

Small Ruminant: Nutrition and Forages

W417 Effect of chromium supplementation on performance of feedlot lambs. T. M. C. Leme*, E. A. L. Titto, C. G. Titto, C. A. S. Bonato, D. L. Jimenez Filho, and S. L. Silva, *Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, Pirassununga, São Paulo, Brazil.*

Recent experiments have demonstrated that chromium supplementation improves weight gain and immune function and reduces morbidity of animals. The aim of this study was to evaluate effect of chromium supplementation on weight gain, DMI, and feed efficiency of feedlot lambs. Sixty-four crossbred White Dorper × Santa Ines lambs (initial BW 18.4 ± 4.7 kg, 60 d old) were allotted to individual pens and confined for 60 d, preceded by 7 d of adaptation. During confinement, all animals received the same diet containing 30% corn silage and 70% concentrate composed primarily of corn, soybean meal and mineral mix, delivered daily at 08:00. The animals were divided into 2 groups, one group in which each animal received 2 mg daily of supplemental organic chromium in the mixed diet with 30 g extra fine corn meal (SC), and a control group (CO) that received only 30 g extra fine corn meal (without supplementation with organic chromium). Feed offered and orts were recorded daily, and weight gain, DMI, and feed efficiency were determined. Animals were weighed at the beginning of the trial and every 14 d. Animal performance was analyzed by ANOVA, considering treatment as fixed effect and sex as random effect. There was no significant effect ($P > 0.05$) of daily supplementation of chromium on BW gain, DMI and feed efficiency. Average weight gain (ADG) in this study was 0.225 kg/d for CO and 0.235 kg/d for SC ($P = 0.373$). The DMI was 1.15 kg/d for the CO and 1.25 kg/d for SC group ($P = 0.288$). Feed efficiency values were 0.198 kg weight gained per kg feed for CO and 0.199 kg weight gained per kg feed for SC ($P = 0.288$). The supplementation of 2 mg per d of chromium did not affect weight gain, DMI and feed efficiency of lambs.

Key Words: dry matter intake, feed efficiency, weight gain

W418 Effects of levels of Boer goats and Dorper sheep on feed intake, digestibility, growth, and slaughter characteristics in the central highlands of Ethiopia. T. Mekonnen¹, K. Kefelegn², G. Abebe³, and A. L. Goetsch⁴, ¹*Sirinka Agricultural Research Center, Sirinka, Ethiopia*, ²*School of Animal and Range Sciences, Haramaya University, Haramaya, Ethiopia*, ³*Ethiopia Sheep and Goat Productivity Improvement Program, Addis Ababa, Ethiopia*, ⁴*American Institute for Goat Research, Langston University, Langston, OK.*

Twenty-seven male goats (6–9 mo) and 27 male sheep (3–5 mo) were used in 90-d experiments. Animals were indigenous or local goat and sheep genotypes of the central highlands of Ethiopia (LG and LS, respectively) and crossbreds of local with 25 and 50% Boer (B) goats or Dorper (D) sheep. Grass hay (9% ash, 6% CP, and 64–67% NDF) was consumed ad libitum supplemented with 2% BW (DM basis) of concentrate (46% noug seed cake, 28% wheat bran, 24% sorghum grain, and 2% salt; 8% ash, 24% CP, and 24% NDF). Initial BW was 18.1, 20.8, and 24.9 kg for Local, 25%B, and 50%B, respectively (SE = 0.77) and 14.8, 20.3, and 17.9 kg for Local, 25%D, and 50%D, respectively (SE = 0.74). Total DMI ranked ($P < 0.05$) LG <25%B <50%B (675, 763, and 891 g/d) and LS <50%D <25%D (810, 1120, and 980 g/d for LS, 25%D, and 50%D, respectively). Goat ADG was greatest ($P < 0.05$) for 50%B (32, 32, and 53 g for LG, 25%B, and 50%B, respectively) and of sheep was least ($P < 0.05$) for LS (89, 132, and 126 g for LS, 25%D, and

50%D, respectively). Empty BW of goats at slaughter (17.6, 20.7, and 24.3 kg) and hot (9.0, 10.9, and 12.8 kg) and cold carcass weights (8.7, 10.4, and 12.3 kg for LG, 25%B, and 50%B, respectively) ranked ($P < 0.07$) LG <25%B <50%B. Slaughter BW of sheep was 22.8, 32.7, and 31.8 kg for LS, 25%D, and 50%D, respectively (SE = 1.04). Likewise, hot (10.3, 16.6, and 15.3 kg) and cold carcass weights (9.9, 16.2, and 14.9 kg for LS, 25%D, and 50%D, respectively) were lowest for LS ($P < 0.05$). In addition to the difference between 25%B and LG, these results show potential for greater meat yield with 50 vs. 25%B, which would be due to both the greater level of heterosis and higher level of B breeding. The findings also depict considerable opportunity for increased meat production by crossbreeding with D. However, greater benefit was not realized with 50 than 25%D as expected. Nonetheless, the results provide an example of marked improvement in performance possible with 25%D and, presumably, there would be little or no difference in adaptation to harsh production conditions between LS and 25%D.

Key Words: goat, sheep, breed

W421 Effects of level and length of supplementation on carcass amounts and percentages of ash, N, water, total fat, and energy. R. C. Merkel*, T. A. Gipson, Z. Wang, and A. L. Goetsch, *E (Kika) de la Garza American Institute for Goat Research, Langston University, Langston, OK.*

