rumen, Biohydrogenation, Lipolysis

473 Feasibility of using total purine concentration to estimate numbers of rumen bacteria in pure culture. N. Obispo* and B. A. Dehority, *Ohio Agricultural Research and Development Center, Wooster.*

The procedure of Zinn and Owens (Can. J. Anim. Sci. 66:157), for measuring purine content of mixed rumen bacteria, was adapted for analysis of small quantities of purines in pure cultures of rumen bacteria. Using adenine and guanine, alone or in mixture, as standards, recoveries were quite variable. The variation was traced to solubility of the silver salt of adenine in the solution used to wash the precipitate. With this corrected, recoveries of the purines or yeast RNA, either alone or in combination, were above 99%. Purine concentration and number of cells were determined for three organisms: *Ruminococcus albus* 7, *Butyrivibrio fibrisolvens* D16f, and *Prevotella ruminicola* H15a. Three large batches of cells were grown with each organism and three most-probable-number (MPN) assays and three purine analysis were conducted with each batch of organisms. The range in coefficients of variation for the MPN assay and the purine analysis were 18.9 to 78.5 and 3.3 to 6.1 for *R. albus* 7. Ranges for *B. fibrisolvens* D16f were 31.8 to 70.7 and 3.2 to 4.3, and for *P. ruminicola* H15a 0 to 54.9 and 1.5 to 4.5. Mean purine concentration per cell ($\times 10^{-8}$) was 3.12, 9.31 and 0.48 for *R. albus* 7, *B. fibrisolvens* D16f and *P. ruminicola* H15a, respectively. The purine content per cell of *P. ruminicola* H15a was less than *R. albus* 7 and *B. fibrisolvens* D16f ($P < .05$), and *R. albus* 7 was less than *B. fibrisolvens* D16f ($P < .07$). Based on these differences, the use of total purines as a marker for mixed bacterial populations is questionable.

Key Words: Bacterial Marker, Purines

474 A comparison of techniques for isolating ruminal microorganisms. B. W. Hess, L. A. Burgwald-Balstad*, and M. B. Whitney, *University of Wyoming, Laramie.*

Purines are often used as a marker to quantify the microbial protein synthesized in the rumen. Several procedures for preparing ruminal contents for the purine assay have been published; however, no consistent method has been established. The objective of this experiment was to evaluate a variety of preparation schemes for isolating the microbial contents from ruminal digesta. Four mature ewes, consuming alfalfa pellets (CP = 21%, TDN = 63%) ad libitum, were completely emptied of their reticulo-rumen contents. All ruminal contents were mixed together before being sub-sampled. Preparation techniques included 1) squeezing and straining the ruminal digesta through four layers of cheesecloth or 2) homogenizing, squeezing and straining through four layers of cheesecloth. Within each straining sequence microbial contents were isolated by 1) centrifuging immediately (I), 2) preserving in formaldehyde (25mL, .9% NaCl [wt/vol] in 37% formaldehyde [wt/vol]/100 mL of ruminal fluid) at 4° C before centrifugation (P), 3) storing at –20° C, then thawing at room temperature before centrifugation (S). Following centrifugation at 1000 × *g* for 10 min, one half of the ruminal fluid was preserved in formaldehyde then stored at 4° C before completing the isolation procedure. The data were analyzed as a 3 × 2 factorial in a randomized complete block design. The block effect was straining sequence. Contrasts included I vs P + S and P vs S. Microbial N content was greatest ($P = .06$) for treatment I. Purine content tended ($P = .15$) to be lower for strained contents not centrifuged immediately, which was the result of low ($P = .16$) purine concentrations for the S treatment. Purine:N ratios were greater ($P = .11$) for P compared to S. Preserving the supernatant in formaldehyde following the initial centrifugation step resulted in decreased purine concentration ($P = .009$) and purine:N ratios ($P = .004$). Preserving strained ruminal contents in formaldehyde will prevent degradation of microbial purines during initial processing but not after the initial centrifugation step.

Key Words: Laboratory Procedure, Purines

475 Enrichment, enumeration and isolation of propionic acid producing bacteria is enhanced by using erythritol. T. E. Dawson* and B. P. Glenn, *Nutrient Conservation and Metabolism Laboratory, USDA-ARS, Beltsville, MD.*

Production of volatile fatty acids (acetic, propionic, and butyric) by fermentation of carbohydrates by ruminal microorganisms supplies the majority of energy to ruminants. However, along with the formation of volatile fatty acids, excessive amounts of lactic acid are produced in the rumen which can cause ruminal acidosis. Propionic acid producing bacteria are common inhabitants to the rumen microbial ecosystem and convert lactic acid to propionic acid as part of their normal metabolism. Generally the number and activity of propionic acid producing bacteria in the rumen is insufficient to decrease lactic acid accumulation when animals are fed high levels of rapidly fermented carbohydrates. Propionic acid producing bacteria of the genus *Propionibacterium* have a unique characteristic of fermenting erythritol to propionic acid. The objective of this study was to develop an experimental media for the enrichment, enumeration and isolation of propionic acid producing bacteria. Media components include erythritol as a selective fermentation source, peptone, yeast extract, mixed salts, and bromocresol purple as a fermentation indicator. A most probable number dilution scheme was successfully used in 300 μl microplate wells with initial results obtained after 24 h aerobic incubation at 37 C and single colony isolation after 5 d at appropriate dilutions. This media shows promise for the selection and enumeration of propionic acid producing bacteria from various microbial ecosystems such as the rumen and ensiled feedstuffs.

Key Words: Propionic Acid, Erythritol

476 ***Fusobacterium necrophorum*** **in ruminal contents and adherent to the ruminal wall of cattle.** K. R. Bedwell*, N. Wallace, and T. G. Nagaraja, *Kansas State University, Manhattan.*

Three experiments were conducted to evaluate *Fusobacterium necrophorum* in ruminal contents and adherent to ruminal wall of cattle. In Exp. 1, a total of 76 samples of ruminal contents and ruminal wall sections were obtained at slaughter; 39 samples were from cattle with normal livers and 37 were from cattle with liver abscesses. Mean *F. necrophorum* counts in ruminal contents were 2.4×10^6 and 0.6×10^6 from cattle with normal or abscessed livers, respectively. Mean pH of ruminal contents was similar in both groups. The mean counts of *F. necrophorum* adherent to ruminal wall were $2.5 \times 10^3/cm^2$ and $6.5 \times 10^3/cm^2$ for samples collected from cattle with normal or abscessed livers, respectively. *F. necrophorum* counts in ruminal contents or on ruminal wall in relation to severity of abscesses were not different (P>.1). In Exp. 2, 8 rumens were obtained at slaughter and ruminal wall tissue samples were taken from the cranial, dorsal, dorsal blind, ventral, and ventral blind sacs to quantify adherent *F. necrophorum*. Mean concentration of *F. necrophorum* on the ruminal wall ranged from 2.9×10^3 to 6.1×10^5 per cm^2, and the dorsal blind and ventral sacs had the highest counts. In Exp. 3, *F. necrophorum* counts in ruminal contents of two steers were monitored during experimentally induced acidosis in two steers adapted to a high roughage diet. Ruminal contents were sampled at 3,6,9,12,and 24 h following daily intraruminal dosing of fermentable CHO to induce acidosis. Ruminal *F. necrophorum* counts increased initially, peaking at 24 h on day 2 for steer 1 and at 6 h day 4 for steer 2. Subsequent rapid decline corresponded with declines in ruminal pH and accumulation of lactate. The concentration of *F. necrophorum* in ruminal contents or adherent to the ruminal wall was not related to the occurrence of liver abscesses and concentration in ruminal contents was reduced in the acidotic rumen possibly due to low pH.

Key Words: *Fusobacterium necrophorum*, Ruminal Wall, Ruminal Acidosis, Liver Abscesses

477 **Rumen degradation of forages using the *in situ* method and an *in vitro* technique.** F. Masoero, M. Santi, M. Moschini, F. Rossi, and G. Piva*, *ISAN-UCSC University, Faculty of Agriculture, Piacenza, Italy.*

The need of fast and easy analytical methods for determining the nutritional value of forages for dairy cattle diet formulation is growing. This work was 1) to compare the *in situ* and *in vitro* (gas-test) forage organic matter (OM) degradation (alfalfa, fescue and corn silage) and 2) to measure and compare the *in vitro* rumen degradation kinetics of several forages (alfalfa, fescue, brome, orchardgrass and timothy; pool of 3 phenological stages). Feeds were ground with either 1 or 4 mm sieves for the *in situ* trial. Five grams of sample (1 mm particles size) were incubated 48 hours with 400 ml of rumen liquor and Mc Dougall buffer solution (1:2 ratio). The gas production was measured in graduated cylinder every other hour for 48 hours. Three fermentations were carried out in triplicate. The OM degradation was correlated with the gas production; higher correlation values were observed when using the 4 mm compared to the 1 mm particles size (.99, .81, .96 *vs* .95, .97, .91, respectively for alfalfa, fescue and corn silage for the 4 mm and 1 mm particle size). The alfalfa rumen degradation rate (c) was higher compared to grasses, whereas the latter had higher fermentability (a+b), probably because of the lower ADL content compared to the legumes. The *in vitro* fermentation kinetics analyzed according to Ørskov [$y = a + b^* (1 - e^{-ct})$] can be used to evaluate the *in situ* forage degradation.

Kinetic parameters	Brome	Orchardgrass	Fescue	Alfalfa	Timothy	S.E.
a, %	1.84^{c}	$-.86^{a}$	1.01^{bc}	$.89^{b}$	$.61^{b}$	.312
(a+b), %	56.02^{b}	43.72^{a}	53.42^{b}	40.34^{a}	55.66^{b}	2.251
c, % h^{-1}	5.94^{b}	5.08^{ab}	4.46^{a}	10.1^{c}	5.29^{ab}	.302
Lag phase, minute	31.33^{b}	27.09^{ab}	26.5^{ab}	16.83^{ab}	11.83^{a}	5.607

$^{a,b,c}P \leq .05$.

Key Words: Forage Degradation, *In vitro*, Rumen

478 **Effects of corn silage maturity and sample processing method on in situ degradability of DM, starch, and NDF.** C. G. Doggett[1]*, C. W. Hunt[1], J. G. Andrae[1], J. H. Harrison[2], and D. A. Sapienza[3], *[1]University of Idaho, [2]Washington State University, and [3]Pioneer Hi-Bred International, Inc.*

Preparation of feed samples for evaluation of in situ or in vitro degradability typically involves grinding samples through a 1- or 2-mm screen. In the case of corn silage, this destroys physical barriers in stover and kernels which naturally resist ruminal microbial attack making corn silage incubated in situ or in vitro much different than corn silage degraded in vivo. Five ruminally fistulated heifers were used in a 5×2 factorial experiment. Main effects included silage maturity and pre-incubation processing. Corn was harvested and ensiled at dent (early) and black line (late) maturities. Samples of each maturity were prepared by the following treatments prior to ruminal incubation: 1) fresh-ensiled, not ground, 2) dried, not ground, 3) dried, coarse ground, 4) dried, medium ground, and 5) dried, fine ground. Treatments 2 to 5 were dried in a forced air oven at 50° C. Twenty g of DM from treatments 1 and 2 were incubated in 30×35 cm nylon bags, while 4 g of DM from treatments 3 to 5 were incubated in 10×20 cm nylon bags. Samples were incubated in duplicate for 24 and 48 h. Residues were analyzed for DM, NDF, ADF, and starch disappearance. Unground treatments resulted in greater in situ DM ($P < .01$) and starch ($P < .05$) disappearances at 24 and 48 h for early than late maturity silage. Maturity effects were not observed for ground samples. Unground treatments produced trends of greater NDF disappearance for early (29.4%) than late (22.1%) maturity silage; however, fiber disappearance was greater for late than early maturity silage for ground samples. Twenty-four and 48 h starch disappearance was greater ($P < .05$) when samples were dried than incubated fresh. Results of this study demonstrate that grinding and heat treatments of corn silage prior to in situ incubation affect ruminal degradability and can lead to misinterpretation of quality comparisons.

Key Words: Corn Silage, Digestion, In situ

479 **The effect of maturity, heat treatment and frost killing of forages on the degradation kinetics and escape protein concentration.** M. A. Karsli* and J. R. Russell, *Iowa State University, Ames.*

Two consecutive in situ studies were conducted to determine the effects of maturity, heat treatments and frost killing of forages (alfalfa and berseem clover) on degradation kinetics and escape protein concentrations. Four maturities (3, 5, 7 and 9 wk after 2nd harvest) of forages, collected from three locations, were used. Alfalfa collected 4 and 7 wk post-harvest and berseem clover collected 5 and 7 wk post-harvest were freeze-dried and then heated to 100, 125 and 150 °C for 2 h. Four weeks after a killing frost (–2 °C), 10-wk regrowth of berseem clover was harvested from the same locations previously sampled. To evaluate maturity effects, 336 Dacron bags containing all maturities of either alfalfa or berseem clover were placed into the rumen of 2 fistulated steers fed alfalfa-grass hay. Heat treatment or frost effects were determined by placing 252 Dacron bags containing heat-treated or frosted forages into the rumen of one fistulated steer fed alfalfa hay. Bags were incubated for periods of 0 to 48 h. With increasing maturity, the proportion of non-degradable protein (NDP) and the rate of crude protein (CP) degradation increased (P<.05) in both forages. While the rate of NDF degradation and potentially degradable protein proportion (PDP) increased (P<.05) with increasing maturity in alfalfa, the rate of NDF degradation and PDP proportion decreased and proportion of WSP increased in berseem clover . The proportion of protein escaping rumen degradation (PESP) was greater (P<.05) for berseem clover than alfalfa, but was not affected by maturity. Total escape protein concentrations of both forages linearly decreased (P<.05) with maturity. Increasing levels of heat treatments of forages increased (P<.05) NDP, PDP and escape protein concentrations while decreasing WSP concentration and the rate of CP degradation of mature forages. PESP was greater (P<.05) and the rate of CP degradation was lower at 100 and 150 °C in immature berseem clover compared to heating at 125 °C. Total escape protein concentration was the highest with the heating of immature berseem clover at 100 °C. Frost killing of mature berseem clover decreased (P<.05) WSP concentration and increased (P<.05) NDP concentration compared to mature berseem clover harvested live. Even though the rate of CP degradation was similar, PESP and total escape protein concentration of frost-killed berseem clover were greater (P<.05) than mature clover harvested live.

Key Words: In situ Degradation, Escape Protein, Frost Killing

480 In-situ carbohydrate availability with ammonia and ozone processing. J. J. Williams*, J. C. Branum, T. D. Rogers[2], G. C. Carstens, F. M. Byers, and A. J. Denvir[2], *[1]Texas A&M University, College Station and [2]Lynntech Inc.*

The majority of crop residues harvested in the U.S. are of limited nutritional value due to availability of structural carbohydrates. Elephant grass as in crop residue contains high levels of structural carbohydrate. Control or ammonia processed dwarf elephant grass was subjected to ozone at 0,.2,2 and 20% concentrations by weight, followed by in-situ dacron satchel dry mater and carbohydrate fraction digestion measurements from 0 through 96 h. Ozone at .2 or 2% had negligible effects on any variable. Ozone at 20% proved to be highly effective in disrupting the ligno-cellulose complex. Dry matter solubility at 0 h for control (C) was 17.0% and increased ($P < .05$) to 26.4%, 44.6% and 54.2% for ammonia processed(A), ozone at 20% and the combination of ammonia and 20% ozone (A-O). Dry matter disappearance (DMD) was 54.6% for C and increased ($P < .05$) to 80.8%, 82.6% and 92.1% ($P <. 05$) at 48 h, and from 60.9% to ($P <. 05$) 86.2%, 84.8% and 93.5% ($P <. 05$) at 96 h with A, O, and A-O. This reflected carbohydrate fractionation and the reduction in hemicellulose and lignin with O and A. NDF disappearance at 0 h increased ($P < .05$) from 4.9% for C to 10.1%,16.1% and 23.9% for A, O, and A-O. At 48 h NDF disappearance increased ($P < .05$) from 47.5% to 74.4%, 71.2% and 85.1% with A, O, and A-O vs C. Availability of hemicellulose increased from 17.36% to 46.7%, 33.3% and 56.8% at 6 h and from 52.3% to 82.1%, 55.8% and 87.9% at 48 h for C vs A, O and A-O respectively. While A was more effective then O alone in enhancing amount of hemicellulose, O in combination with A was highly effective in enhancing availability of all elephant grass carbohydrate fractions assessed. The combination resulted in a highly digestible foodstuff with over 90% DMD at 48 h.

Key Words: Ozone, Ammonia, Carbohydrates

481 Comparison of Idagold and Steptoe barley and corn as energy supplements for a forage-based diet. B. S. Sanford*, C. W. Hunt, J. G. Andrae, and G. T. Pritchard, *University of Idaho, Moscow.*

Three ruminally cannulated steers were used in a replicated 3×3 Latin square design to compare Idagold and Steptoe barley and corn as energy supplements for a forage-based diet. Steers were individually fed a diet that contained 56% forage (alfalfa silage and wheat straw) and 44% grain (corn, Steptoe, or Idagold). Each period of the Latin square contained 7 d of diet adaptation, 7 d of *ad libitum* intake determination, and 4 d of sample collection. Samples of the grains were ruminally incubated *in situ* for 0, 4, 8, 12, 16, 24, and 48 h, and samples of the dietary forage were incubated for 0, 8, 16, 24, 32, 40, 48, and 96 h. Barley hull samples were incubated for 24 h. Three grams of Cr_2O_3 were fed for 7 d followed by collection of 6 fecal samples throughout the sample collection period to determine total tract digestibility. Ruminal fluid characteristics were determined from samples gathered on d 1 of sample collection. *In situ* DM disappearance (**ISDMD**) of barley was greater ($P < .01$) at 4, 8, 12, 16, and 24 h and lower ($P < .01$) at 48 h of incubation compared with corn. Idagold had greater ISDMD than Steptoe at 16 ($P < .05$) and 48 ($P < .01$) h of incubation. Source of grain supplement had no effect on the ISDMD of forage or ruminal fluid pH. Digestibility of DM ($P < .01$) and NDF ($P < .10$) was greater for barley diets than the corn diet. Dry matter digestibility was greater ($P < .05$) for Idagold than Steptoe. Idagold hulls comprised numerically less of the total kernel than Steptoe hulls (10.9 vs 15.0%) and contained lower ADF (34.2 vs 38.4%). Also, Idagold hulls had greater ($P < .01$) 24 h ISDMD than Steptoe hulls (38.9 vs 26.2%). Dry matter intake was greater ($P < .05$) for corn than barley diets. Results of this experiment indicate that barley varieties can be identified that are superior to corn and that much of the differences observed in feed quality of barley can be attributed to the amount and quality (digestibility) of hull present in the kernel.

Key Words: Barley, Corn, Digestibility

482 Effect of malate on lactate fermentation by *Selenomonas ruminantium*. J. D. Evans* and S. A. Martin, *University of Georgia, Athens.*

Previous research demonstrated that lactate utilization by *Selenomonas ruminantium* is stimulated in the presence of malate. Therefore, the objective of this study was to further characterize the effect of malate on lactate fermentation by *S. ruminantium*. When *S. ruminantium* HD4 was grown in batch culture on 25 mM DL-lactate (n = 2), DL-malate (20 mM) addition to the medium resulted in an accumulation of succinate and inhibition of malate utilization. Malate utilization was also inhibited in the presence of 15 mM glucose in batch culture. Growth of *S. ruminantium* HD4 on lactate in continuous culture (dilution rate = 0.05 h^{-1}) resulted in the production of acetate and propionate at pH 6.7. However, cells were unable to grow on 6 mM DL-lactate at an extracellular pH of 5.5 and washed out of the culture vessel. Addition of 8 mM DL-malate to the medium prevented washout at extracellular pH 5.5 on 6 mM DL-lactate and resulted in succinate accumulation in the medium. Malate addition also corresponded to increased protein, acetate, and propionate production in continuous culture. When cell extracts from *S. ruminantium* HD4 were used to measure NAD-linked lactate dehydrogenase activity, differences in K_m and V_{max} were observed depending on if the cells were grown on only DL-lactate or DL-lactate plus aspartate, fumarate, or DL-malate. Malate addition to the growth medium increased estimated K_m and V_{max} values, while aspartate and fumarate addition tended to lower the estimated kinetic values.

