

**M257 Validation of right ruminal artery and vein as models of bovine foregut vasculature.** J. L. Klotz\*<sup>1</sup>, L. P. Bush<sup>2</sup>, and J. R. Strickland<sup>1</sup>, <sup>1</sup>USDA-ARS, FAPRU, Lexington, KY, <sup>2</sup>University of Kentucky, Lexington.

Endophyte-infected (*Neotyphodium coenophialum*) tall fescue (*Lolium arundinaceum*) produces alkaloids that have been associated with peripheral vasoconstriction in grazing animals and ingestion of these alkaloids may effect splanchnic vasculature. Because of significant differences in morphological and functional characteristics between vasculature supporting digestive and peripheral tissues, the implementation of a bovine foregut vascular model required validation. Experiments were conducted, using dose-responses to norepinephrine (NE) and serotonin (5HT), to evaluate the responses of vessels equilibrated at different tensions and determination of a reference compound. Segments of a branch of right ruminal artery and vein were collected from the ventral coronary groove of healthy mixed breed and gender cattle (n=7) at local abattoirs. Tissues were placed in Krebs-Henseleit buffer and kept on ice until they were trimmed of excess fat and connective tissue, sliced into 2-3 mm sections and suspended on luminal supports in a chamber of a multi-myograph containing continuously oxygenated Krebs-Henseleit buffer (95% O<sub>2</sub>/5% CO<sub>2</sub>; pH=7.4; 37°C). Vessels were allowed to equilibrate at either 0.5 or 1.0 g of tension for 1.5 h prior to additions of either NE or 5HT. Increasing doses of each compound were administered in 15-min intervals following buffer replacement. Data were normalized as a percent of contractile response induced by the maximal dose (1×10<sup>-4</sup> M) of NE or 5HT for each tension. Ruminal artery and vein both contracted in a dose-dependent manner (P<0.05) to both NE and 5HT treatments. Tension did not affect contractile response of the vein, but 0.5 g tension resulted in a greater arterial response (P<0.05) than 1.0 g. Contractile response to NE was greater than 5HT for both the artery and the vein (P<0.05). These results enable future experiments to separate the effects tall fescue alkaloids have on both the right ruminal artery and vein as representative vessels that support tissues functioning in nutrient absorption.

**Key Words:** bovine, ruminal artery and vein, tall fescue

**M258 Effects of a commercial product containing *Morinda citrifolia* extract on growth performance and health of calves with a high risk of developing bovine respiratory disease.** M. S. Brown\*<sup>1</sup>, R. Godbee<sup>2</sup>, B. Coufal<sup>1</sup>, C. L. Maxwell<sup>1</sup>, J. O. Wallace<sup>1</sup>, and C. H. Ponce<sup>1</sup>, <sup>1</sup>Feedlot Research Group, West Texas A&M University, Canyon, <sup>2</sup>Morinda Agriculture, Provo, UT.

Continuing development of technologies to improve health and performance of high-risk calves are needed to improve beef production efficiency. Crossbred male calves (n = 139, initial weight = 222 kg) were purchased at auction barns in the Southeast US and used in a 45-day pilot receiving study to evaluate the influence of a product containing *Morinda citrifolia* extract (MorindaMax, Morinda Agriculture, Provo, UT) on growth performance and health. Treatments included a basal 65% concentrate diet based on steam-flaked corn that was supplemented with a top dress of 0 or 0.55 g of MorindaMax/kg of BW from days 1 through 10 and days 28 through 32. Calves were processed on arrival, including metaphylaxis with ceftiofur crystalline free acid and castration by knife (91% bulls on arrival), and randomized to pens (5 pens/treatment, 13 to 14 cattle/pen). Calves fed *Morinda citrifolia* extract consumed more feed (P = 0.01; 10.2%) and gained weight more rapidly (P = 0.09; 22.9%) during the first 28 d than calves fed the control treatment, but feed efficiency did not differ (P = 0.32). The improvement in performance was associated with a tendency (P = 0.14) for fewer calves to be treated for respiratory disease during the first 28 d (20.5% and 10.0% for 0 and 0.55 g/kg). Overall DMI was also greater (P = 0.03; 6.1%) for calves fed *Morinda citrifolia* extract than for calves fed the control treatment. However, overall ADG and feed efficiency were not influenced by treatment (P > 0.31). Over the entire trial, the number of calves treated once and the total number treated for respiratory disease did not differ (P > 0.66) among treatments. Feeding *Morinda citrifolia* extract tended (P = 0.17) to reduce mortality over the entire trial (7.4% and 1.4% for 0 and 0.55 g/kg), perhaps due to the numeric reduction in the number of cattle retreated for respiratory disease during the first 28 d. *Morinda citrifolia* extract fed at 0.55 g/kg of BW for days 1 through 10 and days 28 through 32 increased feed intake and tended to reduce death loss in high-risk calves.