Spanish (S; 28 to 40 wk of age) and Boer (B; 33 to 46 wk) wethers were used to determine effects of level and length of supplementation on carcass amounts and concentrations of ash, N, water, fat and energy. The completely randomized experiment had 110 and 108 d periods (PR). Wethers resided on pastures with free-choice alfalfa hay and supplemented with 0.5 or 1.5% BW (SL; DM basis; L and H, respectively) of a pelleted diet (16% CP, 60% TDN). Five S and 6 B were harvested initially, and 12 per breed (BR) and SL after PR 1 and 2. There were BR differences ($P < 0.05$) in initial BW (33.3 and 23.7 kg), carcass weight (15.4 and 10.9 kg) and amounts of ash (0.71 and 0.45 kg), protein (3.49 and 2.24 kg), fat (3.31 and 2.16 kg), and energy (211 and 137 MJ) for B and S goats, respectively. On a carcass basis B goats had a lower ($P < 0.05$) level of water (51.3 and 55.2%) but more energy than S goats (13.6 and 12.2 MJ/kg). H goats had greater ($P \leq 0.05$) ash (0.97 and 0.87 kg), protein (4.1 and 3.5 kg), and water (12.7 and 11.5 kg) than L goats. H goats in PR2 had greatest ($P < 0.05$) amounts of fat (4.04, 3.65, 6.31, and 4.19 kg; SEM = 0.321) and energy (255, 227, 340, and 243 MJ for PR1H, PR1L, PR2H, and PR2L, respectively; SEM = 15.3), with corresponding differences in % carcass fat and energy/kg carcass. B goats had greater ($P < 0.05$) ash (1.03 and 0.80 kg), water (13.7 and 10.5 kg), fat (5.79 and 3.32 kg), and energy (327 and 206 MJ) than S goats. Carcass protein was greater in B goats in PR1 than PR2 and greater than amounts in S goats (4.58, 4.01, 3.37, and 3.17 kg for PR1B, PR2B, PR2S, and PR1S, respectively; SEM = 0.177; $P < 0.05$). Carcass protein percentage was lowest ($P < 0.05$) for H goats in PR2 (20.1, 18.8, 16.0, and 16.9%, for PR1B, PR1S, PR2B, and PR2S, respectively). The differences in component amounts are in accord with those seen in carcass weight (23.6 and 20.4 kg for H and L; 25.5 and 18.5 kg for B and S; 20.3 and 23.8 kg for PR 1 and 2, respectively). Supplementation and period led to increased weights of carcass components and B goats accumulated fat in the carcass to a greater extent than S goats.

Key Words: meat goat, breed, supplement

W422 Effect of *Jatropha curcas* meal (nontoxic) substituted for soybean meal on apparent digestibility and energy concentration of feed in growing Pelibuey sheep. A. Estrada-Angulo^{*1}, M. A. Angulo-Escalante², J. J. Portillo¹, R. Gutierrez-Dorado³, A. Rubio-Angulo¹, C. Castro-Martinez⁴, F. G. Rios¹, and A. Plascencia⁵, ¹FMVZ-UAS, Culiacan, Sinaloa, Mexico, ²CIAD-Culiacan, Culiacan, Sinaloa, Mexico, ³FCQB-UAS, Culiacan, Sinaloa, Mexico, ⁴CIIDIR-IPN, Guasave, Sinaloa, Mexico, ⁵IICV-UABC, Mexicali, Baja California, Mexico.

The objective of this study was to determine the effect of nontoxic *Jatropha curcas* meal (JCMNT) as a substitute for soybean meal on apparent digestibility and energy concentration of feed in growing sheep. Twenty male Pelibuey sheep (26.5 ± 0.5 kg) individually housed for 20 d were used in a randomized complete block experiment (blocking by live weight). Dietary treatments were 1) control (without JCMNT), 18.02% CP and 3.60 Mcal DE/kg, and contained 30.0% Sudan hay, 40.5% cracked corn, 15.0% soybean meal, 2.0% zeolite, 10.0% sugarcane molasses, and 2.5% mineral premix; 2) control plus JCMNT, 17.80% CP and 3.58 Mcal of DE/kg, and contained 2.5% JCMNT and 12.5% soybean meal; 3) control plus JCMNT, 17.60% CP and 3.56 Mcal of DE/kg, and contained 5.0% JCMNT and 10.0% soybean meal; 4) control plus JCMNT, 17.40% CP and 3.54 Mcal of DE/kg, and contained 7.5% JCMNT and 7.5% soybean meal; and 5) control plus JCMNT, 17.20% CP and 3.52 Mcal of DE/kg, and contained 10.0% JCMNT and 5.0% soybean meal. The DMI was adjusted to 614 g/d/head (307 g am and 307 g pm). The DM excreted in feces was similar ($P > 0.05$) in control group compared with JCMNT treatments (151.5 vs. 160.8 g/day/head). The apparent digestibility of DM for control and JCMNT treatment groups was similar ($P > 0.05$), with 75.35 and 73.77%, respectively. The DE concentrations were not significantly different ($P > 0.05$) between control and JCMNT treatment groups (3.22 vs. 3.15 Mcal/kg of DM, respectively). The observed/expected DE ratio was similar for JCMNT treatment groups (0.95), but the control treatment group had a ratio of 1.01. These results indicate that the calculated energy of JCMNT was overestimated in this experiment. It is concluded that JCMNT can be substituted for soybean meal for up to 10% of the diet without affecting apparent digestibility of DM and energy concentration in diets for growing Pelibuey sheep. Further, JCMNT had similar energy value as soybean meal when included in diets for growing hair sheep.

Key Words: apparent digestibility, *Jatropha curcas* meal, Pelibuey sheep

W423 Mineral requirements for growth of female Saanen goat kids. F. O. M. Figueiredo*, T. T. Berchielli, K. T. Resende, A. M. Mobilgia, and I. A. M. A. Teixeira, *Univ Estadual Paulista, Jaboticabal, Sao Paulo, Brazil.*