Key Words: Malate, *Selenomonas ruminantium*, Lactate

483 Effects of laidlomycin propionate and monensin on the in vitro mixed ruminal microorganism fermentation. E. J. Domescik* and S. A. Martin, *University of Georgia, Athens.*

The objective of this study was to compare the effects of laidlomycin propionate and monensin on the in vitro fermentation of ground corn, Trypticase, and alfalfa by mixed ruminal microorganisms. Ruminal fluid was collected from two steers fed 10.3 kg of a high concentrate (62.2% ground corn, 17.4% cottonseed hulls) diet per day and composited. In the first study, no ionophore was included in the diet, while the diet in the second study contained 11 mg of laidlomycin propionate per kg of feed. The animals were allowed an adjustment period of 14 d for each dietary treatment before samples were collected. Mixed ruminal microorganisms were incubated in anaerobic media that contained 20% (vol/vol) ruminal fluid and .4 g of substrate. Incubations were carried out in batch culture for 24 or 48 h at 39°C. Both ionophores were dissolved in ethanol and included in serum bottles at final concentrations of 0, 2 ppm (laidlomycin propionate) or 5 ppm (laidlomycin propionate, monensin). When unadapted ruminal fluid was used, both monensin and laidlomycin propionate decreased ($P < .05$) methane concentration and the acetate:propionate ratio with ground corn and alfalfa. Monensin also increased ($P < .05$) final pH for both substrates. Both ionophores decreased ($P < .05$) concentrations of acetate, propionate, isobutyrate, methane, and ammonia in Trypticase fermentations. When adapted ruminal fluid was used, both ionophores still reduced the concentrations of most of the fermentation products mentioned above. However, there was less inhibition compared to fermentations with unadapted mixed ruminal microorganisms. In conclusion, it appears that laidlomycin propionate alters the ruminal fermentation in a manner similar to monensin. Adaptation of the ruminal microbial population to dietary exposure of laidlomycin propionate suggests a similar mode of action for both ionophores.

Key Words: Laidlomycin Propionate, Monensin, Rumen

484 Effects of laidlomycin propionate and monensin on glucose utilization by the ruminal bacteria *Streptococcus bovis* and *Selenomonas ruminantium*. J. L. Wampler[1]*, S. A. Martin[1], and G. M. Hill[2], [1]*University of Georgia, Athens and* [2]*Coastal Plains Research Station, Tifton.*

The objective of this study was to compare the effects of laidlomycin propionate and monensin on cell growth, glucose fermentation, and glucose transport in *Streptococcus bovis* JB1 and *Selenomonas ruminantium* HD4. Batch cultures (500 mL) of each bacterium were grown on 20 mM D-glucose in semi-defined medium and treated with either 5 ppm monensin or 2 ppm laidlomycin propionate (n = 2). Cell growth was monitored by measuring optical density at 600 nm (OD_{600}). Glucose and L-lactate concentrations were measured using enzyme assays. In *S. bovis*, both monensin and laidlomycin propionate decreased OD_{600} ($P < .05$), glucose utilization ($P < .10$), and L-lactate production ($P < .10$). Neither ionophore had any effect on glucose utilization by *S. ruminantium*. Uptake of ^{14}C-glucose between 5 and 30 min of incubation by *S. bovis* tended to be inhibited to a greater extent by 5 ppm monensin than by 2 ppm laidlomycin propionate. Radiolabelled glucose uptake was not altered by either ionophore in *S. ruminantium*. In conclusion, both laidlomycin propionate and monensin inhibited glucose utilization by the Gram-positive bacterium *S. bovis* and had little effect on glucose utilization by the Gram-negative bacterium *S. ruminantium*. These results suggest that laidlomycin propionate alters the ruminal fermentation by inhibiting Gram-positive bacteria.

Key Words: Laidlomycin Propionate, Monensin, Rumen

485 Highly active plant-cell-wall degrading enzymes from rumen anaerobic fungi. X.-L. Li*, H. Z. Chen, Y. He, D. L. Blum, E. A. Ximenes, and L. G. Ljungdahl, *University of Georgia, Athens.*

Anaerobic fungi were first isolated more than two decades ago from the rumen of sheep. So far more than a dozen morphologically distinct anaerobic fungi have been isolated from digestive tracts of herbivores and pond settlements of pastures. Several isolates efficiently solubilize plant materials, which is attributed to their ability to produce a broad spectrum of cellulases and hemicellulases. These enzymes include endoglucanases, cellobiohydrolases, β-glucosidases, xylanases, mannanases, β-glucanases, and phenolic esterases. Some of the enzymes together form high molecular weight complexes while others are secreted into the culture medium as individual enzymes. An enzyme complex isolated from a polycentric anaerobic fungus, *Orpinomyces* sp. strain PC-2, is larger than 2 million daltons, contains more than 20 protein bands on sodium dodecyl sulfate-polyacrylamide gel electrophoresis, binds to both microcrystalline cellulose and fungal mycelium surface, and is capable of hydrolyzing microcrystalline cellulose. Genes encoding highly active cellulases, β-glucosidase, xylanase, and β-glucanase have been isolated from an *Orpinomyces* cDNA library constructed in *Escherichia coli*. Characterization of the recombinant cellulases has demonstrated that some are endoglucanases while the others are cellobiohydrolases with both endoglucanase and exoglucanase activities. Sequence homology analyses indicate that the genes coding for the hydrolases have either bacterial or fungal origins. In addition to catalytic domains, some of the hydrolases contain either a repeated peptide domain or a cellulose binding domain. Evidence has been obtained that the repeated peptide domain is involved in protein-protein interaction, facilitating the formation of the high molecular weight complex.

Key Words: Enzyme, *Orpinomyces*, Cellulase, Hemicellulase, Rumen

486 Characteristics of *Actinomyces pyogenes* isolated from liver abscesses of cattle. S. Narayanan*, N. Wallace, J. Staats, T. G. Nagaraja, and M. M. Chengappa, *Kansas State University, Manhattan.*

Actinomyces pyogenes is a frequently encountered pathogen, next only to *Fusobacterium necrophorum*, in liver abscesses of feedlot cattle. Our objective was to characterize biochemically and biologically, *Actinomyces pyogenes* isolated from liver abscesses of cattle. A total of 96 isolates was used in the study. Comparison of three commercial identification kits (API 20 Strep, Api Zym, and API Coryne) suggested that API Strep was best suited for identification of *A. pyogenes* and differentiating it from other coryneforms. Culture supernatants of isolates grown in serum free medium were used for assaying toxins (hemolysin and leukotoxin) and enzymes (proteases and neuraminidase) that may be relevant to the pathogenicity of the organism. All the isolates were hemolytic, but the amount of hemolysin production, determined by using sheep erythrocytes, varied between strains. Hemolysin titer ranged from 14.3 to 250 units/ml, with a mean of 49.9. Leukotoxin activity, assayed using bovine neutrophils, ranged from 0 to 640 units/ml, with a mean of 43.6. Neuraminidase activity was detected in all the strains but was not quantified. The protease activity ranged from 6.6 to 13.9 units per mg protein, with a mean activity of 8.7 units/mg protein. Minimum inhibitory concentrations (MIC) of five antimicrobial feed additives, approved for liver abscess control, for *A. pyogenes* were determined. Mean MICs were 2.3 units/ml for bacitracin, and 21.4, 22.5, 12.0 and 4.6 μg/ml for chlortetracycline, oxytetracycline, tylosin, and virginiamycin, respectively. Genetic characterization of *A. pyogenes* using restriction fragment length polymorphism with various endonucleases including *Eco* R1, *Eco* RV, *Sma* 1, Cla *1*, Bst E11, *Sal* 1, and *Pst* 1 and also double digestion with combination of these enzymes failed to show any specific pattern among the isolates. The production of hemolysin and neuraminidase may contribute to pathogenic synergy between *A. pyogenes* and *F. necrophorum*.

Key Words: Liver Abscesses, *Actinomyces pyogenes*, Characteristics, Antimicrobial Susceptibility

487 Investigation of bacterial nitrogen (BN) marker (diaminopimelic acid) concentrations as affected by sampling site and day. L. Spicer*, C. B. Theurer, and O. Lozano, *University of Arizona, Tucson.*

Objective was to determine effects of sampling ruminal versus abomasal digesta, and sampling of abomasal digesta on two different days (d 1 vs d 8), on the use of diaminopimelic acid (DAP) as a BN marker. Bacterial samples were collected 3 h after the morning feeding from six beef steers fed sorghum grain-, corn-, and barley-based diets. Design was a replicated 3×3 Latin square. Bacteria harvested from ruminal or abomasal digesta (adjacent days) had similar concentrations of DAP (.74 ± .04% of BN, corrected for feed DAP), thus, providing similar estimations of BN as a percentage of total abomasal N (63 ± 5%). The CV for each mean was high, 24 and 39%, respectively. Values for DAP were different (P=.01) between abomasal sampling days (.75 vs .63% of BN). The fraction of BN in total abomasal N was smaller (P=.01) for sorghum grain (50%) than for corn (74%) or barley (82%) diets for ruminal digesta, and for each abomasal sampling day. Sampling bacteria from abomasal versus ruminal digesta for determination of BN appears valid, but each animal should be sampled repeatedly during each treatment to better ensure representative sampling.

Key Words: Bacterial Marker, Microbial Nitrogen, Diaminopimelic Acid

488 Effects of alfalfa hay particle length on steer feedlot performance, ruminal pH, rumen digesta load, and carcass characteristics. G. L. Huck*, K. K. Kreikemeier, and K. K. Bolsen, *Kansas State University, Manhattan.*

The objective was to determine the optimum particle length of alfalfa hay to be fed at low levels in steer finishing diets. Alfalfa hay was ground through a 6.35 cm screen then reground through a 1.91 screen (fine), ground through a 6.35 cm screen (medium), or non-processed (coarse), and included at 5% of the diet in a high-moisture corn based finishing ration. Two hundred sixteen crossbred steers (347.5 kg) were allotted to 24 pens and pens were assigned randomly to one of three finishing diets (8 pens per treatment/9 steers per pen), fed for 135 d, then slaughtered. Six ruminally cannulated steers (635 kg) were used in a replicated 3 × 3 Latin Square design to obtain rumen fermentation characteristics. No significant treatment differences were observed in feed intake and final weight. Steers offered the coarse diets gained faster (P<.10) and were more efficient (P<.005) than steers fed the medium hay diets. No significant differences occurred in dressing percentage, liver abscess score, backfat thickness, or quality grade. Digesta weight, % dry matter and rumen pH were similar for all treatments. We concluded that feeding unprocessed hay in finishing diets improved animal performance.

Item	Fine	Medium	Coarse	SE
Initial wt., kg	347	348	348	1.76
Final wt., kg	565	562	573	3.58
Feed intake, kg	9.30	9.43	9.28	0.12
Daily gain, kg[1]	1.61	1.59	1.67	.03
Feed/gain[2]	5.76	5.95	5.57	.08

[1]Medium vs. Coarse, (P < .10).
[2]Medium vs. Coarse (P < .005).

Key Words: Alfalfa, Particle Size, Cattle

489 In vitro dry matter disappearance and starch availability of corn and sorghum grain as influenced by the degree of processing and nitrogen source and level. M. S. Brown[1]*, M. L. Galyean[2], G. C. Duff[1], D. M. Hallford[1], and S. A. Soto-Navarro[1], *[1]New Mexico State University, Las Cruces and [2]West Texas A&M University, Canyon.*

Ruminal fluid from two heifers (384±2 kg) fed an 85% concentrate diet at 1.7% of BW was used to determine effects of processing and N source and level on in vitro DM disappearance (DMD) and starch availability. In Exp. 1, treatments (2 × 4 factorial) unprocessed corn and sorghum (**UP**) and each grain steam-flaked to bulk densities (**BD**) of .38, .33, and .28 kg/L (**C38**, **B33**, **A28**, respectively). Treatments in Exp. 2 (2 × 2 × 3 factorial) were consisted of **UP** and **A28** with 0, 5, or 10 mg of N/culture provided by urea (**U**) or casein hydrolysate (**CH**). Starch availability of corn (168, 390, 475, 578 mg of glucose/g) and sorghum (187, 475, 548, 633 mg of glucose/g) increased linearly (P<.001) as **BD** decreased. In Exp. 1, grain type did not influence DMD at 4 and 8 h incubation, whereas DMD of sorghum was 3.3 and 2.8% greater (P<.10) than corn at 24 and 48 h. For both grains, DMD was less (P<.01) for **UP** and increased linearly (P<.02) as **BD** decreased at 4 and 8 h. At 12 h, corn treatments did not differ in DMD, whereas DMD increased linearly (P<.10) as sorghum **BD** decreased, with the DMD of **UP** sorghum less (P<.02) than processed sorghum. At 24 and 48 h, degree of processing did not affect (P>.10) DMD. In Exp. 2, increasing **CH** level linearly increased (P<.02) DMD of **UP** and **A28**, whereas increasing **U** level linearly increased (P<.10) DMD of **UP** but linearly decreased DMD of **A28** at 4 h. The DMD of **A28** corn was greater (P<.03) than **UP** corn at 8, 12, and 24 h. Source of N did not affect (P>.10) DMD of corn, whereas DMD increased linearly (P<.04) as N level increased at 8, 12, and 24 h. The DMD of **A28** sorghum was greater (P<.04) than **UP** sorghum at 4, 8, 12, and 24 h. Supplementation with **CH** increased (P<.04) DMD of sorghum 15% at 4 h. The DMD of sorghum increased linearly (P<.04) with increasing N level at all incubation times.

Key Words: Steam Flaking, Grain Processing, In vitro Fermentation

490 The effect of corn hybrid on processing time, kwh of electricity used in steam-flaking, and flake quality. S. M. Swift[1], D. L. Holthaus[1]*, C. R. Richardson[1], S. D. Soderlund[2], and D. W. Rice[2], *[1]Texas Tech University, Lubbock and [2]Pioneer Hi-Bred International, Inc., Johnston, IA.*

Twelve Pionner® brand corn hybrids were utilized in this study and are identified as number 1 through number 12. Variables measured included time required to steam-flake 22.7 kg of each hybrid, electrical energy required to steam-flake 22.7 kg, flake durability, and percent fines. Data were analyzed in a completely randomized design using the GLM procedures of SAS. Exactly 22.7 kg of each hybrid was weighed out, steamed for 30 min. and flaked utilizing a laboratory steam-flaker. Each replication was flaked to a consistent density of .36 kg/l (28 lb/bu). Electrical energy consumption was measured using a multi-function power systems monitor. Flake durability and percent fines evaluations were performed on representative samples from each steam-flaking replication. Differences (P<.05) were found for usage of electrical energy required to flake, and for time required to flake each 22.7 kg batch. Hybrid number 2 required the least (P<.05) KWH when compared to hybrid number 8 which required the most. Hybrid number 3 required the least amount of time to flake. However, this was only less (P<.05) than hybrid number 7, 8, and 9. Hybrid number 7 had the highest (P<.05) flake durability index rating of 92.5 % when compared to hybrid number 6 which had the lowest rating of 85.9 %. These results are supported by the percent fines determined for each hybrid. The only differences (P<.05) were found between hybrid number 7 which had the least amount of fines and hybrid number 6 which had the most.

Key Words: Steam-Flaking, Corn Hybrids, Energy Usage

491 The effect of corn hybrid on the content of crude protein, ether extract, starch availability, and disulfide bonds. S. M. Swift[1]*, D. L. Holthaus[1], C. R. Richardson[1], S. D. Soderlund[2], and D. W. Rice[2], *[1]Texas Tech University, Lubbock and [2]Pioneer Hi-Bred International, Inc., Des Moines, IA.*

Twelve Pioneer® brand corn hybrids were utilized in this study and are identified as number 1 through number 12. Variables measured included crude protein and ether extract content, starch availability, and degree of disulfide bonding. Data were analyzed as a completely randomized design using the GLM procedures of SAS. Exactly 22.7 kg of each corn hybrid were weighed, steamed for 30 min., and flaked utilizing a laboratory steam-flaker. Each replication was flaked to a consistent density of .36 kg/l (28 lb/bu). Crude protein, ether extract, ash, and dry matter contents were determined utilizing standard AOAC methodology on the flaked samples. Enzyme susceptible starch was determined by enzyme degradation and subsequent analysis of liberated glucose. Free sulfhydryl groups were quantitated using a method outlined by Blackwood, (1994). Hybrid number 7 contained more (P<.05) crude protein and ether extract than any other hybrid tested. Differences in enzyme susceptible starch (ESS) were found among corn hybrids. Hybrid number 4 contained the most ESS but was not different (P>.05) than hybrid number 1, 2, 3, 7, 8, and 9. The mean ESS was 66.17%. Corn hybrid had an effect (P<.05) on amount of free sulfhydryl groups detected by titration. Hybrid number 3 contained 0.382 % free sulfhydryl groups. This was the greatest for all hybrids but was not different (P>.05) than hybrid number 1, 2, 5, 6, and 7. This indicates that disulfide bond cleavage due to steam-flaking was greatest in hybrid number 3.

Key Words: Steam-Flaking, Corn Hybrids, Nutrient Composition

492 Growth performance and feed efficiency of lambs fed diets containing extruded cull cotton seed and cotton gin trash. S. P. Jackson, *Texas Tech University, Lubbock.*

The objectives of this study were to compare two lamb finishing diets that contained extruded cull cottonseed and extruded cotton gin trash with traditional finishing diets that contained cottonseed meal and cotton seed hulls. The ADG, ADFI, and feed efficiency were measured during a 7 - week growth trial. Rambouillet ewe lambs (n = 54) were randomly divided into nine groups of six lambs. Diet 1 was a control diet that utilized cotton seed hulls (CSH) as the dietary roughage source and soybean meal (SBM) as the primary source of protein. Diet 2 was formulated to replace the CSH and SBM in the control diet with an extruded 60:40 blend of cull cotton seed and cotton gin trash. Diet 3 was formulated to utilize half of the CSH and SBM used in the control ration and replace half with the 60:40 extruded product. Each of the three diets were fed to three pens of six lambs. The ADG (kg/hd/d) was similar for lambs on all diets (Diet 1, .31; Diet 2, .28; Diet 3, .32)and the ADFI was higher ($P < .01$) for lambs fed the control diet (1.61 kg) compared to both (Diet 2, 1.45 kg; Diet 3, 1.49 kg) experimental diets, however ADFI did not differ between experimental diets. Feed efficiency (gain:feed) was superior ($P < .01$) for lambs fed diet 3 (.21) when compared to lambs on the control diet (.19) and experimental diet 2 (.19). Feed cost per pound of gain was lower ($P < .05$) for both experimental diets that contained the extruded cotton products when compared to the control diet (Diet 1, $.48; Diet 2, $.44; Diet 3, $.43). This study shows that extruded cotton by-products can be used effectively in lamb finishing diets to reduce the cost of gain without negatively affecting animal performance.

Key Words: Sheep, Growth, Cotton By-Products

493 Nutritional value and incisor enamel-eroding characteristics of sweet potato cannery waste with or without the addition of broiler litter. M. H. Poore[1]* and G. M. Rogers[2], *[1]Department of Animal Science and [2]Department of Food Animal and Equine Medicine, North Carolina State University, Raleigh.*

Sweet potato cannery waste (SPCW) is a wet (8.64% DM) highly acidic (pH 3.2) material that has been clinically observed to cause enamel erosion of bovine incisors. Objectives of this 84-d trial were to demonstrate enamel erosion experimentally and to evaluate neutralization of SPCW with broiler litter (to pH 4.0). Six pens (2/treatment) of six Holstein steers each were used to compare three treatments (TMT); 1) 2.8 kg/hd/d (DM basis) corn and soybean meal (16% CP, dry basis), and free-choice ryegrass hay, 2) .4 kg/hd/d soybean meal (DM basis), plus free-choice SPCW and hay, and 3) a free-choice mix (15% DM) of 90% SPCW and 10% broiler litter (as mixed) and free-choice hay. At trial termination, carcass weights were obtained. Esophageal and ruminal tissue sections, and incisors were collected for additional study. Hay intake (DM basis) was higher ($P<.05$) for TMT 1 than TMT 2 and 3 (6.4, 3.3 and 3.6 kg/hd/d for TMT 1, 2 and 3, respectively). DMI was different for each treatment ($P<.05$), and was 9.3, 7.1 and 11.1 kg/hd/d, for TMT 1, 2 and 3, respectively. ADG was similar for TMT 1 and 3 (1.06 and .98 kg/d, respectively), but was reduced ($P<.05$) for TMT 2 (.70 kg/d). Hot carcass weight was higher for TMT 3 than either TMT 1 ($P=.06$) or TMT 2 ($P<.05$) and was higher ($P<.05$) for TMT 1 than TMT 2 (173, 167 and 179 kg for TMT 1, 2 and 3, respectively). Adjusted ADG (calculated from carcass weight and a common dressing %) was different ($P<.05$) for each treatment (.88, .72 and 1.02 kg/d, for TMT 1, 2, and 3, respectively). Severe enamel erosion was observed in all cattle fed TMT 2 but not in either TMT 1 or 3. These results show; 1) feeding SPCW results in enamel erosion and poor performance, and 2) neutralizing to pH 4.0 with broiler litter prevented the problem and improved animal performance.

