

## Ruminant Nutrition: General

**330 Effect of trace minerals and different levels of starch on digestibility and ruminal fermentation in diets for dairy heifers.** Felipe Pino\* and Jud Heinrichs, *The Pennsylvania State University, State College, PA.*

Eight rumen cannulated dairy heifers ( $15.4 \pm 0.8$  mo of age and  $438.31 \pm 18.08$  kg of BW) were fed a high forage diet with 4 different levels of starch (3.5, 12.9, 22.3, and 31.7%) and 2 types of trace minerals (TM; organic and inorganic; OTM and ITM). Inorganic TM were provided as sulfates and organic TM as proteinate (Bioplex; Alltech, Inc.). The TM analyzed were Cu, Mn, Se, and Zn. Heifers were subject to a split-plot,  $4 \times 4$  Latin square design with 19-d periods; 15 d adaptation and 4 d sampling. The whole-plot factor was TM, and the subplot was starch concentration. Total collection of feces and urine were completed on d 15 to 19 to determine digestibility and TM excretion. Rumen contents were sampled (d 18 to 19) from 5 different locations in the rumen at 0, 1, 2, 4, 8, 12, 16, 20, and 22 h after feeding to measure pH and VFA concentrations. Plasma samples were collected to evaluate TM concentrations. Data were analyzed with the mixed procedure of SAS. Trace mineral intake was lower for OTM compared with ITM. No effect of TM on digestibility was detected, but as level of starch increased, DM digestibility increased ( $P = 0.08$ ). Rumen pH was lower for diets with OTM ( $P = 0.01$ ), which is consistent with higher total VFA production and butyrate proportion ( $P = 0.03$ ) observed for OTM diets. These variables may be explained by the higher bioavailability of OTM and faster utilization and fermentation by rumen microorganisms. Heifers that consumed ITM had higher moisture in feces and urine excretion, which increased total manure production ( $P < 0.01$ ). Excretion of TM was not different by treatment. Blood plasma was not different between treatments except for Mn that was higher for OTM. Because mineral intake was reduced and blood mineral levels were not different, these results suggest enhanced absorption of OTM compared with ITM. In conclusion, based on pH, VFA production and plasma TM concentration, OTM may be more ruminally bioavailable and absorbed in a greater extent than ITM. Also, the form of TM affects fecal moisture and urine excretion suggesting that ITM might stimulate water intake.

**Key Words:** trace mineral, starch digestibility, heifer

**331 Small intestinal starch digestion in cattle is linearly increased by duodenal glutamic acid flow.** Ethan J. Blom\*<sup>1</sup>, Derek W. Brake<sup>1</sup>, and David E. Anderson<sup>2</sup>, <sup>1</sup>South Dakota State University, Brookings, SD, <sup>2</sup>University of Tennessee Knoxville, Knoxville, TN.

Postruminal infusion of glutamic acid has been shown to increase small intestinal starch digestion in cattle. Our objective was to determine response among small intestinal starch digestion in cattle provided increasing amounts of postruminal glutamic acid. Five ruminally, duodenally, and ileally cannulated steers ( $351 \pm 11$  kg BW) were fed ( $5.1 \pm 0.06$  kg DM/d) a soybean hull-based diet that contained only slight amounts of starch (0.8% DM) and placed in a  $5 \times 5$  Latin square with 12-d periods. Cattle received (DM basis) continuous duodenal infusion of raw cornstarch ( $1.5 \pm 0.08$  kg/d), and either 0 (control),  $30.9 \pm 0.6$ ,  $62.4 \pm 1.2$ ,  $120.4 \pm 3.4$  g/d glutamic acid or  $407 \pm 18.3$  g/d casein (a positive control). Ileal and fecal nutrient flows were measured during the last 4 d of each period and CrEDTA served as an indigestible marker. Amounts of starch infused did not differ ( $P = 0.46$ ). Casein increased ( $P = 0.05$ ) small intestinal starch digestion. Similarly, small intestinal starch digestion increased linearly ( $P = 0.02$ ) with increasing amounts