Mineral retention depends on the composition of weight gain (bones, muscles and fat). In general, greater fat deposition reduces mineral deposition and, consequently, mineral requirements of animals. Factors such as sex, breed, age and diet can affect mineral composition and net mineral requirement for weight gain. Recently, few studies have focused on the mineral requirements of goats; however, studies with female goats are scarce. The objective of this study was to estimate the macromineral (Ca, P, Mg, K and Na) net requirements for growth of female Saanen goat kids using the comparative slaughter technique. A total of 18 female Saanen goat kids with BW ranging from 30 to 45 kg were used. At the beginning of the experiment 6 animals at 30.1 ± 0.22 kg BW were slaughtered. Another 6 kids were slaughtered at 38.3 ± 0.38 kg BW and the remaining 6 kids were slaughtered at 45.5 ± 0.13 kg BW. Animals were fed ad libitum. Logarithmized allometric equa-

tions were used to calculate macromineral body composition through the relationship between macromineral content and EBW based on the following equations: Log Ca, $g = 1.27 + 0.78 \times \text{Log EBW}$; Log P, $g = 1.30 + 0.74 \times \text{Log EBW}$; Log Mg, $g = -0.13 + 0.81 \times \text{Log EBW}$; Log Na = $-0.30 + 0.71 \times \text{Log EBW}$; Log K = $0.57 + 0.782 \times \text{Log EBW}$. Body Ca decreased from 9.21 to 8.27 g/kg EBW; P decreased from 8.68 to 7.65 g/kg EBW; Mg decreased from 0.40 to 0.37 g/kg EBW; Na decreased from 0.20 to 0.17 g/kg EBW; K decreased 1.52 to 1.32 g/kg EBW, as body weights increased from 30 to 45 kg. Net macromineral requirements for growth decreased from 7.18 to 6.45 g Ca; 6.42 to 5.66 g P; 0.33 to 0.30 g Mg; 0.14 to 0.12 g Na and 1.11 to 0.97 g K/kg of EBW as BW of for the females kids increased from 30 to 45 kg.

Key Words: body composition, gain, macromineral

W424 Effect of *Jatropha curcas* kernel (nontoxic) substituted for soybean meal on productivity and carcass characteristics in finishing Pelibuey sheep. A. Estrada-Angulo^{*1}, M. A. Angulo-Escalante², J. C. Robles¹, I. Contreras³, H. Davila¹, L. E. Sanchez-Ramirez¹, H. Landeros-Lopez¹, B. I. Castro¹, F. G. Rios¹, and A. Plascencia⁴, ¹FMVZ-UAS, Culiacan, Sinaloa, Mexico, ²CIAD-Culiacan, Culiacan, Sinaloa, Mexico, ³FCQB-UAS, Culiacan, Sinaloa, Mexico, ⁴IICV-UABC, Mexicali, BC, Mexico.

To determine the effect of substituting ground nontoxic *Jatropha curcas* kernel (JCKNT) for soybean meal on productivity and carcass characteristics in finishing sheep, 15 male Pelibuey sheep (28.4 ± 1.5 kg) were used in a completely randomized design with the following dietary treatments: (1) control (without JCKNT), 18.02% CP and 3.60 Mcal DE/kg, and contained 30.0% Sudan hay, 40.5% cracked corn, 15.0% soybean meal, 2.0% zeolite, 10.0% sugarcane molasses, and 2.5% mineral premix; (2) control plus JCKNT, 17.02% CP and 3.64 Mcal of DE/kg, and contained 5.0% JCKNT and 10.0% soybean meal; and (3) control plus JCKNT, 16.02% CP and 3.68 Mcal of DE/kg, and contained 10.0% JCKNT and 5.0% soybean meal. Final live weight (FLW), ADG, slaughter weight (SW), hot carcass weight (HCW), Longissimus muscle (LM) area, fat thickness (FT), kidney-pelvic fat (KPF), carcass total fat (CTF), and carcass tissue were determined. FLW was similar ($P > 0.05$) among treatment groups (33.93, 33.55 and 33.61 kg for treatments 1, 2, and 3, respectively). ADG was also similar ($P > 0.05$) for the 3 treatments (177, 169 and 171 g/d). HCW (19.58, 19.31 and 18.68 kg) and KPF (1.35, 1.11 and 1.34%) values were not different ($P > 0.05$) among treatment groups. Total muscle in carcass (67.21, 64.86, and 63.87%), FT (3.37, 2.73, and 2.45 mm), and LM area (14.80, 13.22 and 12.29 cm²) decreased ($P < 0.05$) with increasing levels of JCKNT in the diet. CTF (11.89, 12.81, and 13.36%) and total bone (20.64, 21.80, and 22.10%) increased with increasing levels of JCKNT in the diet. It is concluded that ground JCKNT can be a substitute for soybean meal at up to 10% of the diet without affecting FLW, ADG, HCW, and KPF. However, JCKNT inclusion modified some other carcass characteristics in finishing hair sheep.

Key Words: carcass characteristic, *Jatropha curcas* kernel, Pelibuey sheep

W425 Effects of short-term oligofructose-enriched inulin supplementation on growth performance and selected fecal characteristics of weanling Saanen kids. C. Kara^{*1}, Y. Meral¹, H. Biricik¹, A. Orman², H. Gencoglu¹, I. Cetin¹, D. Yesilbag¹, G. Deniz¹, and I. Turkmen¹, ¹Uludag University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases, Bursa,

Turkey, ²Uludağ University, Faculty of Veterinary Medicine, Department of Zootechnics, Bursa, Turkey.

Twenty-four Saanen kids (44 ± 1 d of age) were used to study the effects of oligofructose-enriched inulin supplementation on growth performance, fecal score, fecal pH, and fecal SCFA concentrations. Kids were sorted by parity of their dams and their BW at the beginning of the study and assigned to 1 of 2 groups (control; CG and experimental; EG) at 44 ± 1 d of age. Each group consisted of 12 kids (6 males and 6 females). Kids were weaned early, at 48 ± 1 d of age. Each kid in EG was supplemented with 0.8 g/d and 1.6 g/d of chicory inulin powder enriched by a specific fraction of oligofructose (Orafti Synergy1, BENE0-Orafti S.A., Belgium) from d 1–5 and from d 6–15, respectively, while kids in CG did not receive oligofructose-enriched inulin. Data were analyzed using Statistical Package for the Social Sciences software (SPSS, 2004). There were no differences ($P > 0.05$) in BW, average daily feed intake, and feed efficiency for the whole period between groups. Average daily weight gain (ADG) during d 1–5 was higher for EG ($P < 0.01$), while no differences were observed during d 6–15 and d 1–15 ($P > 0.05$). Fecal score and fecal pH were not different ($P > 0.05$) between groups. Oligofructose-enriched inulin supplementation did not adversely affect fecal score. The amounts of acetate, propionate, and total SCFA (acetate + propionate + butyrate) in feces did not differ ($P > 0.05$) between groups, whereas fecal butyrate concentration tended to be higher ($P = 0.05$) in EG. Because of a tendency to increase fecal butyrate concentration in EG, oligofructose-enriched inulin supplementation may be useful during the intestinal infections with epithelial damage and colonic inflammation.