Key Words: Cattle, Sweet Potatoes, Broiler Litter

494 Effects of feeding a diet balanced using the 1996 Beef NRC to meet the amino acid requirements in feedlot steers. T. F. Robinson, D. H. Beermann, T. C. Perry, D. J. Ketchen, and D. G. Fox, *Cornell University, Ithaca, NY.*

The objective of this experiment was to determine the effects of feeding a diet balanced to meet the amino acid requirements on growth and carcass characteristics of feedlot steers. Fifty crossbred steers were allocated by weight to one of five treatments. The diet was formulated using the 1996 Beef NRC to meet rumen microbial and amino acid requirements with blood, fish, hydrolyzed feather and meat and bone meal. The protein supplement was included in the diet at 0, 3, 6 and 9 % of DM (11.4, 11.6, 12.8 and 13.1% CP). Daily feed intake was measured and live weight was measured every 28 days. Plasma urea nitrogen (PUN) was determined on day 0, 56 and 120. When 75% of the steers reached 28% body fat, determined by ultrasonic attenuation, they were slaughtered and carcass composition determined by Hankins and Howe rib dissection. Overall dry matter intake was not affected by treatment, ranging from 7.8 to 8.8 kg/d. Gain:feed ranged from 0.22 to 0.24 across treatments. PUN averaged 1.15 mmol/l for day 0, day 56 were 0.93, 0.87, 1.05 mmol/l for the 0, 3, 6 and increased to 1.76 mmol/l at the 9% level ($P<.05$). Day 120 PUN levels increased from 1.25 to 1.96 mmol/l ($P<.05$). There were no treatment affects on slaughter and carcass weight, marbling score, yield grade, backfat or rib-eye area. Protein accretion increased from 111.6 to 159.7 g/d at the 6% level ($P<.05$) then decreased to 125.2 at 9%. Lipid accretion was not affected by the protein supplementation. Balancing for amino acid requirement increased efficiency of amino acid use up to the 6% level resulting in an increase in lean accretion.

Key Words: Cattle, Undegradable Intake Protein

495 Feeding a mixture of animal protein sources improves nitrogen metabolism in Holstein steers during both the growing and finishing stages of growth. W. Knaus, D. H. Beermann*, T. F. Robinson, and D. G. Fox, *Cornell University, Ithaca, NY.*

The Cornell Net Carbohydrate and Protein System (CNCPS) model was used to formulate a corn-based diet to meet rumen requirements for 250 kg and 425 kg large-frame steers with an estrogen implant and fed an ionophore. The model was then used to formulate a UIP supplement from meat and bone meal, blood meal, fishmeal and hydrolyzed feathermeal that provided the amino acids needed to supplement the amino acids derived from microbial protein. In two separate studies six 250 kg and four 425 kg Holstein steers were fed 95% of ad libitum intake a 90:10 concentrate-forage diet at hourly intervals. Twice daily sc injections of 500 ug estradiol 17-beta were used to mimic the effects of an estrogenic implant. Treatments consisted of 0, 2.5, 5, 7.5% and 10% of the UIP mixture for the 250 kg steers; the 10% level was not fed to the 425 kg steers. Diets contained approximately 11, 13, 14, 15 and 16% CP on a DM basis, respectively. DM digestibility was not affected, but N digestibility increased ($P<.01$) from 64% for the control diet to 73% with the highest UIP level in both studies. N intake increased from 80 to 118 g/d in the light steers and from 114 to 152 g/d in the heavy steers, and the amount of N absorbed increased from 52 to 85 g/d and 73 to 111 g/d, respectively. N balance increased ($P<.05$) from 20 to 42.7 g/d and from 22.9 to 42 g/d when the highest level of UIP was fed to light and heavy steers, respectively. Corresponding biological values increased from 0.35 to 0.49 and from 0.32 to 0.38. Plasma urea N was not altered in the light steers, but increased ($P<.02$) from 4.5 to 6.2 mg/dL in the heavy steers. Results demonstrate that feeding a mixture of UIP sources formulated to improve amino acid balance and increase total mass of absorbed N increases N digestibility, N balance and efficiency of N use at both stages of cattle growth.

Key Words: Cattle, Undegradable Intake Protein, N Metabolism

496 Effects of dietary protein amount and ruminal undegradability on feed intake and growth in early-weaned beef cattle. S. S. Donkin[1]*, M. R. Lehrschall[1], R. P. Lemenager[1], and M. J. Cecava[2], *[1]Purdue University, West Lafayette, IN and [2]Consolidated Nutrition, L. C., Fort Wayne, IN.*

The rapid accretion of lean body mass by early-weaned beef calves may require feeding greater amounts of ruminally undegradable protein sources in order to satisfy metabolizable protein demands. To test this hypothesis, thirty-six Angus and Angus × Simmental calves (24 steers and 12 heifers), approximately 100 days of age, were weaned, blocked by sex and weight, and randomly assigned to one of six treatments. Diets contained either 14 or 18% CP and 33, 38, or 45% UIP in a 2 × 3 factorial arrangement. Calves were individually fed, for ad libitum intake, a total mixed diet consisting of high moisture corn coblage, soybean meal, specially processed soybean meal, and NPN as urea. Intake and body weights were determined weekly for a total of 16 weeks. Average daily gain increased ($P < .05$) with increasing UIP within each protein level (14% CP and 33, 38, or 45 UIP : 1.34, 1.56, 1.76; 18% CP and 33, 38, or 45 UIP: 1.35, 1.84, 1.79) during the first 5 weeks of the experiment. Increasing the protein level or proportion of UIP in the diets had no effect on dry mater intake but UIP intake was different across treatments ($P < .05$). Efficiency of gain (liveweight gain / DM intake) increased ($P < .05$) with increasing UIP (14% CP and 33, 38, or 45 UIP: 0.19, 0.23, 0.25; 18% CP and 33, 38, or 45 UIP: 0.19, 0.26, 0.27). The growth and feed efficiency effects were not observed after 5 weeks on treatment. These data indicate that UIP enhances growth rate and feed efficiency in the early growth phase after weaning but that this effect diminishes beyond approximately 250 kg liveweight.

Key Words: Early-Weaning, Beef Cattle, Undegradable Protein

497 The effect of feeding graded levels of ruminally undegradable protein on the growth of sheep and nitrogen flow in continuous culture. F. N. Lusweti, M. Kerley, C. J. Nelson, R. Belyea, J. Spain, and J. Williams, *University of Missouri, Columbia.*

Supplemental Diets 1 to 4, containing 31, 61, 102 or 138 g RUP per kg, respectively, were fed to growing lambs receiving an *ad libitum* supply of good quality alfalfa hay. The supplemental diets were analyzed for CP degradability and flow in continuous culture. Diet had no effect ($P > .8$) on the growth of the lambs. Weight gains averaged 144 ± 14.2, 161 ± 13.6, 160 ± 13.6 and 166 ± 13.0 g/lamb/day for lambs on Diets 1 through 4, respectively. Gains in Periods 1 and 2 were 171 ± 7.3 and 124 ± 7.3 g/animal/day, respectively, and were significantly different ($P < .01$). In Period 1, gains were 163 ± 15.2, 175 ± 14.7, 143 ± 14.7, and 201 ± 14.0 for Diets 1 through 4, respectively. Diet 3 gave similar gains to Diet 1 ($P < .35$) and 2 ($P < .13$) but higher ($P < .006$) gains than Diet 4. In Period 2, gains were 127 ± 15.2, 147 ± 14.7, 176 ± 14.7, and 131 ± 14.0 g/day for Diets 1 through 4, respectively. Gains on Diet 3 were higher than on Diets 1 ($P < .02$) and 4 ($P < .03$), but similar to gains on Diet 2 ($P < .16$). Effects of Diet 1 on gains were similar to those of Diet 2 ($P < .34$) and Diet 4 ($P = .8$). There were no differences between the growth rates of lambs on Diets 2 and 4 ($P < .46$). Diet had no effect on the apparent or true digestibility of dry matter and organic matter, CP degradability, microbial efficiency of CP synthesis or the effluent bacterial N ($P = .90$). Effluent dietary N increased ($P < .01$) with increasing dietary RUP. Effluent dietary N averaged 587, 591, 729 and 664 mg per day from Diets 1 through 4, respectively. Effluent dietary N on Diet 3 was higher than on Diets 1 and 2 ($P < .003$), and Diet 4 ($P < .03$). Diet 4 gave higher effluent dietary N than Diets 1 and 2 ($P < .02$). Total N flow was marginally increased ($P < .07$) by increasing dietary RUP, peaking at 1152 mg per day on Diet 3.

Key Words: Lambs, Rumen Undegradable Protein,

498 Digestion of nitrogenous compounds by steers fed diets containing raw or extruded soybeans. F. Orias*, N. R. Merchen, C. G. Aldrich, J. C. Elizalde, and L. L. Bauer, *University of Illinois, Urbana.*

The objectives of this study were to evaluate the site and extent of digestion of nitrogenous compounds by steers fed raw soybeans or soybeans extruded at temperatures of 114, 136, and 158°C. Five Holstein steers (450 kg) with cannulas in the rumen, proximal duodenum, and terminal ileum were used in a 5 × 5 Latin square design. The basal diet contained 50% corn silage, 24% alfalfa hay, 6% corn-urea concentrate, 16.6% corn starch, and 3.4% soybean oil. Raw soybeans or soybeans extruded at the designated temperatures replaced the soybean oil and most of the corn starch in the test diets. Nitrogen intake was greater ($P<.05$) for the soybean supplemented diets. Total N (g/d) reaching the duodenum was: 232, 293, 285, 308, and 299 for the basal, raw, 114, 136, and 158 diets, respectively. Nonbacterial N (g/d) reaching the duodenum was: 63.0, 104.5, 106.6, 101.9, and 113.9 for the same diets, respectively. Total N and nonbacterial N flows at the duodenum were greater ($P<.05$) for the soybean supplemented diets, but no difference ($P<.05$) was detected between the raw and extruded soybeans, nor due to extrusion temperature. Nitrogen disappearance(% of N entering the duodenum) was 64.1, 66.1, 65.7, 71.3, and 71.1 for their respective diets. Small intestinal N disappearance was greater ($P<.05$) for the soybean supplemented diets. No differences ($P<.05$) due to diet were detected for flows of essential amino acids (EAA), nonessential amino acids (NEAA), or total amino acids (AA) to the duodenum. Small intestinal disappearance of EAA, NEAA, and total AA (g/d) were greater ($P<.05$) for the soybean supplemented diets compared to the basal diet. Extrusion of soybeans at 114 or 136°C did not increase supply of N or AA to the steers when compared to raw soybeans; however, extrusion at 158°C increased the amount of most individual and total AA disappearing in the small intestine.

Key Words: Soybeans, Steers, Extrusion

499 Comparison of feeding raw soybeans versus soybean meal in steer finishing diets. T. T. Marston, K. K. Kreikemeier*, and J. D. Sartwelle III, *Kansas State University, Garden City.*

Two hundred crossbred steer calves (313.0 kg BW) were randomly assigned to 20 pens and pens were randomly assigned to four treatments. Steers were fed steam-flaked corn based diets (95% concentrate) for 137 days, and implanted with Synovex-S® (d 0) and Revalor® (d 51). There was four dietary treatments: 1) 4% beef tallow, 1.6% urea (**NEG**); 2) 4% beef tallow, 6% soybean meal (**SBM**); 3) 2.5% beef tallow, 7.5% steam rolled soybeans (**SRB**); and 4) 2.5% beef tallow, 7.5% dry rolled soybeans (**DRB**). Diets fed to treatments 2, 3, and 4 also contained .6% urea. No differences in ADG, daily DMI, and feed efficiency were noted. Measured carcass traits were similar among treatments, except SRB had a lower percentage of choice carcasses than NEG and DRB. It appears that soybeans with minimal processing can be substituted for soybean meal and beef tallow used in cattle finishing diets.

	NEG	SBM	SRB	DRB	SEM	*P* value
ADG, kg	1.52	1.48	1.40	1.51	.04	.20
Daily DMI, kg	9.02	8.86	8.59	8.99	.17	.28
Feed:gain	5.96	6.00	6.11	5.96	.13	.80
Carcass wt, kg	331.5	329.9	324.5	335.1	2.96	.13
Dressing %	63.64	64.03	64.21	64.32	.22	.17
Marbling score[a]	319	302	304	333	10.8	.18
Percent Choice	59.33	50.00	40.00	61.33	4.97	.03
Fat, cm	.74	.70	.79	.71	.03	.21
Ribeye area, sq cm	87.1	86.2	84.7	85.0	1.02	.32
KPH, %	1.8	1.9	1.8	1.8	.05	.23
Yield grade	1.34	1.35	1.46	1.44	.07	.46
Liver abscess score	.10	.20	.10	.20	.10	.82

[a]Marbling score: 200 = Slight 00, 300 = Small 00, etc.

Key Words: Steers, Soybean, Protein

500 Effect of urea, fish meal and carnitine in liquid supplement on growth and metabolites of grazing calves. T. W. White*, L. R. Gentry, G. T. Gentry, J. M. Fernandez, A. M. Chapa, and D. C. Blouin, *Louisiana State University Agricultural Center, Baton Rouge.*

Two experiments were conducted to evaluate the influence of urea (U), fish meal (FM, Sea-Lac™), and L-Carnitine (LC) (Lonza, Inc) in a molasses-urea mixture (PM Ag, Inc) on growth rate and ruminal and blood characteristics of early-weaned calves grazing late-summer forage. Four supplements (24% CP) were made by adding 2.8% U or 16% FM to a 17% molasses-urea mixture and to each of these adding 0 or 1 g of LC per .9 kg of supplement. In Exp. 1, each supplement was fed to two pens of 5 calves (BW = 160 kg) for 84 d. Blood samples were collected at 1400 on d 56. Exp. 2 used a 4×4 latin square arrangement of 4 calves (BW = 167 kg) and 4 periods. Each calf was drenched (0 h) with 3 g of supplement per kg BW and ruminal and blood samples collected at 0, .5, 1, 2, and 4 h. Calves were rotated and fed for 10 d before drenching and sampling again. ADG was improved ($P<.01$) by including FM in the supplement (.28 vs .08 kg). ADG was improved from .03 to .14 kg with no FM and decreased from .33 to .25 kg with FM by LC ($P<.01$). Plasma urea was reduced, and glucose increased by LC with FM but was reversed when LC was fed without FM ($P<.05$). In Exp. 2, plasma glucose, urea, insulin, ammonia, and ruminal ammonia levels were affected ($P<.01$) by sampling time (T) with levels increasing after drenching but were near 0 h levels by 4 h. Ruminal ammonia was reduced ($P<.01$) by FM and LC. Glucose levels were effected by T × LC ($P=.08$) with levels reduced at .5,1 and 2 h and increased at 4 h by LC. Urea levels were reduced more at 4 h than at other T (T × LC $P=.08$; T × FM $P=.01$). Areas under the curve (AUC) for plasma urea and ruminal ammonia levels were reduced ($P<.04$) by FM. There was a trend for LC to reduce AUC for plasma urea ($P=.10$). These data suggest the benefit of including FM and LC in supplement.

Key Words: Calves, Fish Meal, Carnitine

501 Effect of protein source on fleece and liveweight production in Angora doelings. A. J. Litherland*, T. Sahlu, C. A. Toerien, R. Puchala, and K. Tesfai, *E (Kika) de la Garza Institute for Goat Research, Langston University, OK.*

The objective of this experiment was to determine fleece and liveweight response to various sources of protein in Angora goats. Yearling Angora doelings (n = 51) were randomly allocated to one of 4 dietary protein (70% of feed protein) source treatments: corn gluten meal (CGM), cotton seed meal (CSM), hydrolyzed feather meal (HFM) and Menhaden fish meal (FM). A totally mixed ration (18% CP, 2.8 MCal ME/kgDM) was offered at 1.6 × maintenance for 94 d. Mean DM (707 g/d) and CP (133 g/d) intakes were similar. Mean fleece free liveweight gain was 47% higher ($P < .01$) in FM (50 g/d) than the other treatments (33-35 g/d). Fleece production was 27% higher ($P < .001$) in CGM (4.4 kg) than the other treatments (3.4-3.6 kg). Apparent DM and CP digestibilities were highest in FM (73.7% and 79%) and lowest in HFM (71 and 62%). Total VFA concentration in the rumen was lowest in CGM and HFM (39 and 41 mM) and highest in CSM and FM (47 and 46 mM). Overall mean plasma urea concentrations was higher in FM (15.2 mg/dL) compared to the other treatments (13.3-14.4 mg/dL; $P < .05$). Goats fed FM also had higher plasma concentrations of LYS (87 vs 56-73 mg/L; $P < .001$) while CGM goats had higher concentrations of MET (28 vs 21-25 mg/L; $P < .001$) and PHE (74 vs 63-66 mg/l; $P < .05$). In conclusion, protein sources differed in their capacity to support fleece and liveweight growth; CGM showed ability to increase mohair production while FM improved liveweight gain of Angora goats.

Key Words: Angora Goat, Mohair, Protein

502 Influence of forage from native shrubs of northeastern Mexico on nitrogen utilization by goats. R. G. Ramirez*, *Universidad Autonoma de Nuevo Leon, San Nicolas de los Garza.*

Three individual digestion experiments were conducted, using metabolism stalls, to evaluate the influence of leaves from six native shrubs on N balance of Spanish goats. In Experiment 1, 12 male castrated goats (32.2 ± 2.1 kg BW) were randomly assigned to three diets: (1) 23% alfalfa hay plus 77% bean straw (BS); (2) 25% blackbrush acacia leaves (*Acacia rigidula* Benth.) plus 75% BS (3) 20% huisache leaves (*Acacia farnesiana* (L.) Willd.) plus 80% BS. In Experiment 2, the same 12 goats were randomly assigned to three diets: (1) 23% alfalfa hay plus 77% BS; (2) 22% hackberry leaves (*Celtis pallida* Torr.) plus 78% BS; (3) 18% ceniso leaves (*Leucophyllum texanum* Johnst.) plus 18% soapbrush leaves (*Porlieria angustifolia* Gray.) plus 64% BS. In Experiment 3, the same 12 goats, were randomly assigned to three diets: (1) 23% alfalfa hay 77% BS; (2) 13% palo verde leaves (*Cercidium macrum* Johnst.) plus 87% BS and (3) 100% BS. In the three experiments, goats were adapted to the diets during 15 d, the last five d were used for feces and urine collection. Simple regression and correlation analyses were performed to evaluate the relationships among N balance characteristics of goats. With exception of the diet that contained only BS, all had the same amount of N (1.5% N). The N intake (g/d) of goats, in all experiments, was highly correlated ($r=.91$; $n=36$; $P<.001$) to the retained N (g/d). The CP intake ($g/kg^{.75}$) and the fecal N (g/d) of goats, were also correlated ($r=.62$; $n=36$; $P<.01$ and $r=.69$; $n=36$; $P<.01$, respectively) to the retained N (g/d). The digestible CP (%) and the urinary N were poorly correlated to the retained N (g/d). Leaves from native shrubs can be considered as good protein supplements in diets for grazing ruminants. Besides, fecal N may be considered as an indicator of the N status of goats.

Key Words: Spanish Goats, Native Shrubs, Nitrogen Balance

503 Effects of trenbolone acetate-estradiol benzoate and protein level on wether lamb performance. K. E. McClure[1]*, S. C. Loerch[1], and M. B. Solomon[2], [1]*The Ohio State University, Wooster and* [2]*USDA/ARS, Beltsville, MD.*

A 2×2 factorial experiment was conducted with 48 Hampshire crossbred wether lambs (initial BW 23.6 kg) to determine the performance response of lambs to dietary CP at recommended (RCP) or high (HCP) when implanted with trenbolone acetate-estradiol benzoate (TBA). Half the lambs were ear implanted with (TBA) at the initiation of the experiment (23.6 kg) and allotted to 12 pens with 4 lambs per pen. Lambs were fed an all-concentrate diet (shelled corn + pelleted supplement), offered ad libitum, during both phase 1 (23.6 to 39.2 kg) and phase 2 (39.2 to 52.4 kg). Lambs on HCP received 20 and 17 % CP, whereas lambs on RCP received 16 and 13 % CP during phases 1 and 2, respectively. Twelve intermediate lambs were removed from experiment for slaughter at 39.2 kg and 36 lambs continued on experiment to 52.4 kg. There were no differences ($P>.05$) in DMI for implant or CP level. Gain/feed was more ($P<.01$) for implants vs non-implants (.32 vs .28) and more ($P<.01$) for HCP vs RCP (.33 vs .28). Average daily gain was more ($P<.03$) for implants vs non-implants (449 vs 390 g) and more ($P<.01$) for HCP vs RCP (463 vs 377 g). There were no interactions, however ADG of implanted lambs tended to be more than non-implants at both CP levels. These data suggest that lambs responded to TBA implants and that implanted lambs responded to additional CP in the diet.