of glutamic acid. Ileal flow of ethanol soluble starch tended to decrease (linear = 0.16) with greater amounts of glutamic acid, but ileal flow of ethanol soluble starch was not affected by casein ( $P = 0.42$ ). Ileal flow of glucose was small ( $8.5 \pm 3.0$  g/d); however, greater glutamic acid flow tended (quadratic = 0.08) to decrease ileal glucose flow. Fecal starch flow decreased in response to casein ( $P = 0.01$ ) and glutamic acid (linear = 0.04; cubic = 0.04); however, fecal flow of ethanol soluble starch and glucose were not affected by casein or glutamic acid. Postruminal starch digestion was increased by both casein ( $P = 0.02$ ) and glutamic acid (linear = 0.05; cubic = 0.03). Our data indicate that small intestinal starch digestion is linearly increased by postruminal glutamic acid flow.

**Key Words:** cattle, small intestinal starch digestion, glutamic acid

**332 Protein chemical profile, energy values, protein fractions, and rumen degradation characteristics of the newly developed yellow and brown carinata lines for dairy cattle compared with commercial canola seeds.** Yajing Ban\*, David A. Christensen, John J. McKinnon, and Peiqiang Yu, *Department of Animal and Poultry Science, College of Agricultural and Bioresources, University of Saskatchewan, Saskatoon, SK, Canada.*

*Brassica carinata* (Yellow: AAC A110; Brown: 110915EM) are newly developed oil crop lines for bio-fuel industry. However, there is little research on chemical profile, nutritive value and biodegradation characteristics of seeds as a feed source for animal diets. The objectives of this study were to systematically determine (1) chemical composition, (2) energy values, (3) protein fractions, (4) rumen protein degradation kinetics of the new yellow and brown carinata lines in comparison with brown commercial canola seeds, and to provide detailed information for feed registration in Canada. The 2 carinata lines were bred by Agriculture and Agri-Food Canada, and 2 sources of seeds were combined for each line. Four cannulated lactating dairy cows were used for rumen degradation trial. Protein fractions were partitioned based on Cornell Net Carbohydrate and Protein System (CNCPS). Statistical analyses were performed using PROC MIXED procedure of SAS 9.3 with significance declared at  $P \leq 0.05$ . The results showed that yellow carinata seeds were higher than canola seeds in crude protein, non-protein nitrogen but lower in neutral detergent insoluble crude protein and acid detergent insoluble crude protein ( $P \leq 0.05$ ). Yellow carinata seeds were not significantly different from canola seeds in total digestible nutrient (TDN) and energy values, while brown carinata seeds had the lowest TDN and energy values. Results from CNCPS indicated that yellow carinata seeds were lower in unavailable protein C fraction and higher in true protein ( $P \leq 0.05$ ), while brown carinata seeds had no significant difference with canola seeds in protein subfractions. Yellow carinata seeds had more rumen undegraded feed crude protein (RUP) and effective degradability of feed crude protein (EDCP) than canola seeds. In conclusion, *Brassica carinata* have potential to be utilized as a good feed protein source compared with commercial canola seeds, and the yellow carinata line had a higher protein supply than the brown line.

**Key Words:** carinata seed, protein fractions, rumen degradation

**333 Effect of an increased ruminal ammonia supply on lysine utilization by growing steers.** A. H. Hussein<sup>\*1</sup>, E. D. Batista<sup>1,2</sup>, M. D. Miesner<sup>3</sup>, and E. C. Titgemeyer<sup>1</sup>, <sup>1</sup>*Department of Animal Sciences and Industry, Kansas State University, Manhattan, KS*, <sup>2</sup>*Departamento de Zootecnia, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil*, <sup>3</sup>*Department of Clinical Sciences, Kansas State University, Manhattan, KS*.