Key Words: fecal characteristic, growth performance, oligofructose-enriched inulin

W426 Apparent digestibility of dry matter and nutrients from lambs fed diets with or without glycerin. E. M. de Oliveira*, J. M. B. Ezequiel, V. C. Santos, A. P. D'aurea, M. T. CA. Costa, A. C. Homem Junior, V. B. Carvalho, J. R. Paschoaloto, E. H. Fernandes, and C. S. Costa, *Universidade Paulista Júlio de Mesquita - Unesp.*

The aim of this study was to evaluate the apparent digestibility of DM and nutrients in feedlot finished lambs fed diets with or without glycerin. A total of 40 Santa Inês × Dorper intact male lambs (average BW = 21 kg) were kept in confinement stalls and fed Tifton 85 bermudagrass hay as forage, and corn grain, soybean meal, calcarium and mineral premix as concentrate in the ratio 20:80. Experimental diets were G0 - control without glycerin and G10 - 10% glycerin as part of the concentrate. Internal indicator indigestible neutral detergent fiber (iNDF) was used to estimate the values of dry matter digestibility and nutrients. Diet, orts, and fecal samples were collected in first 5 d of the fourth week of the performance test. The samples were composited by animal, oven-dried at 55°C for 72 h for determination of DM, and ground in a Wiley mill to 1 mm for subsequent incubation. The iNDF levels were measured after 264 h of incubation in situ using nylon bags (14 × 7 cm) containing 5 g of the sample. After that, the bags were washed and treated with neutral detergent. The residue was assumed as iNDF. The experimental design was randomized block with 2 treatments and 20 replications, and means were compared by Tukey test at 5% probability. There was a significant reduction ($P < 0.05$) in digestibility of neutral detergent fiber (NDF) in the G10 group. The glycerin, by not having cell wall, has a higher rate of degradation than other energy sources from grains, but in less time. There was no effect ($P < 0.05$) on the digestibility of DM, OM, CP, EE and ADF. Inclusion of 10% glycerin in diet resulted in decreased NDF digestibility, without impairing the digestibility of other nutrients, including DM and OM.

Key Words: biodiesel, co-product, sheep

W427 Blood metabolite and rumen VFA concentrations of lambs fed a diet containing artichoke (*Cynara scolymus*). M. Dehghani-Sanij*, A. Afzalzadeh, K. Rezayazdi, and M. A. Norouziyan, *University of Tehran, Tehran, Iran.*

The objective of this experiment was to evaluate the effects of replacing alfalfa hay by artichoke (*Cynara scolymus*) hay on certain blood metabolites, rumen pH, and VFA concentrations in Lori-Bakhtiary lambs. Fourteen Lori-Bakhtiary lambs (30 ± 3.2 kg of initial BW; mean ± SD) were penned individually and used in a completely randomized design with 2 treatments and 7 lambs in each. One group received alfalfa hay as roughage (control; alfalfa 30%, wheat straws 15% and concentrate 55%) and the other group received artichoke (*Cynara scolymus*; test group) hay, which was used in full replacement of alfalfa hay during 78 d. Significant effects ($P < 0.05$) for blood cholesterol (57.4 ± 7 (control) and 46.9 ± 8 (test group) mg/dL) and triglycerides (70.9 ± 10 (control) and 60.7 ± 6 (test group) mg/dL) were observed due to artichoke hay inclusion in the diet. Blood total protein and glucose concentration did not differ between the experimental groups. Treatment did not affect minimum pH, mean pH, maximum pH, standard deviation of mean pH, and duration or area under pH 5.8, indicating that inclusion of artichoke hay did not appear to affect rumen pH. Inclusion of artichoke hay in the diet did not affect total VFA (92.4 ± 2.8.2 and 82.1 ± 14.2 mmol/L in control and test groups, respectively) and individual VFA concentrations in rumen liquor. The acetate, propionate, butyrate, valerate, and iso-valerate in control were 53.4 ± 13.4, 23.15 ± 12.3, 12.46 ± 4.76, 2.03 ± 0.91, and 1.33 ± 0.78 mmol/L, respectively, and in the test group, the concentrations were 51.6 ± 10.2, 18.18 ± 7.1, 9.42 ± 2.4, 1.9 ± 0.55, and 1.02 ± 0.47 mmol/L, respectively. In conclusion, alfalfa hay can be replaced by artichoke hay in the diet of growing Lori-Bakhtiary lambs with no adverse effects on blood metabolites, rumen pH, and VFA concentrations.

Key Words: alfalfa hay, artichoke hay, rumen pH

W428 Mineral metabolism in Saanen and Oberhasli goats during pregnancy. C. J. Härter*¹, A. R. Rivera¹, D. S. Castagnino¹, L. D. Lima¹, H. G. O. Silva¹, A. M. Nunes¹, S. Sgavioli¹, S. M. B. Artoni¹, A. Liesegang², N. St-Pierre³, K. T. Resende¹, and I. A. M. A. Teixeira¹, ¹Department of Animal Sciences, Universidade Estadual Paulista, Jaboticabal, SP, Brazil, ²Institute of Animal Nutrition, University of Zurich, Zurich, Switzerland, ³Department of Animal Sciences, The Ohio State University, Columbus.