Key Words: Lambs, Trenbolone Acetate, Protein

504 Influence of α-linked glucose on sodium-glucose cotransport activity along the small intestine in cattle. M. L. Bauer*, D. L. Harmon, D. W. Bohnert, A. F. Branco, and G. B. Huntington, *University of Kentucky, Lexington.*

Thirteen steers (378 ± 23 kg) were used in a split-plot experimental design to evaluate the effect of small intestinal carbohydrate on sodium-glucose cotransport (SGLT1) specific activity (SA). Steers consumed 8.1 ± .5 kg/d ground fescue hay and soybean meal based supplement and were infused ruminally (control) or postruminally with a partial α-amylase starch hydrolysate (914.5 ± 8.3 g/d) for 7 d. On the seventh day, five equidistant 1-m small intestinal sections were harvested and frozen in liquid N for later preparation of brush-border membrane vesicles. Maltase (MALT) SA of the homogenate and vesicles changed ($P < .001$) and alkaline phosphatase (AP) decreased ($P < .001$) along the small intestine. Vesicles were enriched 9.80 ± .83 and 7.64 ± .67 fold for AP and MALT, respectively; and were not different between treatments ($P = .76$ and .39, respectively). Maltase and AP enrichment changed ($P < .001$) along the small intestine. Recovery of AP and MALT SA (25.0 ± .2% and 19.5 ± .2%, respectively) in the vesicles was not affected ($P = .29$ and .21, respectively) by treatment, but changed ($P < .001$) along the intestine. Protein recovery in the vesicles was 2.60 ± .01% and was unaffected by treatment or intestinal site. The SGLT1 SA (220 ± 44 $pmol \cdot mg^{-1} \cdot s^{-1}$) was unaffected ($P = .34$) by treatment, but changed ($P < .001$) along the small intestine. There were no treatment × site interactions ($P > .10$). Apparent K_m of SGLT1 for glucose was 62.7 ± 5.8 μM. Maltase SA was highest in the jejunum and lowest in the duodenum. The SGLT1 SA was highest in the first two jejunal sites and lowest in the ileum. Sodium-glucose cotransport activity may limit small intestinal starch assimilation in the distal small intestine. It does not appear glucose arising from carbohydrate hydrolysis regulates sodium-dependent glucose transport activity in cattle.

Key Words: Starch, Small Intestine, Beef Cattle

505 Influence of abomasal sucrose infusion on small intestinal disaccharidase activity in lambs. K. C. Swanson* and D. L. Harmon, *University of Kentucky, Lexington.*

Eight wether lambs (41 kg) with abomasal infusion catheters were used to determine the effect of small intestinal sucrose on mucosal disaccharidase activity. Lambs were adapted to a 15.8% CP diet (1178 g of DM/d) for 7 d prior to the infusion period. Lambs were housed in metabolism crates and infused abomasally with 42.5 ml/h of a sucrose solution or water (control) for 5 d. Lambs on the sucrose treatment received .73 and 1.67 g/h of sucrose for d 1 and 2, respectively, and 2.75 g/h for d 3 through 5. After the infusion period, lambs were overdosed on pentobarbital and the second and fifth meters of small intestine (posterior to pyloric sphincter) were obtained. Sections were rinsed in ice-cold saline, split longitudinally, frozen in liquid N_2, and stored at –80°C for 4 wks. After tissues were thawed, small intestinal mucosa was removed by scraping with a glass slide and a 20% homogenate in saline was prepared using a polytron. Sucrase and maltase activities were determined by incubating homogenate with proper substrate and measuring the amount of glucose liberated. Protein concentrations of the homogenates were also determined. Final BW, BW change, and fresh mucosa weight/cm intestine were not influenced (P>.10) by treatment. No detectable amount of sucrase activity was present in intestinal tissue samples from lambs in either treatment. Maltase activity [units (U)/g mucosa and U/cm intestine] was greater (P<.10) in the fifth compared with the second meter of small intestine, but was not affected (P>.10) by treatment. Maltase specific activity (U/g protein) was not influenced (P>.10) by treatment or sample site. Overall maltase specific activity averaged 35 μmoles maltose hydrolyzed/(min * g protein). These data indicate that sucrose infusion does not induce mucosal sucrase activity and has no effect on maltase activity. Further work seems warranted to better understand intestinal disaccharidase activity of ruminants in relation to intestinal carbohydrate digestion.

Key Words: Lambs, Disaccharidase, Sucrose

506 Splanchnic metabolite flux and nitrogen retention in lambs fed diets differing in supplemental nitrogen source. D. W. Bohnert*, B. T. Larson, S. J. Lewis, C. J. Richards, K. C. Swanson, D. L. Harmon, and G. E. Mitchell, Jr., *University of Kentucky, Lexington.*

Eight multicatheterized wethers (37 kg) were used in a replicated 4×4 Latin square design to measure N retention (NR) and net uptake and release of plasma metabolites across the portal-drained viscera (PDV), hepatic (HEP) and total splanchnic (TS) tissues in response to supplemental N source. Treatments selected to provide different amounts of undegradable intake protein (UIP) were urea (U), soybean meal (SBM), poultry byproduct meal (PBM) and bloodmeal:corn gluten meal (BM:CGM; 50:50 N basis). Diets were formulated to contain 12% CP with supplemental N source providing 38% of total N intake. Periods were 10 d with total feces and urine collected on d 7 to 10 and blood sampled on d 10. Wethers were fed at 2% of BW in 12 portions/d. NR was 2.2, 3.3, 4.1 and 4.4 g/d for U, SBM, PBM and BM:CGM, respectively. U had less (P<.01) NR than SBM, PBM and BM:CGM while SBM had less (P<.01) than PBM and BM:CGM. Arterial, portal and hepatic plasma flows were greater (P<.09) for SBM compared with PBM and BM:CGM (21 vs 16, 17; 84 vs 72, 72; 105 vs 87, 88 L/h). Portal plasma flow was greater (P<.10) for U compared with SBM, PBM and BM:CGM (85 vs 84, 72, 72 L/h). PDV and TS alpha-amino N (AAN) flux were less (P<.05) for PBM compared with BM:CGM (20.5 vs 26.6 and 7.2 vs 15.1 mmol/h), while TS AAN flux was less (P<.05) for U compared with SBM, PBM and BM:CGM (6.9 vs 16.9, 7.2, 15.1 mmol/h). PDV flux and HEP removal of ammonia-N (NH3N) were greater (P<.001) for SBM compared with PBM and BM:CGM (27.7 vs 19.4, 20.6; –28.1 vs –20.0, –21.4 mmol/h). PDV removal was less (P=.07) and HEP and TS flux of urea-N (UN) were greater (P<.01) for SBM compared with PBM and BM:CGM (–4.92 vs –8.32, –7.93; 25.87 vs 16.54, 20.00; 20.95 vs 8.22, 12.07 mmol/h). These data suggest that PBM and BM:CGM improved protein quality compared with U and SBM by decreasing PDV NH3N and HEP UN flux, thereby, reducing urinary N loss.

Key Words: Sheep, Nitrogen, Liver

507 Effects of ruminally degraded protein and abomasal essential amino acid infusion on net flux of nitrogenous compounds in steers fed a high-grain diet. C. R. Krehbiel[1]*, C. L. Ferrell[2], and H. C. Freetly[2], *[1]New Mexico State University, Las Cruces and [2]USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Seven steers with portal and hepatic catheters were used in a 6 × 6 Latin square design to determine the effects of feeding different amounts of ruminally degraded protein (RDP) and increasing postruminal infusion of essential amino acids (EAA) on net portal and hepatic flux of nitrogenous compounds. Treatments consisted of an unsupplemented (9.5% CP; LP) or urea supplemented (12.5% CP; HP) 92.5% diet concentrate with abomasal infusion of 0, 90, or 180 g of EAA/d. Dietary adaptation was from d one through nine, and adaptation to infusion of EAA or water was from d three through nine. On d 10, simultaneous arterial, portal, and hepatic blood samples were taken five times at 1.5-h intervals. Arterial concentration of ammonia N was not affected ($P>.10$) by increasing RDP or EAA, whereas arterial concentration of urea N was greater ($P<.01$) when HP vs LP was fed. Arterial concentrations of EAA and total amino acids (TAA) were not affected ($P>.10$) by increasing RDP, but increased (linear effect, $P<.001$) as EAA infusion increased. Net portal-drained viscera (PDV) release and net hepatic uptake of ammonia N were greater ($P<.01$) when HP vs LP was fed. Net PDV flux of urea N was not affected ($P>.10$) by RDP or increasing EAA infusion. However, net hepatic release of urea N was greater ($P<.10$) when HP vs LP was fed. Net PDV flux of TAA increased (linear effect, $P<.10$) as EAA infusion increased, whereas net hepatic flux of TAA was unchanged ($P>.10$). Calculating net PDV EAA flux by subtracting EAA flux during water infusion resulted in net PDV EAA absorption accounting for 11 and 65% of EAA infused when 90 and 180 g/d of EAA were infused, respectively. Results suggest that recovery of postruminal EAA in portal blood may increase as postruminal EAA increase. Providing postruminal EAA can increase peripheral amino acid supply in growing steers consuming a high-grain diet.

Key Words: Ruminants, Escape Protein, Ruminally Degraded Protein

508 Effect of breed and short-term changes in plane of nutrition on growth and metabolic responses in lambs. T. W. White, J. M. Fernandez*, L. R. Gentry, L. S. Walz, A. M. Chapa, D. C. Blouin, and D. T. Hoover, *Louisiana State University Agricultural Center, Baton Rouge.*

An experiment was conducted with six Suffolk (S, BW=44.4 kg), six Gulf Coast Native (G, BW=27.3 kg), and seven Suffolk × Gulf Coast Native (SG, BW=32.1 kg) shorn lambs to determine their growth and metabolic responses to changes in plane of nutrition. Treatments consisted of feeding a 10% CP concentrate-base diet containing 20% cottonseed hulls during a 14-d adaptation and three 28-d periods: at 110% maintenance (Per. I); to gain 160 g/d (Per. II), and full-feed (Per. III). Body weights and jugular blood samples were taken at 14-d intervals after a 16 h shrink. An i.v. glucose tolerance test (IVGTT) was conducted every 28-d. Overall, DMI (P<.03) and ADG (P>.20) were 936 and 102 g, 800 and 76 g, and 707 and 81 g for S, SG, and G, respectively. All lambs lost weight during Per. I and gained weight during Per. II and III (P<.05). There was a breed × period trend (P <.12) in ADG, where S lambs lost more weight during Per. I but gained more weight during Per. II and III than SG and G lambs. Overall, plasma albumin was higher in S and G vs SG (30.9 and 30.6 vs 27.6 g/L; P<.02), and thyroxine was greater in S vs G and SG (116 vs 89 and 86 ng/mL; P<.02). No breed effects (P>.10) were noted in plasma concentrations of cortisol, urea N, NEFA, and glucose. Plasma albumin and urea N concentrations were greater in Per. I (P<.02) and III (P<.04) compared with Per. II. Plasma thyroxine and NEFA levels were higher (P<.01) in Per. I compared with Per. II and III. There were no consistent effects of plane of nutrition on plasma glucose or cortisol levels (P>.10). There were no differences (P>.20) due to breed or plane of nutrition in glucose kinetics following the IVGTT. Six additional G lambs (BW = 26.5 kg) were fed with Per. I and II feeding levels reversed and their responses compared with the first G lambs. Differences in plasma thyroxine levels between S and G and SG lambs follow their growth patterns.

Key Words: Lambs, Breed, Plane of Nutrition,

509 Plasma metabolic profiles in late-pregnant goats of breeds with differing mature size. S. Wildeus[1]* and J. M. Fernandez[2], *[1]Virginia State University, Petersburg and [2]Louisiana State University Agricultural Center, Baton Rouge.*

Glucose (GLU), nonesterified fatty acids (NEFA), urea nitrogen (PUN), β-hydroxybutyrate (βHB), as well as insulin (INS), thyroxine (T_4), and cortisol (CORT) levels were determined in plasma of does at wk 14 and 20 of gestation. Animals represented the Myotonic (M), Nubian (N), Pygmy (P), and Spanish (S) breeds (9 does/breed). Does were maintained on permanent pasture without supplementation. Blood samples were collected pre- and 3 h postprandial for metabolites, and preprandial only for hormones. A repeated measures analysis using a split-plot design was used to analyze breed, stage of gestation, and time of collection effects. BW ranged (P<.001) from 19.7 kg in P to 60.2 kg in N, and increased (P<.001) with advancing gestation. Prepranidal GLU levels were lower (P<.01) later in gestation, however, a postprandial rise was observed only at this stage (interaction: P<.01). GLU was higher (P<.01) in P (2.89 mmol/L) than the other breeds. PUN levels increased (P<.01) postprandial (12.4 to 14.5 mmol/L) and decreased (P<.01) with advancing gestation, with no differences between breeds. NEFA levels were higher (P<.05) in S than N (772 vs. 505 μEq/L) with M and P being intermediate, and increased with advancing gestation. Similarly, βHB levels tended to be higher (P<.10) in S (764 μmol/L) than the other breeds (<500 μmol/L). INS was similar in all breeds, but increased (P<.01) as gestation advanced (18.2 to 22.5 μU/mL). CORT levels were lower (P<.05) in N (3.2 ng/ml) than the other breeds (>7.5 ng/ml). T_4 was lower (P<.01) in P (55.4 ng/ml) than the other breeds (>75 ng/ml), and decreased later in gestation in S (94.2 to 74.8 ng/ml) but not the other breeds (interaction: P<.05). These findings, together with data from an earlier trial, point to consistent differences in some blood metabolites between goat breeds in late gestation.

Key Words: Goat, Metabolic Profile, Gestation

510 Energy expenditure (EE) of breeding Angora bucks using the doubly-labelled water technique. T. Sahlu[1]*, C. A. Toerien[1], W. W. Wong[2], and S. P. Hart[1], *[1]E (Kika) de la Garza Institute for Goat Research, Langston University, OK and [2]USDA/ARS Children's Nutritional Research Center, Houston, TX.*

The objective was to determine the EE under free-living conditions of Angora bucks during peak breeding season by using the doubly-labelled water technique. Four bucks (57 ± 3 kg) and 4 wethers (45 ± 2 kg; controls) were allocated to 4 breeding flocks (n = 30). All animals were fed ad lib., a TMR providing 2.5 Mcal ME/kg DM and 13.6% CP, for 2 h daily. Experimental animals were fed individually to record intakes. All male animals were fitted with marking harnesses to measure sexual activity. Blood samples were collected prior to jugular infusion with $^2H_2{}^{18}O$ (200 mg ^2H_2O and 250 mg $H_2{}^{18}O$/kg BW), for background isotope enrichment measurements. Postdose blood samples were collected at 6 h post-infusion and at 3-4 d intervals for 15 days. ^2H and ^{18}O dilution spaces were calculated using the multi-point model, isotopic estimates of ^2H_2O flux were corrected for ^2H losses in feces and methane, and fractionated evaporative water loss was determined in a separate study. EE was calculated from CO_2 production and O_2 consumption (respiratory quotient = 0.86), taking energy lost as methane and urinary nitrogen into account. The ratios of isotope distribution spaces (N_D/N_O) were determined to be 1.025 ± .008 for bucks and 1.025 ± .003 wethers. Total EE of bucks and wethers did not differ (154 vs 150 ± 14 kcal ME/kg $BW^{.75}$/d; P > .10). Courtship and attempted mountings by wethers were observed and there was a tendency for EE to be higher in wethers that marked more does (P = 0.11). One wether marked a similar number of does as the buck (14 vs 15). EE for activity (Total EE – energy for maintenance – energy for mohair) of the bucks and wethers were 23 ± 6% and 20 ± 9% higher than the 101.38 kcal ME/kg $BW^{.75}$/d maintenance value for goats (NRC). The variation within both groups was attributed to individual differences in courting behavior in the breeding season. In conclusion, EE associated with mating behavior is estimated to exceed maintenance requirements by 20-30%.

Key Words: Energy Expenditure, Doubly-Labelled Water, Angora Goats

511 Effects of breed, dietary phosphorous, and trace mineral source on immune function, mineral status, and performance in steer calves. T. E. Engle*, J. W. Spears, and T. T. Brown, Jr., *North Carolina State University, Raleigh.*

An experiment was conducted to determine the effects of breed, dietary phosphorous (P) and trace mineral source on immune response, mineral status, and performance in steer calves. Forty-eight, newly weaned, Angus (n=24) and Simmental (n=24) calves were blocked by weight within breed and randomly assigned to treatments in a 2 × 2 factorial design with factors being 0 or .15% supplemental P and inorganic sulfate or organic proteinate trace minerals. Copper, Mn, and Zn were added at levels of 10, 25, and 25 ppm, respectively. Organic treatments supplied 50% of the supplemental Cu and Mn and 66% of the supplemental Zn with the remainder supplied from inorganic sulfate forms. The basal diet was a corn silage-soybean meal-based diet. On d 2, following weaning, calves received an intranasal inoculation of infectious bovine rhinotracheitis virus ($2.7 \times 10^8 CCID_{50}$). Rectal temperatures were unaffected by treatment, but were higher (P < .05) in Angus calves. On d 9, calves were injected with 10 ml of a 25% pig RBC suspension. Total immunoglobulin titers against pig RBC were higher (P < .05) in treatments with no added P and for Angus calves. Immunoglobulin M titers were higher (P < .05) in Angus calves. Cell-mediated immune response to phytohemagglutinin was unaffected by treatment or breed. Serum Cu, P, and Zn concentrations were unaffected by treatment, but serum Cu was higher (P < .05) and serum P lower (P < .05) in Angus calves. Increasing dietary P or replacing inorganic trace minerals with organic forms had little effect on immunity or performance in this study. Results indicate that the immune response of Angus and Simmental calves may differ.

Key Words: Cattle, Immunoglobulin, Mineral

512 Determining the phosphorus requirement of finishing yearlings. G. E. Erickson*, M. J. Klemesrud, C. T. Milton, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

Sixty yearling crossbred steers (386 kg) were fed individually using a 2 × 5 factorial treatment structure (n = 6). Calcium (Ca) was fed at either .35 or .70% of DM and phosphorus (P) at .14, .19, .24, .29, or .34% of DM. The finishing diet consisted of 34.5% dry-rolled corn (DRC), 22.5% brewers grits, 22.5% corn bran, 7.5% ground corncobs, 5% molasses, 3% fat, and 5% supplement. Supplemental P was provided as monosodium phosphate. Ash content was determined on the first phalanx bone from hooves following slaughter. There were no interactions between Ca and P levels, so data were pooled. Performance and bone ash (g or g/100 kg BW) were not affected by P concentration fed or P intake. The .7% Ca diet decreased (P < .06) ADG and efficiency compared with .35% Ca. These results indicate the requirement for finishing yearlings is lower than .14% P, and it is not necessary to add supplemental P above levels supplied by basal ingredients in a typical DRC finishing diet.

	P	ADG	DMI	G:F[a]	Bone ash	
	g/d	kg	kg		g	g/100 kg BW
% P						
.14	16.4	1.76	11.4	.154	28.29	8.01
.19	19.9	1.62	10.3	.157	27.51	8.02
.24	27.6	1.72	11.5	.149	28.86	8.20
.29	32.0	1.75	11.1	.158	27.50	7.83
.34	36.2	1.53	10.8	.142	28.52	8.46
SE		.09	.3	.007	.98	.20
% Ca						
.35		1.76	11.11	.159	28.01	7.95
.70		1.59	10.89	.145	28.27	8.25
SE		.06	.22	.004	.62	.13

[a]G:F = ADG/DMI.