Six ruminally cannulated Holstein steers (202 ± 15 kg) were used to study effects of ruminal ammonia loading on whole-body lysine utilization. Steers were housed in metabolism crates and used in a 6 × 6 Latin square design. All steers received 2.52 kg of DM/d of a diet (10.1% CP) containing 82% soybean hulls, 8% wheat straw, and 5% cane molasses, and 10 g/d of urea was ruminally infused continuously to all steers to ensure adequate ruminal ammonia concentrations. All steers were ruminally infused continuously with 200 g/d acetic acid, 200 g/d propionic acid, and 50 g/d of butyric acid and abomasally infused with 300 g/d of glucose continuously to increase energy supply without increasing microbial protein supply. Steers were also abomasally infused continuously with an excess of all essential amino acids except lysine to ensure that lysine was the only limiting amino acid. Treatments were arranged as a 3 × 2 factorial with 3 levels of urea (0, 40, or 80 g/d) continuously infused ruminally to induce ammonia loading and 2 levels of lysine (0 or 6 g/d) continuously infused abomasally. Treatments did not affect fecal N output ( $P \geq 0.37$ ). Lysine supplementation decreased ( $P < 0.01$ ) urinary N excretion from 51.9 g/d to 44.3 g/d (SEM = 1.3), increased ( $P < 0.01$ ) retained N from 24.8 to 33.8 g/d (SEM = 1.2), and tended ( $P = 0.09$ ) to reduce plasma urea. Urea infusions linearly increased retained N (27.1, 29.3, and 31.5 g/d; SEM = 1.5;  $P = 0.05$ ) and also linearly increased ( $P < 0.01$ ) urinary N excretion (31.8, 48.1, and 64.4 g/d; SEM = 1.6), urinary urea-N (21.9, 37.7, and 54.3 g/d; SEM = 1.5), urinary ammonia-N (1.1, 1.4, and 1.9 g/d; SEM = 0.1), and plasma urea (2.7, 4.0, and 5.1 mM; SEM = 0.5). Assuming that retained protein is 6.25 × retained N and contains 6.4% lysine, the incremental efficiencies of infused lysine utilization were 51, 59, and 69% for steers receiving 0, 40, and 80 g/d of urea, respectively, suggesting that ruminal ammonia loads might improve efficiency of lysine utilization; this is supported by the observed increases in whole body protein deposition in response to ammonia loading of our steers that were, by design, lysine deficient.

**Key Words:** ammonia, lysine, cattle

**334 Relationship between antioxidant capacity, oxidative stress, and feed efficiency in beef steers.** J. R. Russell<sup>\*1</sup>, W. J. Sexten<sup>2</sup>, M. S. Kerley<sup>2</sup>, and S. L. Hansen<sup>1</sup>, <sup>1</sup>*Iowa State University, Ames, IA*, <sup>2</sup>*University of Missouri, Columbia, MO*.

The objective was to evaluate the relationship between feed efficiency (FE), antioxidant activity (ANTI) and oxidative stress (OXI) in feedlot steers representing phenotypic extremes for FE. Steers ( $n = 182$ ) were fed a 70 d growing phase (GP) diet of whole shell corn (GCorn) or roughage (GRough) in GrowSafe bunks at University of Missouri, then shipped to Iowa State University where the 12 greatest (HFE) and 12 least (LFE) efficient steers from each diet ( $n = 48$ ; 467 ± 48 kg) were selected for evaluation. Steers received diets similar to GP diets and 3 d after arrival, blood was sampled to evaluate ANTI and OXI markers for GP. Steers were transitioned to finishing phase (FP) corn (FCorn) or byproduct-based diets (FByp) and on FP d 97, blood samples for FP were collected. Data for GP were analyzed as a 2 × 2, and data for FP as a 2x2x2 using PROC MIXED of SAS. Looking at GP diet effects, GRough had greater ( $P = 0.04$ ) GP plasma protein carbonyl concentrations (PC) and a tendency for greater ( $P = 0.06$ ) FP total blood lysate superoxide dismutase activity (SOD) than GCorn. The FByp had