**Key Words:** morbidity, growth performance, plant extract

## Ruminant Nutrition: By-product Feeds

**M259 Nature of fermentation in stored wet distillers grains.** A. R. Geis\*, P. J. Kononoff, A. M. Gehman, and C. S. Heine, *University of Nebraska, Lincoln.*

Wet distillers grains are commonly stored in polyethylene silo bags until needed for feeding. The preservation of this feed is different from traditional methods of forage preservation through ensiling because the amount of fermentable carbohydrate is limited. The objective of this experiment was to evaluate the nature of ensiling wet distillers grains (WDGS) alone or in combination with other feeds. A 3 x 3 x 4 factorial experiment was conducted in which three loads of distillers grains were co-ensiled with three feeds (corn silage, ground corn, and brome hay) at four levels (0, 50, 75, 100% DM). Approximately 2.4 L of each mix was vacuum-sealed in plastic bags measuring 35 x 40cm. Following a 60-d storage period, a water extraction was used to determine pH, lactic acid, butyrate, and ammonia levels as potential indicators of fermentation. The addition of feeds to WDGS increased (P < 0.01) the pH of stored material. Specifically, when mixed with WDGS at 0, 50, 75 and 100% DM, the pH of corn was 3.78, 4.58, 4.99, 6.29 ± 0.19, 3.86, 4.0, 4.31, 6.42 ± 0.19 for hay, and 3.80, 3.75, 3.93, 4.13 ± 0.19 for corn silage.

Small but significant (P < 0.01) reductions in both butyrate and ammonia were observed when the proportion of ground corn and hay increased. As corn inclusion increased, butyrate decreased from 0.62 to 0.05 ± 0.12% DM and ammonia decreased from 0.15 to 0.002 ± 0.03% DM. As hay inclusion increased, butyrate was reduced from 0.58 to 0.07 ± 0.12% DM and ammonia was reduced from 0.14 to 0.008 ± 0.03% DM. Mixes with corn silage resulted in a reduction (P < 0.01) in butyrate from 0.6 to 0.14 ± 0.12% DM when the percent of silage increased. The addition of corn silage did not decrease ammonia, which averaged 0.20 ± 0.03% DM across levels. These results suggest the low pH of WDGS limits fermentation activity in stored WDGS, but the inclusion of other feeds increases pH. In addition, the low pH, butyrate, and ammonia suggest fermentation by clostridia was limited.

**Key Words:** wet distillers grains, fermentation, pH

**M260 The effect of ensilage storage duration and proportion of wet distillers grains and straw on in situ dry matter disappearance.** K.