Key Words: Phosphorus, Requirement, Beef Cattle

513 Zeranol reduces P excretion in feedlot lambs. D. R. Niemann*, W. S. Ramsey, L. W. Greene, and D. F. Waldron, *Texas A&M University, College Station and Texas Agricultural Experiment Station, Amarillo.*

Sixty-two Rambouillet wether lambs were used to determine the effects of zeranol on P and N excretion, animal performance and carcass characteristics. Lambs were blocked by sire, randomly allotted to pens of 3-5 in an open sided barn and assigned to either an implant (I) or non-implant (N) treatment group. Lambs had ad libitum access to feed containing 64% TDN and 14% CP for 88 d. Lambs were fed for 21 d before implanting. At 14 d intervals post implanting, pens were thoroughly cleaned and excreta allowed to accumulate for 2 d. Excreta was collected and analyzed for P and N content. Lambs were slaughtered on day 88 and carcass characteristics were determined. P excretion expressed as a percentage of P intake for I vs N treatment groups at 14, 28, 42 and 56 d post implanting was 55.7 vs 61.4% (P=.32); 45.4 vs 55.8%(P=.04); 50.5 vs 53.5% (P=.67) and 78.9 vs 80.7% (P=.85), respectively. The percentage improvement in P utilization due to implanting was 9.2 (NS), 18.6 (P=.04), 5.6 (P=.67) and 2.2% (P=.85) at 14, 28, 42 and 56 d post implanting, respectively. These percentage differences appear to follow the pay-out curve of the zeranol implant. There was no effect (P>.10) of zeranol on N excretion in this study. Implanted lambs had a 16.2% greater (P<.002) ADG and 17.3% improvement (P<.002) in feed efficiency compared with N lambs. Implant treatment did not affect carcass characteristics; however, implanted lambs did have thicker hides (P<.01). Results of this study indicate that zeranol improved P utilization, feed efficiency and ADG in feedlot lambs.

Key Words: Phosphorus, Zeranol, Lambs

514 Copper requirements of Angus and Simmental heifers. L. A. Mullis*, J. W. Spears, and R. L. McCraw, *North Carolina State University, Raleigh.*

Two studies were conducted to determine the copper (Cu) requirements of Angus and Simmental heifers fed corn silage-based diets. In experiment 1, 21 Simmental and 21 Angus heifers, in their last trimester of pregnancy, were blocked by initial plasma Cu concentrations and randomly assigned to treatments. Treatments consisted of : 1) control (no supplemental Cu), 2) 7 ppm supplemental Cu and 3) 14 ppm supplemental Cu. The control diet contained 4.4 ppm of Cu and approximately 2 ppm of Mo. Blood samples were collected at 28-d intervals for plasma Cu and ceruloplasmin determination. Plasma Cu concentrations were lower (P < .01) initially in Simmental heifers. Plasma Cu in control Simmental decreased (P < .05) to a level (.37 ppm) indicative of deficiency by d 112, while plasma Cu in control Angus remained in the normal range (> .80 ppm) throughout the study. When 7 or 14 ppm of Cu was supplemented to the diet plasma Cu Concentrations were generally similar in Angus and Simmental heifers. In experiment 2, 42 yearling Simmental (n=21) and Angus (n=21) heifers were randomly assigned to the same treatments described above. The control diet contained 6.4 ppm of Cu. Plasma Cu decreased (P < .05) in control Simmental but not Angus heifers. In heifers supplemented with 7 or 14 ppm of Cu, plasma Cu concentrations were similar in Angus and Simmental. Results indicate that with diets containing 2 ppm of Mo, 4 to 6 ppm of Cu is inadequate for Simmental but adequate Angus heifers. A total dietary Cu of 11 to 13 ppm appears to meet Cu requirements of Simmental heifers fed diets containing 2 ppm of Mo.

Key Words: Copper, Simmental, Angus

515 Bioavailability of copper from tri-basic copper chloride in cattle. J. W. Spears*, E. B. Kegley, L. A. Mullis, and T. A. Wise, *North Carolina State University, Raleigh.*

Two experiments were conducted to determine the bioavailability of Cu from tri-basic copper chloride (TBCC) relative to $CuSO_4$ in steers. In experiment 1, 33 steers (375 kg BW) that had previously been depleted of Cu were used in a 21-d repletion study. Steers were randomly assigned within a breed to treatment and individually fed. Treatments consisted of 0, 50 or 100 mg of supplemental Cu/d from either TBCC or $CuSO_4$. Plasma Cu concentrations and ceruloplasmin activities were measured weekly and liver Cu was determined at the beginning and end of the study. Based on plasma Cu, plasma ceruloplasmin, and liver Cu, TBCC and $CuSO_4$ were similar (P > .10) in terms of their ability to increase Cu status in Cu-deficient steers. Experiment 2 was conducted to compare TBCC and $CuSO_4$ when fed to steers fed diets high in Mo and S. Sixty steers (257 kg BW) were stratified by weight and randomly assigned to treatments. Treatments consisted of 0, 5 or 10 mg of supplemental Cu/kg DM from either TBCC or $CuSO_4$. All diets were supplemented with 5 mg Mo/kg and .15% S. Plasma and liver Cu concentrations and plasma ceruloplasmin activities decreased in all treatment groups during the 98-d study. Bioavailability of TBCC relative to $CuSO_4$ was estimated from plasma data on d 84 and liver Cu on d 98 using a slope-ratio technique. Compared with $CuSO_4$ (100%) relative bioavailability of Cu from TBCC was 121 (P < .08) 118 (P < .38) and 196% (P < .04) using plasma Cu, plasma ceruloplasmin and liver Cu, respectively. Results suggest that TBCC is more available than $CuSO_4$ when added to diets high in the Cu antagonists, Mo and S. When evaluated in Cu-deficient steers fed diets low in Mo, the two Cu sources were of similar bioavailability.

Key Words: Copper, Cattle, Bioavailability

516 Sheep blood response to orally supplemented vitamin A dissolved in coconut oil. S. A. Fichter* and G. E. Mitchell, Jr., *University of Kentucky, Lexington.*

This experiment was performed to determine ruminant animal blood response to oral supplementation of vitamin A dissolved in carrier coconut oil. Dorset wethers with mesenteric arterial catheters, average weight 38 kg, were orally administered 36,000 IU of vitamin A predissolved in 35 g of coconut oil. The control treated group received vitamin A without carrier coconut oil. The sheep received the vitamin A in a single oral dose 1 h after feeding 450 g of ground fescue hay. Blood was drawn via the arterial catheters at time of dosage,0 h, and at 16, 20, 24, 28, 32 and 36 h post treatment. A vitamin A assay was made of Serum taken from the blood of each animal at each sample time. There were 8 animals randomly assigned to the two treatment groups with 4 observations per treatment at each sample period. Significant differences were measured as changes in serum vitamin A concentrations at each sample time from pre-dosage levels, time 0, using a t-test. Significantly different ($P < .05$) serum vitamin A concentrations were found in blood from animals treated with vitamin A in coconut oil sampled at times 16 through 28 h compared to time 0 serum vitamin A levels. There was a peak mean concentration of 59.3 μg/dl ± 5.4 at 28 h and a time 0 concentration of 40.8 μg/dl ± 2.7 for the oil treated group. Blood sampled from animals treated with control vitamin A, no oil, were not significantly different in vitamin A concentration at any sample time compared to the base level. These results show that predissolving orally dosed vitamin A supplement in coconut oil increases serum vitamin A status at hours 16 to 28 post supplementation above predosage levels. This supports earlier findings that amounts of oral dosed vitamin recovered in abomasal digesta 24 h post dosage were significantly higher using coconut oil carrier compared to no oil and does not indicate interference with the process of vitamin A absorption from the GIT into the blood.

Key Words: Vitamin A, Coconut Oil, Serum, Ruminant

517 The immune-potentiating impact of vitamin E and zinc in buffalo calves. O. Mohamed*, B. Edrise, F. Mohamed, and T. Ismail, *Fac. of Vet. Med., Cairo University, Egypt.*

As a dose of non-infectious (killed) cattle vaccines is unable to get a detectable immune response, the objective of this work is to evaluate the potential effect of high level of vitamin E and zinc on buffalo immune response vaccinated with Haemorrhagic septicemia oil adjuvant killed vaccine. Two groups of nonvaccinated young buffalo calves were on trial for 7 wks prior to vaccination and continued for further 6 wks post vaccination (WPV). The diet offered contained 25 ppm Zn. One of the two groups (SG) was supplemented with a combination of 1500 IU of vitamin E and 7 g of zinc oxide per animal at weekly intervals. Heparinized & non-heparinized blood samples were collected at zero point (ZP), vaccination point (VP) and WPV. Serum Zn levels were markedly elevated in the SG throughout the study. The trial is very encouraging as the nutrient supplementation enhanced the immune response to the vaccine antigen. Geometric mean of indirect hemagglutination was higher 4 & 6 WPV for SG (116.5, 136.5) than un-SG (104.7, 128.2). Lymphocyte blastogenesis to PHA mitogen were significantly ($P<0.01$) increased.

	Lymphocyte blastogenic response				
Groups	ZP	VP	2 WPV	4 WPV	6 WPV
Control	1.462 ± 0.07	1.705 ± 0.07	1.660 ± 0.05	1.740 ± 0.06	1.587 ± 0.10
Suppl.	1.513 ± 0.09	1.695 ± 0.06	1.543 ± 0.12	2.460 ± 0.06	2.625 ± 0.40

Key Words: Buffalo Calves, Killed Vaccine, Nutrient Supplementation

518 The effects of pre-weaning vitamin E and selenium supplementation on the performance, serum metabolite concentration, and antibody titers of stressed beef caves. C. L. Wright*, L. R. Corah, G. L. Stokka, and F. Blecha, *Kansas State University, Manhattan.*

Eighty Hereford × Angus beef calves were blocked by weight and allotted to five treatment groups: 1) basal diet only (Con), 2) basal diet + .3 ppm Se (Se), 3) basal diet + .3 ppm Se + 500 IU vitamin E (Low E), 4) basal diet + .3 ppm Se + 1000 IU vitamin E (Med E), 5) basal diet + .3 ppm Se + 1500 IU vitamin E (Hi E). Basal diets were comprised of 60% dry rolled corn, 25% rolled oats, 10% soybean meal, and 5% wet molasses, as fed. Calves and dams were housed together and rotated weekly among 4 pastures (approx. 120 ha). Daily, calves were separated from their dams, sorted into treatment groups and individually fed .91 kg of their appropriate dietary treatment for 53 d prior to weaning. Calves were pre-vaccinated 17 d prior to weaning. At weaning, calves were separated from their dams, re-vaccinated, and shipped 418 km to a commercial feedlot, where they were fed a growing diet for 46 d. Calf weights were taken on d 0, 53 (weaning and post-ship), 60, 81, and 98 (pre- and post-ship). Serum samples were collected via jugular veinapuncture on d 0, 37, 53, 60, and 81. Initial mean serum vitamin E concentration was 1.06 mg/dL. Serum vitamin E on d 53 tended to be greater in Med E calves than those calves in the Con, Se, or Hi E treatment groups, but was not different than Low E calves. Dietary treatment had no effect ($P > .10$) on pre- or post-weaning ADG, or shipping shrink. Serum cortisol concentrations at weaning tended ($P < .09$) to be greater in calves in the Se and Low E treatment groups than in Con calves. Post-ship serum cortisol concentrations tended ($P < .06$) to be greater in Low E calves that in Con calves. Treatment had no effect on serum haptoglobin concentration. Antibody titers to IBR and BVD vaccination were unaffected by dietary treatment. Pre-weaning vitamin E and(or) Se supplementation to beef calves with adequate vitamin E status did not influence calf performance, stress responses or vaccination profiles in shipped calves.

Key Words: Vitamin E, Calf, Immunity

519 *In situ* degradation of two forages by the ruminal ecosystem of bovines and the caecal ecosystem of *equidae*. V. Julliand[1]*, J. L. Tisserand[1], B. Michalet-Doreau[2], and G. Fonty[2], *[1]INRA/ENESAD, Dijon and [2]INRA, Theix (France).*

Generally monogastric herbivores have lower *in vivo* digestibilities of forages than polygastric herbivores. Donkeys have the specific capacity to utilize forages *in vivo* more efficiently than ponies and horses. The objective of this study was to compare the fibrolytic activity of the ruminal microbial ecosystem of cows with that of the caecum of ponies and donkeys. Three ponies (210 kg) 3 donkeys (240 kg) and 3 cows (450 kg), respectively caecally and ruminally-fistulated, were fed a maintenance diet twice daily (30% concentrate-70% lucerne-orchard hay). *In situ* degradation of Neutral Detergent Fibre (dNDF) in wheat straw (WS) and lucerne-orchard hay (LOH) was studied using the nylon bag technique. Bags (48 mm pores, 3.5 × 11 cm, 6.5 mg/cm^2) were incubated for 4, 8, 16, 24 and 48 h in the caecum or the rumen. For short periods of incubation, the caecal ecosystem of donkeys was as efficient as the ruminal ecosystem of cows in degrading both forages. However it was more efficient (21 to 40 %) than that of ponies. After 8 h of incubation, ruminal microorganisms utilized the NDF of the two forages more efficiently than the caecal systems of *equidae*. These observations are partially due to differences in activities and compositions of the microflora of the ecosystems.

Incubation times		4 h	8 h	16 h	24h	48 h
WS-dNDF (%)	Donkey	0.8	6.8^{a}	15.8^{ab}	17.9^{b}	25.7^{b}
	Pony	0.3	5.6^{ab}	13.2^{b}	19.2^{b}	23.6^{b}
	Cow	0.2	4.0^{b}	17.8^{a}	26.4^{a}	42.9^{a}
LOH-dNDF (%)	Donkey	21.0^{a}	30.0^{a}	38.7^{b}	42.3^{b}	46.4^{b}
	Pony	17.1^{b}	21.3^{b}	33.5^{c}	36.7^{c}	41.1^{c}
	Cow	20.5^{a}	30.8^{a}	45.3^{a}	50.4^{a}	55.4^{a}

For one forage, in the same column, different superscripts indicate significant differences ($p<0,05$).

Key Words: Forage Degradation, Rumen, Caecum

520 Effects of pressure toasting at various conditions on in situ degradability of peas, lupins, faba beans and soy beans. J. O. Goelema*, A.F.B. van der Poel, G. Hof, and S. Tamminga, *Wageningen Institute of Animal Sciences, The Netherlands.*

Pressure toasting (PT) was carried out to improve the nutritional value of the legume seeds peas, lupins, faba bean and soy beans. Various processing times (D; 3, 7, 15 and 30 min) and temperatures (T; 100, 118 and 136°C) were compared with respect to in situ protein and starch degradability. In situ degradability of the untreated and treated seeds was determined with four lactating rumen-cannulated HF cows. Degradabilities were calculated as described by Ørskov & McDonald (1979).PT significantly decreased protein degradability due to a reduction in the washable fraction (W) and in the fractional rate of degradation (k_d). Effects on starch degradability was also measured for peas and faba beans. Starch degradability decreased significantly, especially due to a reduced W. The effects of T and D on bypass crude protein (%BCP) and bypass starch (%BSTA), assuming a rumen outflow rate of 6%/h, were analysed by regression. Linear relationships between T and D were found between the %BCP and T as well D for lupins. These effects were additive. For peas, a linear response of T and D was found for %BSTA. A quadratic response to T and D was found for the %BCP of faba beans, while for peas this relationship was quadratic for T, but linear for D. A quadratic response was found for soy beans, and there was interaction between T and D for %BCP. For faba beans a similar relationship was found for %BSTA. Within the tested range of conditions, the 136°C/15 min treatment increased %BCP from approximately 20 (untreated) to about 50 %BCP for faba beans, peas and lupins. For soy beans the 118°C/7 min treatment resulted in an increase from 28 to 43 %BCP, which was identical to the value reached at 136°C/15 min. For peas and faba beans %BSTA increased from approximately 30 to about 52% after 15 min toasting at 136°C.

Key Words: Pressure Toasting, Legume Seeds, Degradability

521 In vitro and in situ evaluation of barley- and wheat-based distillers grain and thin stillage. A. F. Mustafa*, J. J. McKinnon, and D. A. Christensen, *University of Saskatchewan, Canada.*

The objectives of this study were to determine the chemical characteristics and nutrient degradability of barley-based (70% barley, 20% wheat and 10% rye / triticale mixture) thin stillage (BTS) and distillers grain (BDG) relative to wheat-based (100% wheat) thin stillage (WTS) and distillers grain (WDG). Five samples of BTS, WTS, BDG and WDG were analyzed for carbohydrate and protein fractions. In vitro CP degradability (IVCPD) of BTS and WTS was estimated relative to canola (CM) and soybean (SBM) meal in a completely randomized design. One ruminally fistulated cow was used in a completely randomized design to determine effective ruminal degradability of dry matter, CP and neutral detergent fiber (NDF) of BDG and WDG. Relative to WDG, BDG contained more (P<0.05) NDF and acid detergent fiber (ADF) and less CP. The amount of CP associated with NDF (NDICP) and ADF (ADICP) were also higher (P<0.05) in BDG than WDG. BTS had similar NDF (average 32.9%), higher (P<0.05) ADF, NDICP, ADICP and lower (P<0.05) CP levels than WTS. IVCPD had the following order: SBM > WTS > CM > BTS. Results of the in situ study showed that BDG had lower (P<0.05) effective degradability of DM, CP and NDF WDG. It was concluded that barley distillers byproducts had higher fiber and lower protein levels than the corresponding wheat byproducts. As a result, in vitro and in situ nutrient degradability was lower for barley- than wheat-based distillers byproducts.

Key Words: Distillers Grain, Thin Stillage, Nutrient Degradability

522 Effects of supplementing a high-starch diet with degradable protein on ruminal digestion of starch. M. A. Cerrillo* and A. Trenkle, *Iowa State University, Ames.*

Four crossbred steers (avg wt = 280 kg) with rumen and proximal duodenum cannulae were used in a 4 × 4 Latin Square experiment to determine the influence of supplementation of a high corn diet with degradable protein with or without monensin on the digestion of starch in the rumen and the whole digestive tract. Treatments consisted of a corn diet supplemented with urea, soybean meal, urea plus monensin (urea +), and soybean plus monensin (sbm +). The steers were fed twice daily. Chromic oxide (10 g/d) was used intraruminally as a marker of digesta flow. There was a significant interaction (P < .10), between the protein source and monensin supplementation on OM intake. OM apparently digested the in rumen decreased (P < .10) with addition of monensin. No effect was detected for protein supplementation (P > .10). True digestibility of OM in the rumen tended to decrease (P = .15) with the addition of (P = .18) to decrease starch digestion in the rumen. Total tract digestion of starch was not affected. Microbial efficiency (g microbial N/kg OM digested in the rumen) increased (P < .10) when monensin was incorporated in the diets. These data indicate that supplementation with SBM with or without monensin did not improve starch digestion of a high-concentrate diet for beef cattle.

Item	UREA	+UREA	SBM	+ SBM	SEM
OM intake, g/d	5,888.2	6,206.0	6,964.2	5,712.5	342.1
OM digestion, % of intake					
Ruminal, apparent	53.52	60.64	52.03	62.42	4.41
Ruminal, true	64.56	80.87	76.37	75.53	5.00
Total tract, apparent	84.15	83.72	82.05	86.51	1.68
Starch digestion, % intake					
Ruminal	82.60	86.62	85.14	90.55	3.16
Total tract	96.52	96.60	95.49	97.38	.72

Key Words: Starch Digestibility, Soybean Meal, Monensin

523 Influence of *Bos indicus* and cattle age on apparent utilization of a high-grain diet. C. R. Krehbiel[1]*, C. L. Ferrell[2], and K. K. Kreikemeier[3], *[1]New Mexico State University, Las Cruces, [2]Kansas State University, Garden City, and [3]USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Eight *Bos indicus* × MARC III (initial BW = 301±20 kg) and eight MARC III (initial BW = 322±16 kg) steers were used in a 2 × 2 factorial to determine if cattle age or *B. indicus* influence site of digestion of a high-grain diet. Initially, four *B. indicus* × MARC III and four MARC III steers were fitted with duodenal cannula and adapted to a 95% concentrate diet which was offered ad lib for 238 d (calves). During the feeding period, diet, duodenal, and fecal samples were collected for 4 d every 69 d. The remaining eight steers were fed a forage-based diet for a targeted daily gain of .65 kg for 210 d (yearlings). Following this period, yearling steers were duodenally cannulated and adapted to the 95% concentrate diet. Yearling steers were fed for 155 d and samples were collected for 4-d periods every 46 d. Dry matter intake was 8.9 and 7.4 kg/d, and daily gain was 1.7 and 1.1 kg in yearlings and calves, respectively. Organic matter intake (*P*<.001) and apparent OM digestion in the stomach (*P*<.01) were greater in yearlings vs calves. In contrast, postruminal disappearance (*P*<.05) and apparent total tract digestibility (*P*<.01) of OM were greater in calves vs yearlings. Duodenal OM flow responded with a *B. indicus* × age interaction (*P*<.05). *B. indicus* yearlings had greater OM flow than *B. indicus* calves, whereas *Bos taurus* yearlings had similar OM flow as *B. taurus* calves. Duodenal flow of total N, microbial N, nonmicrobial N, and total amino acids, and fecal N excretion were greater (*P*<.01) in yearlings vs calves, whereas apparent total tract digestibility of N was greater (*P*<.001) in calves vs yearlings. Nonmicrobial N flow was lower (*P*<.07) in *B. taurus* compared with *B. indicus* steers. These data suggest little effect of *B. indicus* on utilization of a high-grain diet. However, total tract digestibility of OM and N are greater when cattle are fed as calves compared with yearlings.