greater ( $P < 0.01$ ) PC during FP than FCorn and no other FP diet effects were noted ( $P > 0.2$ ). Analyzing FE group effects, during GP the HFE had greater ( $P < 0.04$ ) PC and ratio of oxidized:reduced blood lysate glutathione concentrations than LFE. There were GP diet × FE group interactions, as LFE-GRough had greater ( $P \leq 0.03$ ) GP total SOD and greater ( $P \leq 0.05$ ) FP glutathione peroxidase activity (GPX) compared with LFE-GCorn and HFE-GRough; HFE-GCorn was intermediate. During GP, the LFE-GRough had greater ( $P < 0.01$ ) GPX than other treatments and had greater ( $P = 0.03$ ) plasma malondialdehyde concentrations than LFE-GCorn. No GP diet × FP diet, FP diet × FE group, or 3-way interactions were noted ( $P > 0.3$ ). The GP diet and FE groups had stronger relationships with ANTI and OXI markers measured during the GP than the FP. Antioxidant activity may play a role in FE as LFE, driven largely by LFE-GRough, had greater SOD and GPX than HFE, potentially using a greater proportion of energy otherwise utilized for tissue accretion.

**Key Words:** antioxidant, feed efficiency, oxidative stress

**335 Efficiency of lysine utilization by growing steers.** Erick D. Batista<sup>\*1,2</sup>, Ali H. Hussein<sup>1</sup>, Matt Miesner<sup>1</sup>, Edenio Detmann<sup>2</sup>, and Evan C. Titgemeyer<sup>1</sup>, <sup>1</sup>*Kansas State University, Manhattan, KS*, <sup>2</sup>*Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil*.

This study evaluated the efficiency of lysine utilization by growing steers. Five ruminally cannulated Holstein steers (165 kg ± 8 kg) housed in metabolism crates were used in a 6 × 6 Latin square design. Data from a sixth steer was excluded due to erratic feed intake. All steers were limit-fed (2.46 kg DM/d) twice daily diets low in RUP (81% soybean hulls, 8% wheat straw, 6% cane molasses, and 5% vitamins and minerals). Treatments were: 0, 3, 6, 9, 12, and 15 g/d of L-lysine abomasally infused continuously. To prevent amino acids other than lysine from limiting performance, a mixture providing all essential amino acids in excess was continuously infused abomasally. Additional continuous infusions included 10 g urea/d, 200 g acetate/d, 200 g propionate/d, and 50 g butyrate/d to the rumen and 300 g glucose/d to the abomasum. These infusions provided adequate ruminal ammonia and increased energy supply without increasing microbial protein supply. Each 6-d period included 2 d for adaptation and 4 d for total fecal and urinary collections for measuring N balance. Blood was collected on d 6 (10 h after feeding). Plasma urea-N was decreased ( $P = 0.01$ ) by lysine supplementation, but plasma glucose was unaffected ( $P = 0.73$ ). Diet DM digestibility was not altered ( $P = 0.94$ ) by treatment and averaged 72.2%. Increasing lysine supplementation from 0 to 9 g/d decreased urinary N excretion ( $P < 0.01$ ) from 32.3 to 24.3 g/d with no further reduction when more than 9 g/d of lysine was supplied. Changes in total urinary N excretion were due to changes in urinary urea-N, which decreased ( $P < 0.01$ ) from 21.6 to 14.8 g/d as supplemental lysine increased from 0 to 9 g/d. Urinary ammonia-N was not affected by treatment ( $P = 0.48$ ). Increasing lysine supply from 0 to 9 g/d increased ( $P < 0.01$ ) N retention from 20.7 to 29.9 g/d with no further increase observed beyond 9 g/d of lysine. Break-point analysis estimated maximal N retention at 9.0 g/d supplemental lysine. Over the linear response surface of 0 to 9 g/d lysine, assuming that retained protein is 6.25 × retained N and contains 6.4% lysine, the efficiency of lysine utilization for protein deposition was 40%.

**Key Words:** cattle, lysine, efficiency

### 336 Effects of preweaning nutrient supply on growth and pre and post-weaning glucose tolerance test in male Holstein calves.