During pregnancy, the maternal body undergoes significant physiological changes. Thus the objective of this study was to evaluate the effect of number of fetuses on physiological changes of calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na) and potassium (K) during the gestation period for Saanen and Oberhasli goats. The 42 goats used (49.5 kg ± 7.6 BW) were fed ad libitum and distributed in a completely randomized design in a 2 × 2 × 3 factorial as follows: 2 breeds (Oberhasli and Saanen), 2 types of pregnancy (single and twin) and slaughtered at 3 gestation periods (80, 110 and 140 d). Digestibility assays were performed at 50, 80, 110 and 140 d of gestation. Mineral retention during pregnancy was determined in the maternal body, femur, uterus, mammary gland, fetus and fetal fluid. Blood samples were taken during pregnancy to determine the mineral concentration and alkaline phosphatase activity. Bone mineral density was determined in the right femur. Statistical analyses were performed using the SAS MIXED procedure. The availability of Ca and P increased until the end of pregnancy

($P < 0.05$), but the balance of these minerals increased only until 80 d of gestation and then declined ($P < 0.01$). Maternal body weight gain and Ca, P and Mg retention (g/kg) decreased during gestation ($P < 0.01$). Macro mineral retention in maternal body (g/kg) was higher in Oberhasli goats ($P < 0.01$), and their fetuses had higher Ca, P and Mg deposition (mg/g; $P < 0.01$). Mineral retention (mg/g) increased in fetuses according to pregnancy development ($P < 0.01$). In the fetal fluid, P, Mg, Na and K retention (mg/g) increased throughout pregnancy ($P < 0.05$). In the mammary gland, the retention of all minerals (g) increased until the end of pregnancy ($P < 0.05$). Ca, P and Mg metabolism is related to maternal body preparation for future demands until 80 d of gestation, and after this period for the transfer of maternal body reserves for fetal development and colostrum formation. Na and K supply is provided by physiological adjustments. The mineral metabolism is specific to each breed and is not affected by the number of fetuses.

Key Words: fetus, genotype, maternal body reserves

W429 Mineral metabolism of dairy goats under feed restriction during pregnancy. C. J. Härter*¹, A. R. Rivera¹, D. S. Castagnino¹, L. D. Lima¹, H. G. O. Silva¹, A. M. Nunes¹, A. Liesegang², N. St-Pierre³, K. T. Resende¹, and I. A. M. A. Teixeira¹, ¹Department of Animal Sciences, Universidade Estadual Paulista, Jaboticabal, SP, Brazil, ²Institute of Animal Nutrition, University of Zurich, Zurich, Switzerland, ³Department of Animal Sciences, The Ohio State University, Columbus.

The present study examined the effects of feed restriction on calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na) and potassium (K) metabolism in goats during gestation. A total of 31 Oberhasli and 32 Saanen (49.0 kg \pm 8.9 BW) goats were used in this study. Six of these (3 Oberhasli and 3 Saanen) were slaughtered at the beginning of the experiment to estimate the baseline body composition of non-pregnant goats. The remaining goats were distributed into groups that were subjected to 3 levels of feed restriction (0, 20 and 40% restriction) and slaughtered at different pregnancy stages (80, 110 and 140 d of gestation), in a randomized complete block design with 2 \times 3 \times 3 factorial arrangement. Mineral balance was determined around 50, 80, 110 and 140 d of gestation. Serum levels of Ca, P, Mg, Na, K, Ca ions and alkaline phosphatase activity were determined during pregnancy. Bone mineral density was determined in the right femur. Mineral retention in maternal body, femur, uterus, mammary gland, fetus and fetal fluid was also determined during gestation. Mixed models with d of gestation, levels of feed restriction, breed and their interactions as fixed effects and blocks as random effect were used for data analysis. Feed restriction caused DM loss in the maternal body ($P < 0.01$). At 40% feed restriction, the retention of all minerals in the body (g/kg BW) decreased ($P < 0.06$), and fetuses were smaller than those of goats without feed restriction ($P < 0.05$). Fetal deposition of P, Na and K (mg/g) was also lower at 40% restriction ($P < 0.06$). In response to the reduction in mineral intake, the maternal body uses its mineral reserves to maintain gestation, while fetal growth is also maintained under mild feed restriction conditions. Severe feed restriction, however, can compromise fetal development because the maternal body gains priority for the use of some nutrients such as P, Na and K.

Key Words: fetal mineral deposition, maternal body, mineral retention

W430 Influence of reducing starch and increasing digestible fiber on hormonal and metabolic profile of lactating ewes. R. S. Gentil*¹, A. Cannas², A. V. Pires¹, E. M. Ferreira¹, D. M. Polizel¹, D. Eysink¹, M. V. Biehl¹, and I. Susin¹, ¹Escola Superior de

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The variations in hormonal status during lactation reflect nutrient partitioning between milk production and body reserves. Thirty-three lactating Santa Ines ewes (68 \pm 3 Initial BW and 13.2 \pm 3 DIM; mean \pm SD) were used in a randomized complete block design to define an optimal combination between carbohydrate sources (starch and high digestible fiber) that can favor energy partitioning toward milk production at different lactation stages. Ewes were housed individually for 10 wk from the second week of lactation. Animals were fed a 60:40 (concentrate:roughage ratio) TMR with 15 \pm 0.4% crude protein. Soybean hulls (SH, source of high digestible fiber) replaced corn (source of starch) by 0, 20 or 40% (DM basis), corresponding to the experimental treatments 0SH, 20SH and 40SH, respectively. Blood samples were collected in the first week of experiment (14 DIM) and every 14 d, 2 h after feeding. The metabolites evaluated were insulin, growth hormone (GH), IGF1, glucose and nonesterified fatty acids (NEFA). A colorimetric assay was used to determine blood glucose and NEFA concentrations. Blood insulin and GH concentrations were determined using RIA. The analysis of blood IGF1 concentrations was made in a chemiluminescent immunoassay analyzer. Data were analyzed using the PROC MIXED procedure (SAS 9.2, 2002). All the variables were unaffected ($P > 0.05$) by replacing corn with SH. There were no effects ($P > 0.05$) of lactation stage on blood glucose and IGF1 concentrations. However, insulin (5.61; 9.89; 9.82; 9.94; 12.87; 10.01 μ IU/mL) concentrations increased, while GH (4.31; 4.22; 3.87; 2.72; 2.61; 2.24 ng/mL) and NEFA (0.60; 0.42; 0.31; 0.30; 0.22; 0.20 mEq/L) concentrations decreased ($P < 0.05$) throughout lactation. There was no interaction ($P > 0.05$) between diet and time. Soybean hulls can partially replace corn without effect on hormonal and metabolic profile of lactating ewes.