L. Neuhold\*, J. J. Wagner, T. E. Engle, S. L. Archibeque, and K. S. Sellins, *Colorado State University, Fort Collins.*

The objective of this study was to investigate the effect of the proportion of wet distillers grains (WDG) and wheat straw (WS) and ensilage storage duration on in situ DM disappearance. WDG and WS were mixed at five different ratios of WDG to WS 100:00, 90:10, 80:20, 70:30, and 0:100. The three combination treatments were packed into experimental silos. Silos were made out of PVC pipe (3.8 cm x 15.0 cm) capped on one end and sealed with a removable rubber cap on the other end. Mixtures were ensiled for 0, 4, 8, 12, and 24 d. Samples were prepared for in situ evaluation by drying the entire silo contents for each time point for 48 hr at 60°C and then grinding the sample through a 2 mm screen. A mass to area ratio of 10 mg sample/cm<sup>2</sup> was utilized for each in situ bag. Bags were incubated in two fistulated steers for 0, 4, 8, 12, 24, 48, and 72 h. Steers were fed a high concentrate diet (70% steam flaked corn) for 21 d, then in situ fermentation was initiated. After the 72 h time point, steers were switched to a high roughage diet (50% corn silage and 50% alfalfa) for 21 d and then in situ fermentation was initiated. After the 72 h incubation, in situ bags were washed, dried for 48 hr at 60°C, and DM disappearance calculated. Polynomial curves were generated over incubation time within each ensiling time by diet. The area under each curve was calculated and analyzed using the Proc Mix procedure of SAS. Days ensiled had no impact on DM disappearance. The straw to WDG ratio was a significant ( $P < 0.0001$ ) source of variation for DM disappearance. One hundred percent WDG had the greatest disappearance, followed by 90:10, 80:20, 70:30, and WS (56.17, 46.92, 42.07, 36.07, 27.12%, LSM respectively). Diet (high concentrate or high roughage diet) was also a significant ( $P < 0.0001$ ) source of variation for DM disappearance (36.7 and 46.9% LSM, respectively). Samples across all time points had greater DM disappearance when incubated in steers consuming a high roughage diet compared to steers consuming a high concentrate diet. Using WS to facilitate storage of WDG did not improve in situ disappearance of WS.

**Key Words:** wet distillers grain, wheat straw, storage

**M261 In situ ruminal protein degradation of whole corn or corn endosperm distiller grains.** W. Z. Yang\*<sup>1</sup>, L. E. Armentano<sup>2</sup>, and Y. L. Li<sup>1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada,* <sup>2</sup>*University of Wisconsin, Madison.*

The grain-based ethanol industry is heading toward a fractionation process by physically separating dry shelled corn into a high fiber bran, germ and endosperm prior to fermentation of endosperm. This process increases fermentation efficiency and market opportunities for by-products. However, ruminal protein degradability of distiller grains (DG) derived from the fractionation process would be different from that of the traditional dry-grind process because the fractions of bran and germ are not subjected to the fermentation. The objective was to determine in situ ruminal protein degradability of traditional and fractional DG. Eight samples with 6 traditional DG with solubles (TraDGS), 1 fractional with solubles (endosperm DGS) and 1 fractional without solubles (endosperm DG) were tested. Five grams of ground (2-mm) sample were incubated in situ in the rumen of 3 lactating dairy cows for 0, 2, 4, 8, 13, 18, 24 and 48 hours. The model  $y = a + b(1 - e^{-kd(t-t_0)})$  was fitted to determine the kinetics of protein degradation, where  $y$  is protein degraded,  $a$  is soluble fraction,  $b$  is slowly degradable fraction,  $kd$  is degradation rate constant,  $t$  is incubation time, and  $t_0$  is lag time. Protein content of endosperm DGS (52%) and endosperm DG (51%) was higher ( $P < 0.01$ ) than that of TraDGS (32%). The soluble fraction and degradation rate constant ( $a$ ,  $kd$ ) were the highest for endosperm

DGS (25%, 5.1%/h), the lowest for endosperm DG (2%, 1.6%/h) and the medium for TraDGS (12%, 2.9%/h). However, the slowly degradable fraction was higher ( $P < 0.01$ ) for endosperm DG (95%) than for TraDGS (74%) and endosperm DGS (72%). Thus, as observed for  $a$  and  $kd$ , effective degradability of protein was the highest for endosperm DGS (56%), the lowest for endosperm DG (22%) and the medium for TraDGS (33%). The results indicate that protein content and ruminal degradability of DG vary considerably with milling process and whether the soluble fraction is included in the endosperm DG products.