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Perinatal nutrient supply can affect metabolism of mammals with effects that persist later in life. We hypothesized that pre-weaning calf milk replacer (CMR) supply can alter energy homeostasis in later growth phases. One hundred twenty male Holstein calves ( $20 \pm 3.2$  d old and  $48.4 \pm 2.2$  kg BW) were assigned to a low (LP) or high (HP) plane of nutrition, in a randomized block design with 12 blocks of 2 pens. LP received 25 kg and HP 50 kg of the same CMR (18% fat, 23% protein) for 7 weeks before weaning. Throughout the 12 weeks of experiment, calves were offered ad libitum calf starter and straw. Body weight (BW) was recorded weekly. A glucose tolerance test (GTT) was conducted before (d 42, PW) and after (d 84, AW) weaning in 24 calves (1 calf randomly selected per pen). After a 12h fasting period, glucose was infused at 180 mg/kg of BW through a venous catheter. Blood was collected at -15, -5, 0, 5, 10, 15, 20, 25, 30, 35, 45, 60, and 90 min relative to glucose infusion. Data were analyzed using PROC MIXED in SAS. BW and average daily gain (ADG) were affected ( $P < 0.01$ ) by treatment, week and treatment  $\times$  week interactions. HP calves were heavier from wk 2 leading to a final BW of  $131.3 \pm 1.88$  and  $140.0 \pm 1.88$  for LP and HP at wk 12, respectively. ADG was greater for HP on wk 1 ( $P < 0.01$ ), 2 ( $P < 0.01$ ), 3 ( $P < 0.01$ ), 10 ( $P = 0.05$ ) and 12 ( $P = 0.04$ ) although on wk 7, LP presented a higher ( $P = 0.01$ ) ADG. Consequently, overall ADG was lower ( $P < 0.01$ ) for LP ( $0.969 \pm 0.029$  vs.  $1.089 \pm 0.029$  kg/d). Glucose responses PW or AW did not differ ( $P = 0.78$  and  $P = 0.32$ , respectively) between the treatments. Serum insulin presented no treatment  $\times$  time interactions ( $P = 0.24$  and  $P = 0.06$ , for PW and AW, respectively). In the PW test, insulin did not differ ( $P = 0.89$ ) between treatments. In the AW test, however, plasma insulin was greater ( $P < 0.01$ ) in HP calves 5, 10, 15, 20, 30 35 and 45 min following glucose infusion. Nutrient supply to calves in early life affects post weaning insulin response, supporting the importance of perinatal nutritional stimuli for later life metabolism.

**Key Words:** calf milk replacer, insulin, metabolic programming

**337 Effects of hemp seed oil on serum antioxidant indicators in dairy water buffalo.** Cai-xia Zou\*<sup>1</sup>, Sheng-ju Wei<sup>1</sup>, Dan Wan<sup>1,2</sup>, Xin Liang<sup>1</sup>, Li-Li Li<sup>1</sup>, Bo Lin<sup>1</sup>, Xian-wei Liang<sup>1</sup>, Bing-zhuang Yang<sup>1</sup>, and Zhong-sheng Xia<sup>1,2</sup>, <sup>1</sup>Key Laboratory of Buffalo Genetics, Breeding and Reproduction technology, Ministry of Agriculture and Guangxi, Buffalo Research Institute, Chinese Academy of Agricultural Sciences, Nanning, China., <sup>2</sup>College of Animal Science and Technology, Guangxi University, Nanning, China.

The aim of the present study was to investigate the effects of hemp seed oil supplementation on serum antioxidant indicators in dairy water buffalo. Eighteen dairy water buffaloes were randomly assigned to 3 treatments: (1) 0 g/d hemp seed oil supplement, (2) 100 g/d hemp seed oil supplement, and (3) 200 g/d hemp seed oil supplement. The whole feeding experiment duration was 6 weeks with 2 weeks for adaptation and measurements were made at the end of whole feeding experiment. The results showed that, compared with group 1, hemp seed oil supplementation tended to increase the activity of total antioxidative capacity (T-AOC), glutathione peroxidase (GSH-PX) and catalase (CAT), and group 3 reached significance level ( $P < 0.05$ ). Group 2 resulted in significantly decreased activity of peroxidase (MDA) compared with group 1, while group 3 had no significant effect. On the other hand, no significant differences were found between group 1 and the other treatments in

the activity of peroxidase (POD) and superoxide dismutase (SOD). In conclusion, these results of this study indicated that supplement hemp seed oil would increase the antioxidant capacity of serum and enhance the immune function in organism of dairy water buffalo.