Key Words: corn, lactation, soybean hulls

W431 Growth and carcass characteristics of ewe lambs fed high-concentrate diets containing increasing levels of calcium nitrate. A. P. A. Freire¹, R. A. Souza¹, D. M. Polizel¹, R. S. Gentil¹, A. V. Pires¹, R. C. Araujo², and I. Susin*¹, ¹Escola Superior de Agricultura Luiz de Queiroz (ESALQ)/USP, Piracicaba, SP, Brazil, ²GRASP Ind. e Com. LTDA, Curitiba, PR, Brazil.

Nitrate is a source of nonprotein nitrogen that can be fed to ruminants having the capability of reducing methane production in the rumen. However, nitrate is not currently used due to the risk of methemoglobinemia. Fifty Dorper \times Santa Inês ewe lambs (initial BW 37.4 \pm 3.1 kg and 185 \pm 4 d old) were used in a randomized complete block design, according to initial BW and age, to determine the effects of calcium nitrate on growth and carcass characteristics. Ewe lambs were penned individually during 69 d and fed an isonitrogenous (14% CP, DM basis) total mixed ration composed of 80% concentrate and 20% coastcross bermudagrass hay. The experimental diets contained increasing levels of calcium nitrate replacing soybean meal as follows: 0 (control-N0), 1% (N1), 2% (N2), 3% (N3) or 4% (N4) in the dietary DM. An adaption period of 4 d was used before moving to a higher nitrate level to avoid toxic effects. There was a quadratic response ($P < 0.05$) in DMI (1.42, 1.44, 1.37, 1.32 and 1.19 kg/d for N0, N1, N2, N3 and N4, respectively), ADG (208, 209, 199, 173 and 130 g for N0, N1, N2, N3 and N4, respectively) and feed efficiency (gain:feed = 147, 148, 146, 131 and 102 for N0, N1, N2, N3 and N4, respectively). Dressing percentage, longissimus muscle area and nitrate/nitrite content in meat were unaffected ($P > 0.10$) by experimental diets. However, back fat thickness (11.2, 8.6, 6.3, 6.9, and 8.5 mm for N0, N1, N2, N3 and N4, respectively) had a quadratic response ($P < 0.05$), showing a decrease up to 2% of nitrate. Calcium

nitrate replacing soybean meal up to 2% of dietary DM maintained feed efficiency with no detrimental effect on animal health.

Key Words: nonprotein nitrogen, sheep

W432 Rumen metabolism in lambs fed high-concentrate diets containing increasing levels of crude glycerin. D. M. Polizel, R. S. Gentil, E. M. Ferreira, R. A. Souza, A. P. A. Freire, J. A. Faleiro Neto, A. V. Pires, and I. Susin*, *Escola Superior de Agricultura Luiz de Queiroz (ESALQ)/USP, Piracicaba, SP, Brazil.*

The objectives in this trial were to determine the effects of partial replacement of corn by crude glycerin (CG) on rumen metabolism of ram lambs fed high-concentrate diets. Five Dorper × Santa Inês ram lambs (BW 56.9 ± 6.4 kg), cannulated in the rumen, were used in 5 × 5 Latin square design. Animals were fed an isonitrogenous (15% CP, DM basis) TMR composed of 90% concentrate and 10% coastcross hay. Crude glycerin (83.6% glycerol, DM basis) was included in the ration at 0%, 5%, 10%, 15% or 20% (DM basis), corresponding to the experimental diets G0, G5, G10, G15 and G20, respectively. Every period of the experiment lasted 19 d. The first 15 d were used to adapt the ram lambs with the diets and the remaining 4 d were used for data collection. In the last day of the period, rumen fluid was collected every 2 h, starting prior feeding, 2, 4, 6, 8, 10 and 12 h after feeding. Short-chain fatty acids (SCFA) profile, pH and ammonia nitrogen concentration were determined. Ruminal measures were analyzed as repeated measures over time by using the MIXED procedure (SAS Inst. Inc.) The LSMEANS option was used to generate individual diet means. Orthogonal polynomials for diet responses were determined by linear, quadratic, and cubic effects. Propionate, butyrate, isovalerate, total SCFA, ammonia nitrogen and pH were unaffected ($P > 0.05$) by the experimental diets. There was an interaction ($P < 0.05$) between diet × hour for acetate, ammonia and pH. There was a quadratic response ($P < 0.05$) for acetate (49.28, 43.19, 37.67, 35.38, 37.83 mM) and acetate-to-propionate ratio (1.01, 0.88, 0.71, 0.71, 0.76). Isobutyrate concentration (0.44, 0.37, 0.36, 0.26, 0.35 mM) decreased ($P < 0.05$) with inclusion of CG. Crude glycerin fed up to 15% of the diet DM decreased acetate and acetate:propionate ratio.

Key Words: co-product, glycerol, short-chain fatty acid

W433 Effect of supplementation with different protein levels on the performance of lambs grazing napiergrass (*Pennisetum purpureum*) pasture. I. F. F. Garcia*¹, F. A. P. Alvarenga¹, D. R. Casagrande¹, J. R. O. Perez¹, P. C. G. Dias Junior¹, V. C. Ferreira², and I. G. Pereira², ¹Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil, ²Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

The aim of the present study was to evaluate the effect of supplements with different crude protein (CP) levels on the development of lambs grazing napiergrass (*Pennisetum purpureum*) pasture. The average initial live weight of 50 crossbred lambs used in this study was 20.2 ± 2.94 kg and the average age was 170 ± 14.4 d. The treatments tested were: control group receiving a mineral mixture; and 4 groups receiving supplements (corn, soybean meal and mineral mixture) with different levels of CP (8, 16, 24 and 32%). A completely randomized experimental design with 5 treatments was used. The averages between groups were compared by Tukey test (5%) and regressions were performed. Lambs were slaughtered after 75 d. Feed consumption was evaluated using chromic oxide and titanium dioxide markers. Fecal egg counts (FEC) were performed to monitor level of worm infection. The control group had higher FEC