**Key Words:** distiller grain, protein degradability, dairy cow

**M262 In situ ruminal degradability and intestinal digestibility of protein in soybean and dried distillers grains with solubles products.** K. Mjoun\*, K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings.*

New fractionation and fermentation technologies in the ethanol industry have resulted in the production of different distillers grains with solubles (DGS). Such products are low fat, high protein, and modified wet DGS. Characterization of the protein fractions of these coproducts is important for formulation of these feedstuffs in dairy cattle diets. In situ and in vitro techniques were conducted to estimate protein availability in four soybean feedstuffs, solvent-extracted soybean meal (SBM), expeller soybean meal (ESBM), extruded soybeans (ES), and soyhulls (SH), and four DGS, regular dried DGS (rDGS), de-oiled dried DGS (dDGS), high protein dried DGS (HPDGS), and modified wet DGS (mWDG). Nylon bags containing 5g of each feed were incubated in the rumen of three cannulated lactating cows for 2, 4, 8, 12, 18, 24, and 48 h. The rapidly degradable CP fraction (A) varied from 8.1 and 36.3%, respectively for SBM and mWDG. The slowly degradable CP fraction (B) was highest for SBM, ES, HPDGS (88.0 ± 3.7%), followed by ESBM, rDGS, and dDGS (76.8 ± 4.1%), SH and mWDG had the lowest B fraction (63.8%). The rate of degradation of B fraction,  $K_d$  (%/h) ranged from 11.8 for SBM to 2.7 for dDGS. Rumen undegradable protein (RUP) varied widely (32.2-60.4%) with dDGS having the highest and SBM having the lowest. Intestinal digestible protein (IDP) was estimated by pepsin-pancreatin digestion of rumen preincubated (16h) samples. The IDP was highest for soybean products (97.7 ± 0.75) with the exception of SH while DGS products were 92.0 ± 0.5%. Similarly total digestible protein (TDP) was highest (99%) for soybean products while DGS grains products had a TDP of 96%. These results suggest that the protein availability in DGS products is relatively comparable to soybean products.

**Table 1.**

Item/ Feed	SBM	ESBM	ES	SH	rDGS	dDGS	HPDGS	mWDG	SEM
A, %	8.1 <sup>e</sup>	11.4 <sup>d</sup>	12.6 <sup>d</sup>	27.1 <sup>b</sup>	18.4 <sup>c</sup>	17.2 <sup>c</sup>	11.1 <sup>d</sup>	36.3 <sup>a</sup>	0.92
B, %	91.9 <sup>a</sup>	81.5 <sup>bc</sup>	87.4 <sup>ab</sup>	64.1 <sup>d</sup>	75.2 <sup>c</sup>	73.7 <sup>c</sup>	84.6 <sup>ab</sup>	63.6 <sup>d</sup>	3.80
C, %	0.0	7.1	0.0	8.9	6.4	9.0	4.2	0.0	3.52
$K_d$ , %/h	11.8 <sup>a</sup>	7.5 <sup>cd</sup>	5.3 <sup>bc</sup>	7.5 <sup>b</sup>	3.9 <sup>cd</sup>	2.7 <sup>d</sup>	4.3 <sup>cd</sup>	3.8 <sup>cd</sup>	0.9
RUP, %	32.2 <sup>e</sup>	53.7 <sup>b</sup>	48.0 <sup>c</sup>	38.0 <sup>d</sup>	52.3 <sup>b</sup>	60.4 <sup>a</sup>	54.5 <sup>b</sup>	39.4 <sup>d</sup>	2.48
IDP, %	97.0 <sup>a</sup>	98.5 <sup>a</sup>	97.7 <sup>a</sup>	42.3 <sup>d</sup>	92.4 <sup>bc</sup>	91.4 <sup>c</sup>	93.5 <sup>b</sup>	92.1 <sup>bc</sup>	0.53
TDP, %	99.0 <sup>a</sup>	99.2 <sup>a</sup>	98.9 <sup>a</sup>	78.0 <sup>d</sup>	96.0 <sup>bc</sup>	94.8 <sup>c</sup>	96.5 <sup>b</sup>	96.9 <sup>b</sup>	0.44