**Key Words:** dairy water buffalo, hemp seed oil, antioxidant indicator

**338 Effects of maternal metabolizable protein supply during late gestation on maternal and fetal intestinal development in sheep.** G. Q. Jia\*, J. S. Caton, K. A. Vonnahme, T. J. Swanson, L. A. Lekatz, P. P. Borowicz, S. T. Dorsam, A. M. Meyer, and L. P. Reynolds, *North Dakota State University, Fargo, ND.*

We hypothesized that metabolizable protein (MP) supply during late gestation would affect maternal and fetal intestinal development in sheep. In Exp. 1, multiparous ewes ( $n = 45$ ) were allotted randomly to 1 of 3 treatments, 60% (MP60), 80% (MP80), or 100% (MP100) of MP requirements fed from d 100 to d 130 of gestation. In Exp. 2, multiparous singleton pregnant ewes ( $n = 18$ ) were randomized to receive 1 of 3 diets that were similar in energy and formulated to supply 60% (MP60), 100% (MP100), or 140% (MP140) of MP requirements during late gestation (d 100 to 130). Pregnant ewes and fetuses were euthanized and necropsied on d  $130 \pm 1$  of gestation, and maternal and fetal intestinal tissues were collected. Data were analyzed with GLM and means separated using PDIF of SAS. In Exp. 1, as previously reported, maternal BW of MP80 was greater ( $P = 0.05$ ) than MP60 and MP100 which were not different, whereas fetal BW was not altered by treatment. Neither maternal nor fetal small intestinal mass or % proliferating jejunal crypt cells (labeling index) were affected by dietary MP supply during late gestation. Fetal large intestinal mass in MP80-fed ewes tended ( $P = 0.08$ ) to be greater than MP60 and MP100 fetuses when examined as a proportion of eviscerated BW. Likewise, in Exp. 2, crypt cell proliferation in fetal jejunal samples was unaltered by maternal MP supply. Thus, maternal MP supply did not affect maternal and fetal intestinal development during late gestation; however, fetal large intestinal weight appeared to be increased when dams were supplied MP80 compared with MP100. Additional research is needed to confirm and extend these results. We hypothesized that metabolizable protein (MP) supply during late gestation would affect maternal and fetal intestinal development in sheep. In Exp. 1, multiparous ewes ( $n = 45$ ) were allotted randomly to 1 of 3 treatments, 60% (MP60), 80% (MP80), or 100% (MP100) of MP requirements fed from d 100 to d 130 of gestation. In Exp. 2, multiparous singleton pregnant ewes ( $n = 18$ ) were randomized to receive 1 of 3 diets that were isocaloric and formulated to supply 60% (MP60), 100% (MP100), or 140% (MP140) of MP requirements during late gestation (d 100 to 130). Pregnant ewes and fetuses were euthanized and necropsied on d  $130 \pm 1$  of gestation, and maternal and fetal intestinal tissues were collected. In Exp. 1, as previously reported, maternal BW of MP80 was greater ( $P = 0.05$ ) than MP60 and MP100 which were not different, whereas fetal BW was not altered by treatment. Neither maternal nor fetal small intestinal mass nor % proliferating jejunal crypt cells (labeling index) were affected by dietary MP supply during late gestation. Fetal large intestinal mass in MP80-fed ewes tended ( $P = 0.08$ ) to be greater than MP60 and MP100 fetuses when examined as a proportion of eviscerated BW. Likewise, in Exp. 2, crypt cell proliferation in fetal jejunal samples was unaltered by maternal MP supply. Thus, maternal MP supply did not affect maternal and fetal intestinal development during late gestation; however, fetal large intestinal weight appeared to be increased when dams were supplied MP80 compared with MP100. Additional research is needed to confirm and extend these results.