Key Words: Calves, Yearlings, Feedlot

524 Limit-feeding corn as an alternative to forage to reduce manure and nutrient excretion by Holstein cows. L. J. Driedger*, F. E. Smith, and S. C. Loerch, *The Ohio State University, Wooster.*

Eleven dry Holstein cows (initial BW 642.3 ± 50.1 kg) were used in a completely randomized block design to determine effects of limit-feeding a whole shelled corn-based diet versus feeding a conventional forage-based diet on nutrient digestibility, and excretion of DM, N, and manure. Cows were allotted by weight to either a high forage (HF) diet (70% forage and 30% concentrate), or a high corn (HC) diet (13% forage and 87% concentrate). Both diets were formulated to provide equal daily amounts of energy and protein according to NRC requirements. Dry matter intake was restricted by 30% for cows fed HC compared to HF (6.8 vs 9.6 kg/d, respectively). Cows were housed in tie stalls for a 28d adjustment period to the assigned diets, then were moved to metabolism stalls for a 6d total collection of feces and urine. The experiment ended approximately 3 wk before calving. Cow weight and body condition score changes, subsequent calf birth weight and first 28d milk production did not differ (P>.15)between treatments. Fecal DM excretion for HF was greater (P<.05) than HC (4.7 vs 2.8 kg/d, respectively), reflecting the greater intake and lower (P<.10) digestibility of the HF diet. Fecal and urinary excretion of N was greater (P<.05) for HF than HC (61.7 and 114.6 vs 43.0 and 101.2 g/d, respectively). N digestibility of HC was greater (P<.05) than HF (74.5 vs 64.8%, respectively); P intake and fecal excretion were lower (P<.01) for HC vs HF. Feed costs were $1.38 and $1.76/cow/d for HC vs HF, respectively. Limit-feeding a corn-based diet reduces significantly the excretion of DM, N and P in the manure of dry Holstein cows without adversely affecting performance.

Key Words: Holstein, Manure Output, Corn-Based Diet

525 Effects of energy source and ionophore supplementation on diet digestibility and nitrogen metabolism in lambs. F. L. Fluharty*, *Ohio Agric. Res. and Dev. Center, The Ohio State University, Wooster.*

Eight Targhee × Hampshire crossbred lambs (initial BW 26.6 ± 1.2 kg) were used in a total collection (feces and urine) metabolism trial with a 2 × 2 factorial design to determine the effects of energy source (fresh cut alfalfa vs limit-fed, all-concentrate), and ionophore supplementation (with or without lasalocid) on diet digestibility and nitrogen metabolism in lambs fed to achieve similar daily energy and protein intakes. Two replicates of each treatment were used in each of two periods. Therefore, a total of four lambs were represented in each of the four diet treatments. Differences in growth between animals fed high-concentrate diets in confinement and those grazing pasture can be influenced by energy density of the feed, physical characteristics of the feed, DMI, visceral organ mass, and energy expended due to exercise. At similar energy and protein intakes, high-forage diets and high-concentrate diets may have different diet digestibiliites and nitrogen metabolism. Lambs fed alfalfa consumed 1000g/d of DM compared with 765 g/d in lambs fed all-concentrate ($P < .001$). Dry matter ($P < .001$), OM ($P < .001$), and NDF ($P < .05$) digestibilities were lower with alfalfa compared with all-concentrate diets. Nitrogen intake was similar (38.7 vs 39.8 g/d for alfalfa and all-concentrate, respectively). Fecal ($P < .001$) and urinary ($P < .05$) N was greater with alfalfa compared with all-concentrate. Apparent and True N digestibility as well as N retention (g/d, % of N intake, and % of N digested) were all greater ($P < .001$) for all-concentrate compared with alfalfa. Even at equal energy and protein intakes, lambs fed all-concentrate diets have greater feed digestibilities and N retention compared with lambs eating fresh alfalfa.

Key Words: Energy Source, Digestibility, Nitrogen Metabolism

526 Influence of weight and volume of rumen content on intake and digesta passage of a forage diet in steers. M. S. Schettini, E. C. Prigge, and E. L. Nestor, *West Virginia University, Morgantown.*

Five ruminally cannulated steers (550 kg) were fed a low quality forage diet (43.1 % ADF, 8.1 % CP) in a 5×5 Latin square design experiment. Differences in weight and volume of ruminal contents were achieved by varying the number and weight of balls (6 cm diameter) added to the rumen immediately prior to the initiation of an experimental period. Treatments consisted of a 0 ball control, 50 balls with a 1.1 specific gravity (SG), 100 balls with a 1.1 SG, 50 balls with a 1.3 SG and 100 balls with SG 1.3. Volumes were 7.25 L and 14.5 L for the 50 and 100 balls, respectively. Weights were 8.5 and 17 kg for the 50 and 100 balls with a 1.1 SG and 10.75 and 21.5 kg for the 50 and 100 balls with 1.3 SG. DMI was 8.3, 7.3, 7.0, 6.5, and 6.0 kg for the control, 50 – 1.1 SG, 50 – 1.3 SG, 100 – 1.1 SG and 100 – 1.3 SG treatment, respectively. Addition of the balls decreased ($P < 0.01$) DMI when compared to the control. Increasing both the number of balls ($P < 0.01$) and their SG ($P < 0.05$) depressed DMI further. It appears that weight of the balls was equal in importance in depressing DMI as volume. Digestibility of DM, NDF, ADF, and CP was not influenced by treatment. Ruminal Yb concentration over time indicated that increasing the number of balls in the rumen resulted in an increase ($P < 0.05$) in rate of passage of digesta from the rumen whereas changing the SG of the balls had no effect($P > 0.10$) on this variable. Inert particles of different SG (1.1 and 1.3), and length (1 mm and 3 mm) were added to the rumen. Passage kinetics of these particles were not influenced by treatment. Functional specific gravity (FSG) of ruminal digesta was measured at 3, 7, and 12 after feeding. There was a treatment × hour interaction ($P < 0.05$) for the proportion of ruminal digesta with a FSG less than 1.1, which decreased with time after feeding for the control and increasing with time after feeding with the addition of the balls. Ruminal pH and NH3-N were not influenced by treatment.

Key Words: Beef Cattle, Voluntary Intake, Rumen Fill, Rate of Passage

527 Metabolism and digestibility of corn bran and steep liquor/distiller's solubles. T. L. Scott*, T. J. Klopfenstein, R. J. Cooper, R. A. Stock, and C. T. Milton, *University of Nebraska, Lincoln.*

Six ruminally fistulated and 6 intact steers were used in two 6 × 6 latin squares to determine the effect of corn bran (B) and corn steep liquor/distiller's solubles (S) on ruminal metabolism and total tract digestibility (TTD; 2 × 3 factorial). Treatments, based on the replacement of dry-rolled corn (DRC) with B and/or S, were DRC control, 15%B, 15%S, 30%S, 15%B–15%S, and 15%B–30%S. Diets were fed ad libitum once daily and periods consisted of 14 d. Fistulated steers (SQ1) were used to continuously measure pH and intake pattern (d 7–13), and sample ruminal fluid for VFA analysis (d 14). Ruminal fluid was sampled every h and analysis was done on 12 h, 24 h, and a composite of h 1–24. There were no differences in average number of meals, meal length, or meal size. Intact steers (SQ2) were used for total fecal collection (d 11–14) to determine DM, CP, NDF, and starch digestibility. There were no differences in starch digestibility (Avg 99.7%). S decreased average pH and B increased average pH and reduced DM digestibility.

Item	ID	DRC	15B	15S	30S	15–15	15–30	SEM
DMI	SQ1	8.50	7.65	9.42	8.15	9.18	9.68	.64
PH	Max	6.52	6.70	6.44	6.40	6.61	6.40	.08
	Avg	6.02	6.10	5.90	5.75	5.95	5.92	.07
	Min	5.45	5.42	5.41	5.25	5.35	5.50	.05
VFA	Ac[a]	58.6	55.1	53.9	49.7	57.6	55.8	2.0
	Pra	33.6	38.6	38.3	41.6	33.6	33.3	2.4
	Bua	2.39	1.96	2.85	2.95	3.68	4.07	.39
	Tot, mM	97.6	96.7	96.2	96.0	94.9	91.6	4.6
DMI	SQ2	7.88	8.24	8.83	7.31	8.14	8.43	.80
TTD	DM, %	84.5	80.3	87.8	84.5	83.0	84.5	1.9
	CP, %	79.4	77.1	83.3	79.0	88.0	79.0	2.3
NDF, %		76.0	73.8	78.4	71.8	75.6	71.8	2.3

[a]Molar proportion of acetate, propionate, or butyrate in composite.

Key Words: Cattle, Digestibility, Metabolism

528 Bypass protein on performance in early lactation Alpine does. I. E. Brown-Crowder*, S. P. Hart, and T. Sahlu, *E (Kika) de la Garza Institute for Goat Research, Langston University, OK.*

Forty Alpine does in early lactation were utilized in a lactation trial to determine the effects of bypass protein on dry matter intake (DMI), milk yield and composition. Does were randomly assigned to one of four protein sources: soybean meal (SBM), blood meal (BM), fish meal (FM) or corn gluten meal (CGM). Diets were isonitrogenous (12% CP) and isoenergetic (2.7 Mcal ME/kg) with a 44% Forage to 56% Concentrate ratio. The forage source was mixed grass hay; concentrate was a corn based diet. The study consisted of a two week preliminary and an eleven week experimental period. Dry matter, energy and crude protein intakes were similar ($P > .10$). Milk production, milk protein % and SCM were not affected ($P > .10$) by treatment. Fat production ($P < .02$) and FCM ($P < .03$) were lower for soybean meal compared to the other diets. Supplementation of bypass protein increased milk fat and FCM without affecting dry matter intake of early lactating does. An increase in milk components could lead to an increase in cheese yield.

Parameters	SBM	BM	FM	CGM	SE	*P*
DM Intake, kg	1.72	1.60	1.70	1.54	.08	NS
Energy intake Ne_L Mcal/kg[1]	1.32	1.23	1.30	1.19	.06	NS
CP Intake, g/day	20.9	20.7	20.8	19.0	1.0	NS
Milk, kg/day	1.76	1.97	1.86	1.79	.11	NS
Fat, g/day	54	63	66	62	3.5	.10
Protein, g/day	41	49	49	48	.003	NS
Milk fat %	3.51	3.07	3.48	3.45	.11	.04
Milk protein %	2.57	2.59	2.56	2.63	.07	NS
FCM, kg/day	1.47	1.70	1.72	1.64	.08	NS
SCM, kg	1.46	1.61	1.63	1.59	.08	NS

[1]Calculated.

Key Words: Bypass Protein, Milk Production, Dairy Goat

529 Interactions among tannins, supplementation and polyethylene glycol in goats fed oak leaves. N. Silanikove*, N. Gilboa, and Z. Nitsan, *ARO, Institute Anim. Sci., Israel.*

The effect of feeding a basal tannin-rich oak leaves diet (*Quercus calliprinos*) supplemented with a high-carbohydrate or high-protein feed with or without polyethylene glycol (PEG) given to goats once daily on feed intake and digestibility, was studied. Providing 10 g/day PEG to goats fed oak leaves ad lib. and supplemented with 300 g/day concentrates containing 16 g/kg crude protein increased digestible crude protein intake by 50 g/day. When the concentrate was given to goats without PEG, leaf dry matter intake dropped significantly (from 664 to 565 g/day) and the goats lost weight rapidly. Therefore, use of concentrate with tannin-rich material is recommended only if done in combination with PEG. High protein supplementation increased leaf (from 664 to 844 g/day) and digestible protein intake (from 4.8 to 92.3 g/day), but a considerable portion of the protein supplementation was wasted due to interaction with tannins. PEG may economize the use of such high-cost feeds due to the greater efficiency of protein utilization (digestible crude protein intake increased from 92.3 to 122 g/day) of the supplementary feed and to increased intake (from 844 to 1023 g/day) and protein utilization of the basal leaf diet. The results confirmed our presumption that the content of tannin in some browse is so high that it may negatively affect the utilization of protein in supplementary feeds. Neutralizing the tannins with once-daily provision of PEG proved to be an effective means of preventing the negative effect.

Key Words: Tannins, Goats, Supplementation, Protein

530 Influence of pregnancy on intake, digestibility, ruminal fill, and passage rate in crossbred heifers. A. N. Scheaffer*, J. S. Caton, and L. P. Reynolds, *North Dakota State University, Fargo.*

Crossbred heifers (avg age 24 mo and BW 369± 155 kg) were used to evaluate the influence of pregnancy and advancing gestation on DMI, IVDMD, ruminal fill, and passage rate. Heifers (naturally serviced, 42; non-pregnant controls, 21) were grouped in common pens from Nov 9, 1995 to Aug 15, 1996. Heifers were provided corn silage and hay-based diets formulated to provide .454 kg of ADG in pregnant (PR) heifers. Treatments (trt) were PR heifers, slaughtered on d 0, 40, 80, 120, 160, 200, 235, and 270 of gestation and non-pregnant (NP) heifers, concurrently slaughtered on d 40, 120, 200, and 270. Ruminal fluid was measured for pH and transported to the laboratory for IVDMD. There was no effect of trt and no trt × day of slaughter interaction detected (P>.10) for BW, IVDMD, total ruminal fill, total ruminal DM fill, ruminal DM fill, DMI, passage rate, or ruminal pH. However, trt effects and trt × day interaction were detected for ruminal fluid fill and total ruminal fluid fill (P<.09). In the PR trt, fluid fill and total fluid fill responded quadratically with advancing slaughter date (P<.09), whereas those of the NP trt increased linearly (P<.09). As a result, fluid fill and total fluid fill were less for PR compared with NP at d 270 (P<.10). Across both trts, significant differences due to day of slaughter were observed for BW (P<.01), which tended to increase quadratically (P<.17); IVDMD (P<.01), which decreased linearly (P<.01) and cubically (P<.01); and ruminal pH (P<.10), which increased quadratically (P<.04) and cubically (P<.03). Data indicate that pregnancy had little effect on parameters measured and that the majority of variation was explained by advancing slaughter date.

Key Words: Pregnancy, Dry Matter Intake, Ruminal Fill

531 Humate modification of fermentation of forage/grain diets in continuous culture. K. W. Bell*, F. M. Byers, and L. W. Greene, *Texas A&M University.*

Commercially available humates now used in the horticultural and turfgrass industry and other areas of agriculture, offer potential in modifying digestive tract nutrient extraction and microbial function in several species of animals. Dry matter, NDF, ADF and hemicellulose digestion were measured in 12 continuous culture experiments with low and high quality forages, a mixed grain diet and a high grain feedlot diet with a specific humate source. Profiles for pH and ammonia were followed at 8 h intervals throughout fermentation runs. Humate enhanced digestion of NDF, ADF, and hemicellulose fractions of high quality coastal bermudagrass (exp 1,2), especially with the .5% and 1.0% levels. Fermentor pH was elevated ($P < .05$) with .5% humate. Concurrently, fermentor NH_3 concentration was reduced ($P < .05$) with .5% humate with a trend for further reductions with greater levels. With low quality coastal hay (exp 3,4) as the substrate, no change in forage carbohydrate digestion was evident. However, pH was elevated with .5% humate. Further, NH_3 concentrations were reduced with .5% and with greater levels of humate. With a mixed forage/grain diet, pH was elevated with humate levels, of 1.0% and greater. As in the forage diets, fermentor ammonia concentration was reduced with .5% and greater levels of humate with a trend for greater depressions with increasing levels. Humate did not alter conditions with the grain diet. A more attenuated NH_3 release pattern, and an increase in pH, as we have observed with this specific humate, would enhance growth and energetic efficiency. It will be important to assess the role of any selected bioactive humate fraction, including humic, fulvic, ulmic and other acids, as microbial cellular regulators in enhancing the ruminal environment for and utilization of carbohydrates and protein in cattle fed specific diets.

Key Words: Humate, pH, Ammonia

532 The effects of incremental increases in added beef tallow and soybean meal to finishing steer diets. T. T. Marston*, K. K. Kreikemeier, and G. L. Kuhl, *Kansas State University, Garden City.*

This experiment was conducted to determine if incremental increases in dietary beef tallow and soybean meal improve finishing cattle performance. One hundred twenty crossbred steer calves (339.8 kg) were randomly assigned to 12 pens which were randomly assigned to treatments. Treatments consisted of a continuously fed, control diet containing 4% added beef tallow and 6% soybean meal (**CONT**); or a step up diet where beef tallow and soybean meal were increased by 2% every 30 d (**STEPUP**). The first diet used within STEPUP consisted of 0% beef tallow and 2% soybean meal. Steers were implanted with Synovex-S® and Revalor® on d 0 and 60, respectively and fed for a total of 150 d. Significant differences in ADG were measured during period 1 and for the total feeding period. Daily DMI was greater for CONT than STEPUP in all periods except period 3. CONT had improved feed efficiency than STEPUP during period 1. Hot carcass weights reflected differences (P = .03) in animal gain while marbling, fat thickness, internal carcass fat and liver abscess scores were not effected (P > .47) by treatments. Results indicated that feeding 2 to 4% beef tallow is optimal and that increasing levels of beef tallow plus soybean meal is not beneficial.

Period	1	2	3	4	5	Total
Percent DM dietary levels of beef tallow:soybean meal						
CONT	4:6	4:6	4:6	4:6	4:6	
STEPUP	0:2	2:4	4:6	6:8	8:10	
ADG, kg						
CONT	1.91[a]	1.79	1.84	1.30	1.05	1.59[a]
STEPUP	1.59[b]	1.79	1.78	1.24	.89	1.46[b]
Daily DMI, kg						
CONT	7.19[a]	8.64[a]	8.31	7.36[a]	7.74[a]	7.84[a]
STEPUP	6.62[b]	8.19[b]	8.25	7.13[b]	7.28[b]	7.48[b]
Feed/gain						
CONT	3.77[a]	4.88	4.52	5.66	7.55	4.94
STEPUP	4.17[b]	4.5 9	4.65	5.80	8.34	5.11

For each response variable within column comparison, different superscript indicates difference (P < .05).

Key Words: Steers, Fat, Protein

533 Performance and carcass characteristics of growing/finishing steers fed high fat diets with an antioxidant. D. L. Holthaus[1], C. R. Richardson[1]*, and L. K. Schlatter[2], *[1]Texas Tech University, Lubbock and [2]Kemin Industries, Inc., Des Moines, IA.*

Fifty-six crossbred steers(272 kg) were used in a growing/ finishing experiment to determine if the addition of an antioxidant to a high fat diet effected performance or carcass characteristics. Steers consisting of several crossbreeds (Hereford, Angus, Charolais, BeefMaster, Chianina, and Brahman) were acquired from a backgrounding operation where they were consuming a growing diet. Upon arrival at the Texas Tech Burnett Center the cattle were vaccinated, implanted, dewormed, dehorned, and weighed. Over a 28 d period steers were adjusted to a concentrate diet, decreasing the roughage level every seven days. The antioxidant was premixed with grain sorghum at a rate of .5% and was mixed into the ration as a dry ingredient. Steers were fed a steam-flaked grain sorghum diet with 4% added fat either with or without an antioxidant once daily. Steers were randomly allocated by weight to one of two treatments, with four replications (pens)/ treatment and seven head/pen, utilizing pen as experimental unit. Duration of the trial was 147 d, with ADG, F:G and Feed Intake data collected every 28 d and carcass characteristics collected at the end of the study. Feed samples were also taken every week for peroxide value determination. No differences (P > .05) were found for performance data throughout the trial. However, inclusion of the antioxidant decreased feed consumption by 4.4% and improved feed conversion by 3.2% over the duration of the trial. Steers fed the antioxidant also tended to have decreased backfat deposition and less KPH fat (P = .11). Use of the antioxidant consistently reduced peroxide values in the feed throughout the duration of the trial. These results indicate that the use of an antioxidant may be beneficial to feedlot steers consuming high fat diets during summer months.