(808/g of feces) compared with the average of the groups that received CP supplementation (359/g of feces). The weight at slaughter and the EBW were similar between the supplemented groups (average 30.6 and 22.9 kg, respectively) but superior to the control group (24.1 and 17.9 kg, respectively). Although weight gain per day (GPD) increased linearly with increased CP in the diet, the group given an 8% CP supplement had GPD similar to control animals (93.0 g/d). The other groups had an average GPD of 137.6 g/d. The daily DM consumption was 602.1 g/d or 2.36% of BW and was not affected by CP level of the diet. The consumption of CP and OM increased with increasing dietary CP. The area of the rumen papilla was larger for treatment groups given diets with 24 and 32% CP (average 0.23 cm²) compared with the control, 8% CP, and 15% CP treatment groups (0.15 cm²). The mitotic index in the rumen was higher for supplemented animals (0.97) than controls. Protein supplementation of lambs grazing napiergrass pasture increases performance, with the best results found at levels of 16% CP or more.

Key Words: nutrients consumption, ruminal tissue, sheep

W434 Effect of a cellulase enzyme additive on hay intake and fiber digestion in goats. S. Hart*, *Langston University, Langston, OK.*

Thirty-six Spanish, Boer, and Boer × Spanish wethers (6 mo of age, 25.0 ± 5.5 kg BW) were used to test the effect of a cellulase/hemicellulase enzyme additive on intake and fiber digestion. Wethers were blocked by BW and breed and randomized to 4 pens with Calan headgates to measure individual intake. Wethers were fed a chopped low quality grass hay (4.8% CP, 48.4 ADF, and 75.3 NDF) at 115% of average intake over the previous 3 d. Two pens of goats were offered a test supplement containing the enzymes and 2 were offered the control supplement. The supplement was composed of 5% of a mineral mix containing trace minerals, 8% liquid molasses, 43% soybean meal, and 44% ground corn. The enzyme preparation (69% distillers dried grains, 30% urea, and 1% enzymes) was incorporated into the supplement at the 2% level. The supplement was fed at 5.5 g/kg BW, resulting in 8.8 g of enzyme preparation/100 kg BW. Blood and ruminal fluid samples were collected before the morning feeding in wk 4 of the study for blood urea nitrogen and rumen ammonia determination. Following the 12-wk intake study, intake was reduced in half the pens to 80% of intake in wk 12, fecal bags were fitted on animals, and fecal and ort samples were collected 5 d for determining digestibility. Data were analyzed with Proc MIXED of SAS. Rumen ammonia and blood urea nitrogen were similar for control and enzyme treatments (6.8 vs. 7.1 mg/dL, SE = 0.38, $P > 0.20$; 13.8 vs. 15.2 mg/dL, SE = 2.3, $P > 0.20$). Hay intake was similar for control and enzyme treatments (2.63% vs. 2.83% of BW, $P > 0.20$; 58.8 vs. 63.0 g/kg BW^{0.75}, $P > 0.20$). Dry matter digestibility and protein digestibility were similar (52.8 vs. 53.5%, SE = 1.1, $P > 0.20$; 79.4 vs. 78.4%, SE = 0.8, $P > 0.20$). Neutral detergent fiber digestibility and acid detergent digestibility also were similar (49.8 vs. 50.6%, SE = 1.5, $P > 0.20$; 26.9 vs. 25.5%, SE = 3.3, $P > 0.20$). The cellulase and hemicellulase additive did not improve intake of low quality grass hay or increase fiber digestibility in goats.

Key Words: cellulase, fiber digestion, feed intake

W435 Effects of stocking rate and physiological state of meat goats grazing grass/forb pastures on forage intake, selection, and digestion, grazing behavior, and performance. A. R. Askar^{1,2}, R. Puchala*¹, T. A. Gipson¹, K. Tesfai¹, G. D. Detweiler¹, A. Asmare¹, A. Keli³, T. Sahlul¹, and A. L. Goetsch¹, ¹American Institute for Goat Research, Langston University, Langston, OK, ²Animal and Poultry Nutrition Department, Desert Research Center, Cairo,

Egypt, ³Department of Animal Production and Pastoralism, National School of Agriculture, Meknes, Morocco.

Effects of forage conditions with different stocking rates (SR) on performance and grazing behavior of goats could vary with animal physiological state, as influencing nutrient demand and usage. Boer goat does with 2 kids (D; 1 mo after kidding), growing wethers (G; 4 mo initial age), and yearling wethers (Y; 14 mo initial age) grazed 0.4-ha grass/forb pastures, with 1 animal per type in each pasture for a low SR and 2 for a high SR. The experiment started in late spring and was 114 d with 4 periods (P1–4). Forage mass was 2,517, 2,433, 2,506, and 2,452 kg/ha for the low SR and 2,680, 1,932, 1,595, and 1,393 kg/ha for the high SR in P1, P2, P3, and P4, respectively (SE = 335). Botanical composition of the diet based on n-alkanes was similar among animal types ($P > 0.10$). Likewise, chemical composition of forage samples did not differ between animal types ($P > 0.10$), with averages of 11% CP and 53% NDF. Digestibility of OM based on C31 (hentriacontane) was greater ($P < 0.05$) for the low than high SR (66.1 vs. 62.3%). Intake of ME was 1,015, 855, and 692 kJ/kg BW^{0.75} for D, G, and Y, respectively (SE = 57.4) and greater for the low than high SR in P1 (1,204, 789, 682, and 445 for high SR and 1,732, 767, 683, and 531 kJ/kg BW^{0.75} for low SR in P1, P2, P3, and P4, respectively; SE = 93.5). There was an interaction ($P < 0.05$) between animal type and period in ADG (13, -12, -44, -8, 83, 25, -28, 73, 127, 51, -43, and -7 g; SE = 21.5) and time spent grazing (7.5, 5.3, 7.4, 8.6, 78.6, 5.6, 10.0, 9.1, 4.8, 5.9, 8.4, and 9.5 h/d for D-P1, D-P2, D-P3, D-P4, G-P1, G-P2, G-P3, G-P4, Y-P1, Y-P2, Y-P3, and Y-P4, respectively; SE = 0.88). Rate of ME intake was greater ($P < 0.05$) for D vs. G and Y (49.5, 21.9, and 33.9 kJ/min for D, G, and Y, respectively; SE = 5.68) and differed ($P < 0.05$) among periods (57.5, 45.3, 24.8, and 12.9 kJ/min in P1, P2, P3, and P4, respectively; SE = 5.17). In conclusion, with this forage of moderate nutritive value, there were no findings suggesting that levels of forage mass above 1,400 kg/ha would improve performance of meat goats of different physiological states.