**Key Words:** gestation, intestine, metabolizable protein

### 339 Effects of supplementation to steers consuming green chopped wheat pasture on energy losses and nitrogen balance.

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British cross steers (n = 10; initial BW: 206 ± 10.7 kg) were studied using respiration calorimetry chambers to evaluate energy losses, N balance, and nutrient digestibility of greenchop wheat forage as affected by energy supplementation. The study was designed as a 2 × 2 factorial arrangement of treatments. Eight steers were assigned to one of 2 BW blocks (4 steers per block) with factors consisting of either dietary treatment [no supplementation (CON) vs. supplemented with a corn-based energy supplement that contained 150 mg monensin sodium per steer/daily) at 0.5% of BW daily (SUP)] and NE<sub>m</sub> intake level [(1-times (1×) vs. 1.5-times (1.5×) maintenance]. Wheat forage was harvested daily and fed as green chop to steers continuously during the 56-d study. No difference (P ≥ 0.29) was observed between CON and SUP for apparent digestibility of OM (79.6% vs. 79.6%), NDF (68.7% vs. 64.7%), or N (82.2% vs. 80.4%). No difference was observed for DE (2.90 Mcal/kg), heat production (8.54 vs. 8.29 Mcal), or retained energy (4.98 vs. 4.06 Mcal) between dietary treatments when fed at 1.5× maintenance. CON steers had greater (P = 0.01) O<sub>2</sub> consumption (1,790 vs. 1,711 L/d), tended to have (P = 0.06) greater CH<sub>4</sub> production (78 vs. 65 L/d), and had similar CO<sub>2</sub> production (1,704 vs. 1,627 L/d; P = 0.62) compared with SUP. Methane, as a proportion of GE intake, was 6.50% and 6.00%, for CON and SUP, respectively, but was not significantly different (P = 0.60) between treatments. No difference (P = 0.69) was noted in retained energy as a proportion of GE intake (24.8 vs. 23.0%) between treatments. We determined that the CON treatment (wheat forage alone) contained 1.61 Mcal/kg NE<sub>m</sub> and 0.98 Mcal/kg NE<sub>g</sub> and the SUP treatment contained 1.78 Mcal/kg NE<sub>m</sub> and 0.95 Mcal/kg NE<sub>g</sub>. By difference, supplementation improved the calculated NE<sub>m</sub> of wheat forage by 10.6% but decreased NE<sub>g</sub> of wheat forage by 3.1%. Under the conditions of this study, supplementation of wheat forage with a corn-based supplement did not affect losses of energy and resulted in similar NE values.

**Key Words:** methane, net energy, wheat forage

### 340 Supplement and undegradable protein influence on beef calf performance grazing stockpiled tall fescue.

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**ABSTRACT:** Ninety crossbred beef calves (277.7 ± 7.1 kg) were utilized in a completely randomized design to determine supplement and rumen undegraded protein (RUP) influence on calf performance while grazing stockpiled tall fescue. Calves were supplemented at 1.15% of BW DM with dried distillers grains w/solubles (DDGS); 80.7% DDGS, 19.3% AminoPlus (DDG19); 80.7% soybean hulls (SBH), 19.3% AminoPlus (SBH19); 61.7% SBH, 38.3% AminoPlus (SBH38), or unsupplemented control (CON). We hypothesized supplement would increase ADG, and supplements with increased RUP would improve performance. Calves were stratified by BW, source, color, and sex, and then randomly assigned to a pasture. Pasture replicates (n = 15) were fertilized with nitrogen at 24.4 kg/ha on 25 August 2014 and at experiment initiation were blocked by percent endophyte infection. Weekly forage allocations were based on 3.25% BW DM hd<sup>-1</sup>d<sup>-1</sup>. Supplement and forage DM allocations were adjusted every 21 d using interim BW. Forage DM substitution was set at 0.5 times average supplemental DMI. Forage allocations were adjusted to maintain 509 kg DM/ha residual. Proc Glimmix procedure of