Key Words: Beef Cattle, Antioxidant, Fat Oxidation

534 Effects of schedule of TBA exposure on performance and carcass traits of yearling steers. S. J. Bierman[1]*, R. H. Pritchard[1], and R. T. Brandt, Jr.[2], *[1]South Dakota State University, Brookings and [2]Hoescht Roussel Vet, Overland Park, KS.*

Implant influences upon steer production and carcass traits were evaluated with yearling steers grouped by biological type. Group 1 consisted primarily of black hide steers (355 ± 2.5 kg) and Group 2 was predominately continental crosses (300 ± 1.9 kg). Each group comprised 20 pens of 10 steers. Implant treatments included control (CO), Synovex Plus (SP), revalor-S (rS), and Ralgro-revalor-S (R-rS). Synovex Plus, revalor-S, and Ralgro were administered on day 1 and revalor-S for R-rS treatment after 56 d on feed. Feed was delivered twice daily for 131 d to Group 1 and 145 d to Group 2 steers. There was a 16-d four diet adaptation to a diet consisting of 10% corn silage, 57.65% whole shelled corn, 23% high moisture corn, 4.25% liquid supplement, and 5.1% dry supplement (2.09 Mcal NE_m/kg and 1.40 Mcal NE_gg/kg). Calculated final BW included a 3% shrink. Treatment differences were determined by orthogonal contrasts of a) Co vs SP, rS, & R-rS; b) SP & rS vs R-rS, and c) SP vs rS. Throughout the trial nonimplanted steers had lower ADG (P < .01) and poorer gain efficiency (G/F; P < .01) than implanted steers. Reimplanting steers caused higher ADG (1.78 vs 1.67; P < .01) and G/F (.167 vs .157; P < .01) during d 57 to harvest. Cumulative data indicated no differences (P > .15) between implanting d 1 only and reimplanting for ADG (1.78, 1.76, and 1.75 kg) and G/F (.178, .178, and .176). The dressing percentage was lower for SP than rS (61.85 vs 62.35; P < .03). Marbling score was higher (P < .03) as was the percentage of choice carcasses (59.6 vs 47; P < .01) for R-rS than SP & rS treatments. Group 1 steers had higher marbling scores (5.20 vs 5.02; P < .01) and percentage of choice carcasses (59.6 vs 51.3; P < .01) compared to Group 2. Yearling steers fed >130 d performed similarly with one or two implants. It is unclear whether the delayed and/or shorter period of exposure to TBA lessened implant effects on marbling.

Key Words: Implants, Beef, Feedlot

535 Effects of humate on feedlot performance and carcass characteristics in feedlot lambs. B. R. Covington*, W. S. Ramsey, L. W. Greene, and F. M. Byers, *Texas A&M University, College Station, and Texas Agricultural Experiment Station, Amarillo.*

Rambouillet wether lambs (n=48; average initial wt.=28.4kg±3.4kg) were used to determine performance ans carcass characteristics when fed increasing levels of humate. Lambs were blocked by initial weight and randomly allotted to pens (4 lambs/pen). One of four dietary levels of humate (0, .5, 1.0, or 2.0% of the total diet) was randomly assigned to the 4 pens in each weight block. Lambs were fed ad libitum. The basal diet (14% CP and 75% TDN) contained primarily corn grain, milo, cottonseed meal, and cottonseed hulls. Feed refusals were recorded every 7 d. Lambs were weighed on 7 d intervals throughout the trial. Lambs were slaughtered on d 63 and carcass characteristics determined. Lambs fed 0 and .5% humate consumed more feed (P <.05) than those fed 1.0 and 2.0% humate (1.56 and 1.50kg/d vs 1.36 and 1.25kg/d, respectively). Lambs fed 0 and .5% humate had a greater (P <.05) ADG than those fed 1.0 and 2.0% humate (.26 and .25kg/d vs .21 and .20 kg/d, respectively). Feed conversion (kg feed/ kg gain)did not differ (P >.01) but favored lower humate levels with conversions of 2.76 and 2.69 for 0 and .5% humate vs 2.94 and 2.90 for 1.0 and 2.0% humate. Hot carcass weight was lower (P <.05) in lambs fed 1.0 and 2.0% humate (22.0 and 21.3 kg) compared to those fed 0 and .5% humate (23.3 and 23.1 kg). Loin eye area (LEA) was greater (P <.05) in lambs fed 0% humate (14.1 cm^2) and lowest in lambs fed 2.0% humate (12.9 cm^2). No differences were noted in back fat thickness or yield grade due to level of dietary humate. These data indicated that as dietary humate increases above .5% of the diet, animal performance and LEA was reduced.

Key Words: Humate, Lambs, Carcass

536 Effect of lasalocid and a *Saccharomyces cerevisiae* culture on growing "Criollo" lambs fed non-conventional ingredients. D. Hernández-Sánchez, S. S. González*, M. E. Ortega-Cerrilla, and M. A. Cobos, *Colegio de Postgraduados, Montecillo, Edo. de México.*

A 120 day growth trial was conducted to study the effect of lasalocid (Bovatec; 0 or 350 mg/head/d) and a *Saccharomyces cerevisiae* culture (SC; Levucell; 0 or 1 g/head/d) on 32 "Criollo" lambs (21 ± 3 kg initial BW) fed non-conventional ingredients. Treatments (T) were the following: T1: Control diet with 28.6% bakery waste, 23.7% dried poultry waste, 18.6% silage (55% dairy manure, 35% cornstalk, 10% cane molasses), 10.6% cornstalk, 9.5% cane molasses, 9.0% corn grain; T2: T1+SC; T3: T1+lasalocid; T4: T1+SC+lasalocid. A completely randomized design with a factorial (2×2) arrangement of treatments (8 lambs/T) and orthogonal contrasts were used, with initial BW or DM intake as covariables. ADG, DMI, partial feed efficiency (PFE), cell fractions digestibilities, NB and EB did not change (P>.05). Carcass fat deposition was decreased (P<.011) by lasalocid (1.36 kg) as compared to SC (2.45 kg). Control group showed a higher ruminal (P<.03) pH (T1= 7.04; T2= 6.48; T3= 6.74; T4= 6.65) and a lower (P<.03) NH_3-N (T1= 10.14; T2= 10.47; T3= 17.47; T4= 17.51 mg/dl). Addition of lasalocid or SC did not change growth response in "Criollo" lambs fed non-conventional ingredients.

Key Words: Lasalocid, *Saccharomyces cerevisiae*, Non-Conventional Ingredients, Criollo Lambs

537 Differences in growth, carcass, and sensory characteristics of young goats of different genotypes. B. W. Roeder*, W. S. Ramsey, B. Hafley, R. L. Miller, E. Davis, and R. Machen, *Texas A & M University, College Station.*

One hundred seventy five spring born wether goats consisting of 5 breeds: Boer-Spanish (B×S), Boer-Angora (B×A), Angora-Spanish (A×S), Spanish (S) and Angora (A); and 12 Boer-Spanish intact males (B×Si) were used. Wethers were randomly assigned by breed type to pen and treatment (22 hd/ 2 pens fed and 13 hd on pasture) and adjusted to feed for 20 d. B×Si were divided into 2 pens on feed(6 hd each) with similar pen weight averages. Fed goats had ad libitum access to feed containing 64% TDN and 14% CP with refusals taken every 3 d. Goats were weighed on 14 d intervals for 154 d. B×S, B×A, and B×Si had a higher (P<.05) ADG than S, A, and A×S(.32 lb/d, .31 lb/d, and .35 lb/d vrs. .26 lb/d,.24 lb/d, and .24 lb/d, respectively). ADG among breeds in pasture did not differ (P>.1) but favored B×A and B×S by .01 lb/d. Fed goats had a higher (P<.01) ADG than pasture goats (.29 lb/d vrs. 04 lb/d). Preliminary data indicates that the boer influence and feed has an advantageous effect on ADG.

Key Words: Goats, Boer, ADG

538 A simulation model of performance of growing steers grazing in tropical pastures. B. Tobias, G. D. Mendoza*, E. Arjona, C. Garcia-Bojalil, and M. E. Suarez, *Colegio de Postgraduados, Monticello, Mexico.*

A simulation model was developed to predict performance of growing steers grazing tropical pastures. The model is deterministic and integrates the effects protein and energy intake from forages and supplements. Protein deposition was predicted by the PDI system and by the California Net Energy System with modifications on requirements by animal activity and heat stress. The model was validated using data from 5 experiments (30 treatments) conducted in humid tropic (Tabasco and Veracruz estates, Mexico). Three outputs results of gain or loss weight performance were obtained with the model from the California system (CS) and with PDI system when energy (PDIE) or nitrogen (PDIN) are deficient with the following regression equations: PDIE Y = –0.65 + 2.44 ×, r^2 .64; PDIN Y = –0.17 + 2.98 ×, r^2 .73; CS Y = .67 + .073 X, r^2 .61. Predicted data were compared to observed (t test P<.05). Predicted intake was better for steers without supplement (r^2= .82) than for supplemented animals (r^2=.77). The model allowed the prediction of steers grazing in tropical pastures based on forage and supplement composition, being better the prediction using the PDI system when protein values are estimated considering nitrogen as a limiting factor in the diet.

Key Words: Simulation, Models, Steer, Growth Grazing

539 Animal performance and methane emitted by beef steers under alternative production strategies. J. A. Walker*, K. C. Olson, R. D. Wiedmeier, and B. R. Bowman, *Utah State University, Logan.*

Animal performance, feed utilization, and methane emission response to an alternative production strategy was evaluated. Eight crossbred steers were assigned to one of two treatments: control (CON) slaughtered at about 400 d of age or early slaughter weight (ESW) slaughtered at about 300 d of age. All steers were fed a 60:40 concentrate:roughage (C:R) diet (25.3% ADF, 14.9% CP, 1.55 Mcal/kg NEm, and .96 Mcal/kg NEg) from weaning to slaughter of ESW. Control steers then received an 80:20 C:R diet (22.3% ADF, 11.7% CP, 1.65 Mcal/kg NEm and 1.04 Mcal/kg NEg) until slaughter. Animal weight was recorded at initiation and end of the study, and beginning of each methane collection period. Feed intake was recorded daily. Methane emission was measured during two periods while steers received the 60:40 diet. Period 1 was after a 30 d adaptation period, and period 2 was immediately before ESW steers reached slaughter weight. Steers reached slaughter weight at different (*P*=.0003) ages (ESW=312 d, CON=402 d). Body weight was higher (*P*=.0001) at all weigh dates for ESW (ESW=405.7, 451.7, 514.8, CON=276.7, 311.4, 380.1 kg for initial, period 1, and period 2, respectively). Daily dry matter intake (*P*=.19), feed efficiency (FE, DMI/ADG; *P*=.50) and ADG (*P*=.86) did not differ by treatment. Total methane emitted per steer (g/d) and methane emitted per ADG (g/kg ADG) did not differ (g/d, *P*=.91; g/kg ADG, *P*=.79) by treatment, but emission per BW (g/d/kg BW) was higher (*P*=.02) from CON (.522 g/d/kg) than ESW (.362 g /d/kg). Emission was higher (g/d, *P*=.01; g/kg ADG, *P*=.003; g/d/kg BW, *P*=08) during period 2 (215.0 g/d, 161.5 g/kg ADG,.493 g/d/kg BW) than period 1 (140.9 g/d, 75.3 g/kg ADG, .390 g/d/kg BW). Steers under ESW emitted less (*P*=.0009) methane during the entire feeding period (ESW=15.7, CON=27.6 kg). Because ESW steers reached slaughter weight 90 days earlier, they produced less total methane than CON steers, despite similar daily performance during the feeding period.

Key Words: Methane, Beef Steers, Feed Utilization

540 The effect of varying water sulfate content on H_2S generation and health of feedlot cattle. G. H. Loneragan[1]*, D. H. Gould[1], J. J. Wagner[2], F. B. Garry[1], and M. Thoren[2], *[1]Colorado State University, Ft. Collins and [2]Continental Beef Research, Lamar, Colorado.*

Polioencephalomalacia(PEM) in ruminants has traditionally been attributed to a thiamin deficiency. Recent studies have demonstrated that PEM lesions may result from excess total sulfur intake. The objectives of this trial were to examine the effect of varying water sulfate (SO_4) on the patterns and magnitudes of hydrogen sulfide (H_2S) generation and health of feedlot cattle. Three treatment levels of 125, 500 and 2000 mg/L SO_4 were used. Nine steers (324kg) were in each treatment group. All steers were sampled for rumen gas cap H_2S concentrations (RGC[H_2S]) 3 times a week for 70 days, then once a week for another 7 samplings. On day 29, whole blood samples were taken to determine thiamin status. During the final month of the trial, pulmonary arterial pressures were measured. Disease occurrence was monitored daily. The magnitude of ruminal H_2S generation increased with increasing water sulfate content (average RGC[H_2S]ppm; 125=136.5, 500=714.9, 2000=2113.7; p=0.0001). All intensively sampled treatment groups demonstrated episodic fluctuations in ruminal H_2S production. The largest peak of ruminal H_2S generation was from day 17 to 35. One animal in group 2000 developed clinical signs of PEM on day 17. There was no significant difference in the thiamin status between groups 125 and 2000(p=0.98). Mean pulmonary arterial pressures(mPAPs) increased with increasing water sulfate levels (average mPAPs mmHg; 125=29.1, 500=33.7, 2000=38.1; p=0.001). Pathological ruminal H_2S levels are primarily a result of excess sulfur intake. Pathological ruminal H_2S levels are associated with PEM. The thiamin status of group 2000 was not different from the other groups when measured during the period of highest H_2S production. This suggests that ruminal H_2S does not significantly affect the active form of thiamin. The increases in mean PAPs may be reflective of pulmonary damage due to increased inhaled H_2S. (funded in part by CSU Ag Exper Station; MRC, Australia)

Key Words: Feedlot, Hydrogen Sulfide, Polioencephalomalacia

541 The effect of varying water sulfate concentration on feedyard performance and water intake of steers. J. J. Wagner[1]*, G. H. Loneragan[2], D. H. Gould[2], and M. Thoren[1], *[1]Continental Beef Research, Lamar, Colorado and [2]Colorado State University, Ft. Collins.*

Two-hundred and forty crossbred yearling steers (324 kg) were utilized to study the effects of varying water sulfate concentration on feedyard performance and water intake. Finishing diet consisted of 5% corn silage, 5% alfalfa haylage, 5% wheat middlings, 2% condensed corn distillers solubles, 3% fat, 76.4% steam flaked corn, .6% soybean meal and 3% supplement on a dry matter basis. Sulfur content of the ration was approximately .14% of dry matter. Six replicates of each treatment for feedyard performance traits and 3 replicates per treatment for water intake estimates were evaluated. Levels of water sulfate (SO4) evaluated were: 125, 250, 500, 1000, and 2000 mg/L. Four time periods: day 1-28 (PER1), day 29-56 (PER2), day 57-84 (PER3), and day 85-113 (PER4) were examined. Dry matter intake (DMI, kg), average daily gain (ADG, kg), feed/gain (FG), and water intake (WI, L) averaged 9.83, 2.15, 4.58, and 33.6; 10.78, 2.11, 5.11, and 34.8; 10.34, 2.14, 4.83, and 31.6; 9.84, 2.10, 4.69, and 31.9; and 9.93, 2.04, 4.86, and 29.7 for the 125, 250, 500, 1000, and 2000 mg/L groups, respectively. Significant (P<.001) sources of variation for DMI were SO4 and PER. PER and SO4*PER were significant (P<.001) for ADG. PER (P=.0001), SO4 (P=.0033), and SO4*PER (P=.0580) influenced FG. WI was affected (P<.05) by SO4, PER, and SO4*PER. Interactions between PER and SO4 indicated that the steers were more affected by increasing SO4 early in the feeding period; when ambient temperature and WI per kg body weight were greatest. High SO4 was associated with decreased ADG, DMI, WI and poorer FG during PER1 and to a lesser extent during PER2. These data indicate that excessive water sulfur intake is detrimental to feedyard performance.(funded in part by CSU Ag Exper Station; MRC, Australia)

Key Words: Feedlot, Water Quality, Sulfates

542 Comparison of the water consumption of growing-finishing bulls fed different rations. S. Bedõ* and Z. Szakács, *University of Gödöllõ.*

Two groups of 52 growing-finishing bulls were fed two different rations over 243 days. Animals were kept in stanchion barns. Group I consumed an intensive fattening ration, comprising concentrate and hay. Group II received a semi intensive fattening ration, consisting of a concentrate, hay and maize silage. Feed and drinking water intake of animals was recorded daily. Nutrient composition of feeds was determined according to the Weende analysis. Air temperature and relative humidity of the shed and the environment were recorded. The feed and nutrient intakes of both groups increased with days on feed. The body weight and weight gain correlated positively with the daily dry matter intake (r=0.646; r=0.326). The correlation for the intensively fattened bulls was definite and significant (r=0.890). It was moderate and nonsignificant (r=0.470) in case of the semi intensively fattened animals. The daily drinking water consumption of the intensively fattened bulls was significantly higher than that of the semi intensively fattened animals. The daily drinking water consumption correlated fairly with the daily dry matter intake (r=0.67). The correlation for the intensively fattened bulls was definite and significant (r=0.770), and it was moderate and non-significant (r=0.57) for the semi-intensively fattened animals. Also positive and good correlation (r=0.650) was found between total daily water consumption and total dry matter intake. The correlation for the bulls fed concentrates and hay was definite and significant (r=0.76). It was moderate and non significant (r=0.54) in case of animals fed on a concentrate, hay and maize silage. The intensively fattened bulls consumed 3.56-4.65 litres of drinking water per 1kg of dry matter. The corresponding figures for the semi intensively fattened animals were 2.34-3.39 litres per kg DM. The total water intakes for the two groups were, however, comparable (4.13 litres and 4.19 litres). In conclusion, drinking water intake and total water intake of young bulls varied primarily according to the type of the ration, i.e. the dry matter content of the diet.

Key Words: Drinking Water, Dry Matter, Feed

543 A potential reason for ponderosa pine needle ingestion by cattle. S. L. Kronberg[1]* and R. E. Short[2], *[1]SD State University, Brookings and [2]USDA, ARS, Miles City, MT.*

Ponderosa pine needle (PN) ingestion by late-term cows often causes abortion and associated problems. Why cattle eat PN, which are low in N and high in fiber and phytochemicals, is not clear. Recent evidence indicates that ruminants can learn to prefer foods that are associated with positive feedback paired with N and energy intake. Evidence has been presented that PN ingestion has a negative effect on N and energy nutrition of cattle, but we suspect that PN ingestion by ruminants often has a net positive effect on their nutritional status and that is why they may eat PN. PN contain high levels of tannins, and tannins can increase amino acid absorption in ruminants. Therefore, we conducted a trial to determine if amino acid (AA) levels increased after yearling cattle consumed PN. For 2 wk before and during the trial, cattle had access to oat hay (9.4% CP), minerals, and water and received 1 kg/d of soybean meal (SBM). Serum was assayed for amino acid levels. Jugular blood was collected at 0730 on d 0 and 24 h later (d 1) from four yearlings. By 1930 on d 0, two yearlings ate .5 kg of air-dried PN (8.4% CP) mixed with the 1 kg of SBM and 1.2 kg of molasses and two yearlings served as controls that consumed the mixture lacking PN. Histidine, leucine, lysine and phenylalanine were elevated 12, 18, 23, and 24%, respectively ($P \leq .10$), on d 1 in PN-consuming cattle as were ($P \leq .03$) isoleucine, valine, and total essential AA (20, 12 and 15%, respectively). Changes in all other essential AA were similar ($P \geq .12$) for PN and control cattle, and none of the changes in these AA were negative for the PN cattle. Changes in total non-essential AA from d 0 to 1 were similar ($P = .16$) in the PN and control cattle (5.2 and –4.7%, respectively). We conclude that cattle and other ruminants may consume PN and other tannin-containing plants to improve their protein status.