<sup>a-e</sup>Means in rows with different superscripts differ ( $P < 0.05$ ).

**Key Words:** crude protein, rumen, intestine

**M263 Effects of feeding different combinations of stored wet corn distillers grains plus soluble (WDGS) on performance of lactating dairy cows.** H. A. Ramirez Ramirez\*, P. J. Kononoff, and A. M. Gehman, *University of Nebraska Lincoln, Lincoln.*

The objectives of this experiment were to evaluate the effects of feeding wet distillers grains plus solubles (WDGS) on milk production and also to investigate the potential of storing WDGS mixed with other feeds. Twenty Holstein cows (8 primiparous and 12 multiparous) averaging (mean  $\pm$  SD)  $620 \pm 61$  kg BW and  $103 \pm 13$  DIM were used in a 4 X 5 Latin rectangle. Prior to initiation of the study WDGS were stored alone or co-ensiled with either 12% ground corn (DM basis), 15% brome hay (DM basis) or 15% corn silage (DM basis) in polyethylene silo bags. Animals were assigned to one of five treatments during each 21-d period. A diet not containing WDGS was formulated (CONT), along with one containing 30% WDGS (DM basis) (WDGS). Three additional diets, similar to the WDGS treatment, were formulated to include one of the three co-ensiled blends. These diets were WDGS+C, WDGS+H, WDGS+S for WDGS co-ensiled with corn, brome hay and corn silage respectively. Dry matter intake (DMI) was affected by diet ( $P < 0.01$ ) and compared to CONT was greater for WDGS ( $23.5 \pm 0.70$  kg) and WDGS+C ( $24.2 \pm 0.70$  kg). Compared to CONT DMI was not different when cows consumed WDGS+H and WDGS+S. Milk yield, 3.5% FCM, and fat yield were not affected by treatment, averaging  $27.9 \pm 0.91$  kg/d,  $29.0 \pm 1.03$  kg/d, and  $1.03 \pm 0.04$  kg/d across treatments. The percentage of milk protein was affected ( $P = 0.03$ ) and yield of protein tended to ( $P = 0.12$ ) be affected by dietary treatment; compared to CONT milk protein percent was higher for cows consuming WDGS and WDGS+C (2.96, 3.01, and  $3.03 \pm 0.06\%$  for CONT, WDGS and WDGS+C respectively). Similarly, compared to CONT milk protein yield was higher for animals consuming WDGS and WDGS+C (0.83, 0.87, and  $0.89 \pm 0.03$  kg/d for CONT, WDGS and WDGS+C). Compared to CONT milk urea N increased ( $P = 0.04$ ) when the diets included WDGS (14.4, 15.3, 15.5, 15.8 and  $15.5 \pm 0.42$  mg/dL for CONT, WDGS, WDGS+C and WDGS+S). These results suggest that dairy rations can be formulated to include stored WDGS at 30% DM without negative effects on milk production and composition.