SAS was used for ANOVA. Supplement increased (P < 0.01) ADG and final BW compared with CON (0.68 vs. -0.03 kg/d; 336.0 vs. 276.7 kg). ADG did not differ (P > 0.05) between DDG19 and SBH38 (0.78 vs. 0.73 kg/d), however DDG19 increased (P < 0.05) ADG compared with SBH19 (0.62 kg/d) and DDGS (0.59 kg/d). ADG was not different (P > 0.05) between SBH38, SBH19, and DDGS. Forage DM disappearance was not different (P > 0.05) between CON (6.7 kg/d), DDG19 (6.5 kg/d) and SBH38 (6.2 kg/d). SBH19 (5.5 kg/d) forage DM disappearance did not differ (P > 0.05) from DDG19, SBH38 whereas DDGS (4.3 kg/d) decreased (P < 0.01) forage DM disappearance compared with CON, DDG19, and SBH38. DDG19 improved (P < 0.05) supplemental G:F compared with DDGS, (0.23 vs. 0.18 kg/kg). SBH38 (0.22 kg/kg) and SBH19 (0.19 kg/kg) supplemental G:F did not differ (P > 0.05) compared with DDG19 or DDGS. DMI did not differ (P > 0.05) between DDG19 (10.0 kg/d), SBH38 (9.7 kg/d), and SBH19 (8.9 kg/d), and was least for DDGS (7.8 kg/d). Supplementation increased ADG, while additional RUP improved ADG and supplemental G:F.

**Key Words:** supplementation, grazing, DDGS

### 341 Performance and economics of supplementing calves with distillers grains or fertilization of smooth brome grass pastures.

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Ten years of performance data were summarized to evaluate distillers grains supplementation and smooth brome grass fertilization on cattle performance and economics. Each year, 45 steer calves (321 kg, SD = 21 kg) were assigned to 1 of 3 treatments with 3 replications per treatment. Treatments included non-fertilized control pasture (CON), fertilized pasture (89.75 kg N/ha; FERT), or non-fertilized and supplemented with distillers grains plus solubles (DGS) at 0.6% of BW daily for an average of 152 d (SUPP). Cattle on FERT and SUPP were stocked at 9.88 AUM (308 kg of forage)/ha while CON cattle were stocked at 6.82 AUM/ha. Pastures had 5 test animals and put and take animals were used to maintain similar grazing pressure among treatments. Cattle on CON and FERT treatments gained the same through the grazing period (0.77 kg/d; P = 0.67); however, fertilized pastures had greater gain per hectare. Supplemented cattle gained 0.31 kg/d more than FERT or CON (P < 0.01), resulting in 45.4 kg more BW at the end of the grazing season. Utilizing performance data from this 10 year period, 3 corn prices (\$3, \$4, and \$5/25.4 kg) and 3 DGS prices (95, 105, and 115% price of corn) were used in a partial budget to compare profit potential of these treatments. To account for the greater BW of SUPP cattle at the end of grazing, a \$10/45.4 kg price slide was used to calculate SUPP cattle revenue. At all prices, CON cattle were set to breakeven for profit comparisons. Across all scenarios, fertilizer costs were offset by savings in land rent, resulting in a \$16.71/animal profit for FERT relative to CON (P < 0.01). As price of corn increased, profit of SUPP relative to CON decreased; however, SUPP cattle had greater profit than CON and FERT (P < 0.01) at all prices evaluated. For every 10% increase in DGS price relative to corn, SUPP profit decreased \$5.32, \$7.09, and \$8.86 per animal for \$3, \$4, and \$5/25.4 kg corn, respectively. Using an average DGS price of 105% the value of corn, SUPP cattle were \$80.76, \$62.14, and \$43.52/animal more profitable than CON (P < 0.01) at corn prices of \$3, \$4, and \$5/25.4 kg, respectively. In these scenarios, supplementing cattle grazing smooth brome grass pasture with DGS increased ADG and profitability.

**Key Words:** beef cattle, grazing, supplementation