Key Words: Beef Cattle, Ponderosa Pine, Diet Selection

544 Effect of timing and duration of grazing on diet selection and performance of cattle. A. A. Ayantunde[1], S. Fernández-Rivera[1]*, P.H.Y. Hiernaux[1], and M. Chanono[2], *[1]International Livestock Research Institute, Niamey, Niger and [2]Ministére de l'Agriculture et l'Elevage, Toukounous, Niger.*

The objective was to determine the effect of timing and duration of grazing on cattle's diet selection, eating time and BW changes. Sixty-four steers (222 ± 78 kg BW) were allotted to eight treatments (T). Grazing time during the day was 6 h for T 1, 2 and 3; 9 h for T 4, 5 and 6; and 12 h for T 7 and 8. Night grazing time was 0 h for T 1, 4 and 7; 3 h for T 2, 5 and 8; and 6 h for T 3 and 6. Eight esophageally fistulated steers were used in a crossover design to sample the diet selected by day grazers (D1) and by night-and-day grazers during the day (D2) and night (N2). The study was conducted during the wet (WS) and dry (DS) seasons. Eating time was determined in DS by recording animals' activities every 5 min. Extrusa samples were analyzed for NDF (g/kg DM), ADF (g/kg DM) and organic matter digestibility *in vitro* (OMD, g/kg). In WS diet NDF (SEM=6) was 583 for D1, 571 for D2 and 580 for N2; ADF (SEM=6) was 437 for D1, 421 for D2 and 437 for N2; OMD (SEM=8) was 586 for D1, 590 for D2 and 586 for N2. In DS diet NDF (SEM=4) was 746 for D1, 732 for D2 and 728 for N2; ADF (SEM=3) was 582 for D1, 569 for D2 and 577 for N2; OMD (SEM=8) was 511 for D1, 516 for D2 and 536 for N2. Eating time in DS and BW changes in DS and WS were:

Day grazing time, h	6	6	6	9	9	9	12	12	SEM
Night grazing time, h	0	3	6	0	3	6	0	3	
Eating time, min/d	245	370	469	320	437	549	432	533	8
BW change in DS, g/d	–288	–219	–203	–258	–193	–173	–159	–99	28
BW change in WS, g/d	368	459	516	500	509	539	536	571	36

Cattle's diet selection is little or not affected by time (day or night) of grazing. Grazing duration influences growth rate. Allowing for additional grazing time at night improves growth rate.

Key Words: Cattle, Diet Selectivity, Grazing

545 Olfaction and feed preference in lactating Holstein cows. R. N. Corley, III*, J. S. Zhu, C.P.A. van de Ligt, S.W.V. Nombekela, A. O. Bahaa, and M. R. Murphy, *University of Illinois, Urbana.*

Olfaction functions in concert with taste and trigeminal sensitivity in the perception of food and has been shown to influence diet preference and total feed intake in bulbectomized and otherwise anosmic animals. Currently, there is very little information available on the influence of olfaction on feed preference in cattle. The objective of this study was to develop a method capable of determining the effects of olfaction on feed preference in lactating Holstein cows. Twelve multiparous lactating Holstein cows were used in six balanced paired comparison studies with 14 d each to evaluate 24 different odors. The cows were offered a fresh TMR mix consisting of corn silage, alfalfa haylage, and a ground corn and soybean meal-concentrate mixture (25:25:50 on a DM basis) 4 periods daily (every 2.5 h) during 10 h of ad libitum feeding. An apparatus was developed which allowed odors to be blown at a set rate over two feeding containers with limited possibility of odor carry over. All odors in a study were compared against each other and against a control (no odor). All comparisons were conducted on the left and right feeding sides and at all four daily time periods to remove side or feeding time affects. Rank values of 0 or 1 were assigned to each odor based on the percentage of total feed intake in a test period. A test of overall equality based on the sum of squares of ranks was used to determine if odors were different. Results indicated that inhalation of odors did not ($P > 0.05$) effect the preference of food eaten during any test period. Rank values within a study, were doubled for several odors when compared to others, which suggests that the sample size may have made the experiment insensitive. With reasonable power for this study at least 6 cows were needed per study. Although, the odors used in this study did not appear to effect olfaction, the method provides a practical technique capable of testing the effect olfaction on food preference in cattle.

Key Words: Olfaction, Cattle, Food Preference

546 Net absorption and hepatic metabolism of VFA and β-hydroxybutyrate (BHBA) by beef steers fed diets containing 78% sorghum grain flaked at different densities. O. Lozano*, M. Sadik, B. Theurer, A. Alio, J. T. Huber, A. Delgado, and R. S. Swingle, *University of Arizona, Tucson.*

Objective was to evaluate effects of feeding steers dry-rolled (DR) or steam-flaked (SF) sorghum grain at densities of 437, 360, and 283 g/L (SF34, SF28, and SF22) on net uptake and release of acetate (C2), propionate (C3), n-butyrate, and BHBA across portal-drained viscera (PDV), liver, and splanchnic tissues (SPL). Eight multicatheterized steers (300 kg; DMI = 6.9 kg/d) were used in a randomized block design. Six blood samples per day were taken at 2-h intervals for each diet and steer. For DR vs SF diets, net uptake or release of VFA and BHBA were not different across PDV, liver, and SPL, except net absorption of C2 tended to be greater (P=.13). Among SF treatments, net absorption across PDV tended to be linear (P=.16) for C3, and was quadratic (P=.05) for BHBA. Steers fed SF vs DR sorghum grain tended to decrease net absorption of C2, but liver release of C2 to rest of the body was not different. Decreasing flake density tended to increase net absorption of C3, but not other VFA or BHBA.

Item	Site	DR	SF34	SF28	SF22	SEM
		mmol/h				
Acetate	PDV[a]	547	415	450	428	65
	SPL	521	530	454	568	76
Propionate	PDV[b]	403	275	371	408	66
	SPL	58	33	37	57	20
Butyrate	PDV	42	37	37	26	4
	SPL	9	11	8	6	3
BHBA	PDV[c]	94	64	112	46	23
	SPL	153	204	131	172	54

[a]DR vs SF, P = 0.13.
[b]Linear SF effect, P = 0.16.
[c]Quadratic SF effect, P = 0.05.

Key Words: VFA Absorption, Hepatic Metabolism, Steam-Flaked Grain

547 Nitrogen retention of lambs fed alternating dietary protein concentrations. N. A. Cole, *USDA-ARS-CPRL, Bushland, TX.*

Much of the N fed to beef cattle is excreted and subsequently lost by volatilization to the atmosphere or by runoff into surface or ground water. Improving the utilization of dietary N would decrease N losses to the environment. The present studies were conducted to determine the effect of intermittent protein supplementation on nutrient balance of lambs fed a 90% concentrate diet. Ten St Croix lambs (avg. BW = 20 kg) were used in two 5 × 5 Latin square experiments. Dietary treatments consisted of the following: 1) 10% CP, 2) 12.5% CP, 3) 15% CP, 4) 10% and 15% CP diets alternated daily, and 5) 10% and 15% CP diets alternated every other day. Supplemental N was provided by cottonseed meal in Exp. 1, and by a 50:50 (N basis) blend of cottonseed meal and urea in Exp. 2. Each period of the Latin square was 28 d with an 8-d excreta collection. Nitrogen retention increased linearly ($P < .01$) with increased N intakes in both trials (.77, 1.36, and 1.89 g/d for 10, 12.5, and 15%, respectively in Exp. 1; .84, 1.43, and 2.19 g/d for 10, 12.5, and 15%, respectively in Exp. 2). Compared to continuously feeding the 12.5% CP diet, alternating CP intake on a daily basis did not significantly affect N retention (1.62 and 1.57 g/d for Exp. 1 and 2, respectively). However, alternating CP intake every other day increased ($P < .05$) N retention 38% in Exp. 1 (1.87 g/d) and 27% ($P < .12$) in Exp. 2 (1.82 g/d). These results suggest that alternating dietary CP concentration could potentially improve N utilization in ruminants fed high-concentrate diets.

Key Words: Ruminants, Protein, Environment

548 L-Carnitine administration prevents the development of subacute hyperammonemia in sheep following an oral urea load test. A. M. Chapa[1]*, J. M. Fernandez[1], T. W. White[1], L. D. Bunting[1], L. R. Gentry[1], D. T. Hoover[1], and S. A. Blum[2], *[1]Louisiana State University Agricultural Center, Baton Rouge and [2]Lonza, Inc., Fair Lawn, NJ.*

Experiments conducted with mice and fish suggest that L-carnitine may alleviate ammonia-related derangements in metabolism and growth. However, the potential of this compound to prevent or even reverse experimentally-induced hyperammonemia in ruminants has not been investigated. Therefore, spring-born Suffolk ewes (n = 16, avg. BW 48.4 kg) fitted with jugular vein catheters were blocked by BW and used in a RBD with a 2 × 2 factorial arrangement of treatments to investigate the effects of i.v. L-carnitine administration (00 and 6.36 mmol/kg$^{.75}$ BW) during an oral urea load test (0 and 300 mg/kg BW). The L-carnitine-water and urea-water solutions (50% w/v) were administered at 30 and 60 min, respectively. Blood samples were collected via the jugular vein catheter at 15 to 30 min intervals for a total of 420 min, and plasma was analyzed for ammonia N, urea N, L-carnitine, and glucose. Rumen fluid samples were collected via stomach tube immediately prior to and 30 min after the urea drench, and analyzed for pH and ammonia-N. There were no treatment differences (P > .10) in rumen fluid pH (mean = 7.03); however, ruminal ammonia N and free, nonionized ammonia N were increased (P < .015) during the oral urea load test. Plasma L-carnitine was increased (P < .0001) by L-Carnitine administration. Plasma ammonia N was highest (P < .0001) in the Urea treatment group compared to the Control, L-Carnitine, and L-Carnitine + Urea treatment groups (148 vs 95, 101, and 108 μmol/L, respectively). Plasma glucose (mean = 3.52 mmol/L) and urea N (mean = 15.3 mmol/L) were not affected by treatment (P > .10). Prior i.v. administration of L-carnitine prevented an increase in plasma ammonia N in sheep challenged with an oral urea load test. Further research is warranted to evaluate the potential use of L-carnitine as a feed additive in the prevention of nutritionally-induced hyperammonemia.

Key Words: Hyperammonemia, L-Carnitine, Sheep

549 Effects of jugular infusion of choline and betaine on blood parameters in Angora goats. R. Puchala*, T. Sahlu, J. J. Davis, and S. P. Hart, *E (Kika) de la Garza Institute for Goat Research, Langston University, OK.*

The effects of jugular infusion of choline and betaine, as sources of methyl groups on plasma methionine and related metabolites were investigated in Angora goats. Twelve Angora wethers (BW 35 ± 2 kg) were bilaterally implanted with silicon catheters in the jugular vein. They were kept in individual cages, offered ad libitum a complete mixed diet (12% CP, 2.3 Mcal/kg DM) once daily at 0800 h, and had free access to water. The animals were randomly divided into three groups of four animals. On day 1 of the experimental period all groups received jugular infusion of saline at the rate of 5 ml h^{-1}. On days 2 and 3, group 1 continued to receive saline, group 2 was infused with choline, and group 3 with betaine. The daily dose (20 mmol) of betaine (2.34 g) or choline chloride salt (2.79 g) was dissolved in 120 mL of water and the pH adjusted to 7.35. Betaine and choline were infused at the same rate as saline. On day 4 all animals received saline infusion. Jugular blood was collected every 6 h throughout the whole experiment. Plasma methionine concentration was not affected by jugular choline or saline infusion (20.7, 20.3 mM); however, jugular betaine increased plasma methionine concentration (25.2 μM, P < 0.01). Betaine and choline increased plasma non-esterified fatty acid concentration (293, 298 μEq/L vs. 203 μEq/L for saline infusion; P < 0.002). Plasma triglycerides were numerically higher in the groups infused with betaine and saline (39.8, 38.0 vs. 33.9 mg/dL choline infusion; P > 0.14). There were no changes in plasma cystine, glucose or urea N concentrations. Betaine supplementation may have positive effects on animal production by increasing the amount of methionine available for protein synthesis. Increased NEFA due to betaine or choline infusion may indicate faster turnover of lipids in the body.

Key Words: Angora Goats, Betaine, Choline

550 Influence of supplementation of energy and protein on gestation, lactation, progeny growth, and cashmere production in goats. D. S. Ivey[1]*, F. N. Owens[2], T. Sahlu[1], T. H. Teh[1], L. Dawson[2], and G. Campbell[2], *[1]E (Kika) de la Garza Institute for Goat Research, Langston University, OK and [2]Oklahoma State University, Stillwater.*

Forty-eight pregnant does and their progeny were used to examine the effects of supplemental energy, protein and number of fetuses on cashmere production by does and the secondary:primary ratio of skin follicles in progeny. Does were assigned randomly to treatments in a 2 × 2 × 2 factorial arrangement. The factors included were single vs twin fetuses; two concentrations of dietary protein (18.6% and 28.5%) and two concentrations of dietary energy (2.2 and 2.8 Mcal of ME/kg). Animals received their supplement at 1% of BW daily in addition with free access to Bermuda hay (8% CP; 40% ADF). Four twin-bearing and three single-bearing does were used to measure milk production and composition. Kids were weaned at 50 d and fed a mixed grain ration for another 50 d. Does bearing twins gained more weight between d 90 of gestation and parturition than does bearing single kids (4.7 vs 3.3 kg; P < .03). Gestation length tended to be shorter (147 vs 149 days, P < .08) for does fed the lower energy supplement. Does bearing twins had higher plasma concentrations of beta-hydroxy butyrate (P < .05) and non-esterified fatty acids (P < .01); while plasma urea nitrogen was higher (P < .01) for does fed the 28.5% protein supplement. Fetus number had no effect on cashmere growth in does; however, guard hair yield tended to be higher for does bearing twins (P < .07). Birth weight of kids born as twins was similar to that of kids born as singles. Daily milk production, estimated from d 15 to d 45 of lactation was 56% greater for does bearing twins (1.31 vs 0.84 kg/d, P < .001). Litter weight gain from d 50 to d 100 was 71% higher for twins than singles (P < .001). Dry matter intake and daily gain during the 50-d post-weaning period were 10 and 20% greater (P < .03; P < .01 resp.) for kids born as twins than kids born as singles. The secondary: primary follicle ratio increased by nearly 60% between d 6 and d 49 but was not altered by prepartum diet or fetus number. No significant interaction was present (P > .10). Productivity was markedly greater for does bearing twins than those bearing single kids but not significantly altered by protein or energy supplements.

Key Words: Energy, Protein, Gestation, Cashmere

551 Substitution of starch for pectin for crossbred Zebu bulls: metabolizable and net energy requirements and efficiency of energy utilization. D.P.D. Lanna[1]*, P. R. Leme[2], W. Henrique[2], C. Boin[1], and G. F. Alleoni[2], *[1]ESALQ-University of São Paulo, Brazil and [2]Inst. de Zootecnia, SP, Brazil.*

Santa Gertrudis bulls with initial weight of 230 kg and 8 months of age were used in a comparative slaughter experiment. Treatments included 80:20 and 20:80 concentrate:corn silage ratios on a DM basis and corn (C) or citrus pulp (CP) as ingredients (80C, 80CP, 20C and 20CP). Six animals were slaughtered to obtain initial composition and 28 allocated to individual pens and slaughtered at 410 kg. Composition was estimated using rib cut analysis and metabolizable energy intake (MEI) by analysis of feed and weightbacks. Empty body weight gain was 1.04, 0.49, 0.69, 0.74 kg/d, higher for 80C (P<.01) and similar for C and CP at low concentrate (interaction P<.01). Maintenance NE requirements were 79.2 and 75.3 Kcal/kg EBW^{0,75} for regressions using animals fed C and C and CP diets respectively (P>.10). Respective maintenance ME requirement were 126.0 and 114.6 kcal/kg EBW^{0,75}. Efficiencies of maintenance ME utilization were 63% and 66% for animals fed C and C and CP diets (P>.10). Efficiencies of ME utilization for growth (K_f) were 21% and 20% respectively. Efficiencies were lower than used standards, but similar to experimental data with young light-weight bulls. Given the relationship between retained energy (RE) and MEI is curvilinear, K_f tends to be lower in experiments in which the lower level of energy intake is well above maintenance (1.7×M in this work). RE in EBWG of Zebu crossbred bulls was determined by RE=5.694EBWG K^2 + 39.1EBWG, which generates lower values than NRC medium frame bulls equation. EBW at 25% lipid was 520 kg. ME content of C and CP were similar at low concentrate levels (P>.10) and different at high concentrate (P<.05; interaction P<.05). Energy content of citrus pulp is dependent on its proportion in the diet, posing problems for nutrient modeling and diet formulation programs which will have to evaluate associative effects.

Key Words: Body Composition, Citrus Pulp, Nutrient Requirements

552 Food selection by nutrient imbalanced sheep. L. L. Scott* and F. D. Provenza, *Utah State University, Logan.*

Protein and energy are macro-nutrients required for maintenance, growth and production. Thus, we hypothesized that preference for macro-nutrients depends on need and preference declines as nutritional needs are met. Based on this hypothesis, we predicted that lambs fed a basal ration deficient in protein (energy), would prefer a food high in protein (energy). Twenty-four lambs were offered 2 foods *ad libitum* from d1 to 5 d to familiarize them with both foods. Food P (high in DP: low in DE) was a ground mixture of bloodmeal (50%), grape pomice (30%), and alfalfa (20%) and contained 35% DP and 2.264 Mcal/kg DE; Food E (low DP: high DE) was a ground mixture of cornstarch (50%), grape pomice (30%), and rolled barley (20%) and contained 2% DP and 3.069 Mcal/kg DE. After familiarization, lambs were assigned to 2 treatments and fed a basal ration of either Food P or Food E (1100 g/d) from d 6 to 9. To determine if the basal ration affected preference, lambs were offered Foods P and E simultaneously from 0800 to 0815 on d 10 to 12. During the preference trial, lambs ate different amounts of each food, which resulted in a treatment by food interaction ($P < .05$). Lambs fed a basal ration high in DP (Food P) ate 53 g of Food P and 112 g of Food E, whereas lambs fed a basal ration low in DP (Food E) ate 86 g of Food P and 93 g of Food E ($LSD_{.05}$= 35 g). Lambs fed a basal ration high in DP consumed less DP than lambs fed a basal ration low in DP (21 vs 35 g, $P < .05$). Lambs in both groups ate similar amounts of DE (.464 vs. .476 Mcal, $P > .05$). Thus lambs fed a basal diet high in protein ate relatively less DP than DE (DP: DE ratio= 46) whereas lambs fed a basal diet low in protein ate relatively more DP than DE (DP: DE = 81)($P < .05$). These results are consistent with the hypothesis that macro-nutrient status affected preference, but preference for energy was affected less than preference for protein.

Key Words: Nutrient Imbalance, Food Selection, Preference

553 The effect of a pre-pubertal dietary restriction on subsequent milk production in ewes. K. L. Waite*, M. E. Benson, B. D. Banks, and H. A. Tucker, *Michigan State University, East Lansing.*

Fifty-three Dorset × Suffolk × Rambouillet ewe lambs were used to examine the effect of pre-pubertal dietary restriction on first lactation milk yield. Ewe lambs (25 kg) were weaned at 60 d of age and randomly assigned to one of two dietary treatments of alfalfa pellets (15% CP, 2.06 Mcal·kg^{-1} ME). Controls (C, n=27)had ad libitum access to alfalfa pellets for 158 d. Restricted ewes (R, n=26) were fed alfalfa pellets to gain 113g·d^{-1} for 120 d, followed by a 38 d realimentation period during which ewes were offered alfalfa pellets at ad libitum intakes. After 158 d of treatment all ewes were managed similarly. On d 158, eight ewes from each treatment were fitted with jugular cannulas and blood was collected at 20 min intervals for 6 h for determination of growth hormone (GH) in serum. Data were expressed as area under the GH curve. Following d 158, estrus was synchronized and ewes exposed for one 20 d period of natural service breeding. Following parturition, milk yield was measured twice weekly over a 60 d lactation using a machine milking technique. Restricted ewes gained 115 g·d^{-1} ± 5.5 during the restriction period, 251 g·d^{-1} ± 13.8 during realimentation and weighed 48 kg at d 158. Control ewes gained 217 g·d^{-1} ± 5 and were heavier (P<.0001) at d 158 (58 kg). Serum GH was greater (P<.004) in R ewes (28.6 ng·ml^{-1}min) compared with C ewes (15.1 ng·ml^{-1}min). Fifteen C and nine R ewes lambed, with C ewes producing 8 pairs of twins and 7 singles and R ewes producing 1 pair of twins and 8 singles. Milk production peaked at d 21 ± 4 (336 g·3h^{-1}) in R ewes and at d 28 ± 4 (303 g·3h^{-1}) in C. There was no difference in average milk yield; R=266 g·3h^{-1} ± 16, C=258 g·3h^{-1} ± 12.4. Reducing growth rate in pre-pubertal ewes from 217 to 115 g·d^{-1}, increased GH in serum, but had effect on milk yield.

Key Words: Sheep, Dietary Restriction, Milk Yield