Key Words: grazing, meat goat, stocking rate

W436 Performance and consumption patterns of vegetation for commercial crossbred meat goats and hair sheep used to clear woodlands. J. A. Pennington^{*1}, J. L. Wilkins², N. T. Witt³, and J. D. Caldwell⁴, ¹Lincoln University, Neosho, MO, ²Crowder College, Neosho, MO, ³NRCS, Neosho, MO, ⁴Lincoln University, Jefferson City, MO.

Commercial crossbred meat goats (MG; final n = 63 with 33 adults, 2 yearlings, and 28 kids) and crossbred hair sheep (HS; final n = 60 with 33 adults, 1 yearling, and 26 lambs) were used for 8 wk in Jun-Jul, 2012, to clear woodlands that included a mix of available vegetation for consumption. Vegetation was divided into 9 categories (% of total feed available, % eaten by animals): sericea lespedeza (18, 83), buck brush (22, 94), multi-flora rose (5, 97), blackberry/other briars (6, 88), fescue/cool season grasses (4, 93), bermuda/cheat/summer grasses (7, 94), broadleaf/clover/ragweed (9, 92), vines/ivy (3, 100), and trees/hackberry/bushes (26, 89). MG ate a greater percentage ($P < 0.05$) of sericea, rose, blackberry, broadleaf, and trees/bushes than HS; there was no difference ($P > 0.10$) in % eaten for cool season grasses, summer grasses, or vines; buck brush consumption was intermediate ($P = 0.08$). Consumption by MG and HS of individual plants of multi-flora rose ($P < 0.05$) and buck brush ($P = 0.12$) showed similar trends. MG had a

higher ($P < 0.01$) browse line (1.41 m) than HS (1.24 m). Estimates of consumption were made weekly after animals were moved from lots of about 0.6 ha. MG ate 96–98% of vegetation and HS ate 93–98% of vegetation until consumption decreased when vegetation matured and extremely hot weather occurred in late July. Performance of 31 does and 31 ewes (1 died of each) showed that does had greater ($P < 0.01$) weight gain and improved ($P < 0.01$) body condition changes and FAMACHA scores compared with ewes. Weight change was +3.9 kg for does and +0.0 kg for ewes during 8 wk trial. Lactation (nursing) status affected or tended to affect gain, change in body condition, final body condition, and FAMACHA scores. Nursing ewes lost 2.2 kg and nonlactating ewes gained 2.3 kg ($P < 0.10$). Nursing and nonlactating does gained weight. Final body condition score was affected ($P < 0.05$) by species and lactation status plus initial body condition score ($P < 0.01$). Overall, both MG and HS cleared the woodlands, but MG ate slightly more vegetation than HS and does performed better than ewes in the woodlands, especially nursing ewes.

Key Words: meat goat, hair sheep, woodland

W437 Effects of continuous or rotational grazing schemes by yearling Katahdin ewes grazing toxic tall fescue in late spring through summer on available forage and forage quality. E. A. Backes^{*1,2}, J. D. Caldwell¹, B. C. Shanks¹, K. R. Ness¹, A. N. V. Stewart¹, C. A. Clifford-Rathert¹, A. K. Wurst¹, D. L. Kreider², and M. L. Looper², ¹Lincoln University, Jefferson City, MO, ²University of Arkansas, Fayetteville.

Rotational grazing has increased in popularity in recent years. However, research of grazing management of Katahdin hair sheep on toxic tall fescue [*Lolium arundinaceum* (Schreb.) Darbysh; E+] has not been well reported. Our objective was to evaluate available forage and forage quality measurements by yearling Katahdin ewes grazing E+ using either continuous or rotational grazing schemes in late spring through summer. Over 2 consecutive years, yearling Katahdin ewes (n = 50; 53 ± 1.41 kg initial BW; 3.3 ± 0.09 initial BCS) were stratified by BW and allocated randomly to one of 5 0.4 ha pastures consisting of 2 treatments: (1) Continuous (C; 5 replications); or (2) 4-cell rotation (4R; 5 replications). Available forage measurements were taken monthly for the duration of the study. Twelve disk meter readings were taken per pasture and calibrated on each sampling day. Six alternating forage quality samples per pasture were collected at time of disk meter readings. Available forage did not differ ($P = 0.45$) across treatments, however, available forage ($P \leq 0.05$) was greater for August compared with May, June, and July, but did not differ ($P > 0.68$) for June compared with May and July. In vitro dry matter digestibility (IVDMD) and crude protein (CP) did not differ ($P > 0.53$) across treatments. In vitro dry matter digestibility was greater ($P \leq 0.05$) for May compared with June, July, and August, but did not differ ($P \geq 0.89$) between June, July, and August. Crude protein ($P \leq 0.05$) was greater for May compared with all other months, but did not differ ($P = 0.35$) for June compared with August, but was greater ($P \leq 0.04$) for June and August compared with July. Grazing days did not differ ($P = 0.24$) from C compared with 4R. Therefore, rotational grazing yearling Katahdin ewes on E+ pastures in late spring through summer may not increase available forage, IVDMD, or CP when compared with continuous grazing.

Key Words: grazing, forage quality, Katahdin