**Key Words:** wet distillers grains plus solubles, feed storage, dairy cow

**M264 The effect of feeding dried distillers grains plus solubles on the performance of Chinese Holstein cows.** Z. Yan, J. Wang\*, D. Bu, M. Wang, and H. Wei, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The objective of this study was to evaluate the effects of dried distillers grains with solubles (DDGS) on the lactational performance of Chinese Holstein cows. 48 multiparous Chinese Holstein cows average  $99 \pm 58.56$  d in milk were randomly assigned to one of 4 treatments. During the 8-wk periods, cows were fed total mixed diets containing 20.9% soybean meal (control), 11.8% soybean meal and 14.1% DDGS (DDGS1), 4.8% soybean meal and 26.4% DDGS (DDGS2), or 36.9% DDGS (DDGS3) as the major protein source. All diets had a 55:45 forage-to-concentrate ratio, and were formulated to be isonitrogenous at 15.15% CP. Results showed that dry matter intake did not differ among control, DDGS1 and DDGS2 (16.54, 16.47 and 16.54 kg/d), but was lower for DDGS3 (16.27 kg/d). Milk yield (16.36, 16.45, 16.83 and 16.67 kg/d) tended to increase linearly when DDGS replaced soybean meal and corn until when the percentage of DDGS reached 36.7% DM. Milk SNF, TS, Fat and protein percentages decreased for DDGS3 compared with other groups, but only the percentage of milk SNF and

protein reached significant level. Milk fat yield was higher for DDGS2 and DDGS3 compared with control and DDGS1. Milk protein yield were lower for DDGS1, DDGS2 and DDGS3 compared with control. The percentage of milk lactose was higher for DDGS1 compared with the other three treatments, whereas the milk lactose yields of DDGS2 and DDGS3 were higher than control and DDGS1. Results of this study showed that maximum economic payback could be obtained when the dairy ration was formulated to contain about 26% DDGS (DM basis).

**Key Words:** dried distillers grains with solubles (DDGS), performance, Chinese Holstein cow

**M265 The effects of replacing barley silage or barley grain with dried distillers grains plus solubles on productivity of lactating dairy cows.** S. Z. Zhang\*, G. B. Penner, and M. Oba, *University of Alberta, Edmonton, AB, Canada.*

The objective of this study was to determine the effects of partially replacing barley silage or barley grain with dried distillers grain plus soluble (DDGS) on dry matter intake (DMI), chewing activity, rumen fermentation, and milk yield and composition. Six ruminally cannulated lactating Holstein cows (160  $\pm$  97 days in milk) were used in a replicated 3x3 Latin square design with 21-d periods. Cows were fed a control diet (CON: 45% barley silage, 5% alfalfa hay, and 50% concentrate mix), a low forage (LF) diet or a low grain (LG) diet in which barley silage or barley grain was replaced by DDGS at 20% of dietary DM, respectively. All diets were formulated to contain 18% crude protein by partially replacing beet pulp in the LF and LG with canola meal, corn gluten meal and urea in the CON. Compared to the CON, feeding the LG diet did not affect any response variables measured in this study. The LF diet had higher DMI (26.0 vs. 22.4 kg/d,  $P = 0.004$ ) than CON, but no difference in the passage rates of solid and liquid, averaging at 2.94 and 22.8%/h. The LF diet increased milk yield (36.4 vs. 33.0 kg/d,  $P = 0.03$ ), and milk protein yield (1.18 vs. 1.05 kg/d,  $P = 0.01$ ) without affecting milk fat yield (1.14 vs. 1.14 kg/d,  $P = 0.23$ ). Chewing time was decreased with the LF diet (29.7 vs. 39.1 min/kg DMI,  $P = 0.01$ ), which was likely due to reduced intake of large particles (particles retained on 19- or 8-mm screens of the Penn State Particle Separator) compared to cows fed the CON diet (2.70 vs. 3.61 kg/d,  $P = 0.0001$ ). However, mean ruminal pH was not decreased and the duration that ruminal pH below 5.8 was not increased by feeding the LF diet, averaging at 6.19 and 258 min/d, respectively. These results indicate that DDGS can be effectively used as a partial replacement of barley grain without negatively affecting milk production, and that partial replacement of barley silage with DDGS can increase DMI and milk yield without affecting milk fat production providing ruminal pH is not depressed.

**Key Words:** barley silage, barley grain, DDGS

**M266 In vitro intestinal digestion of ruminal undegraded protein of distiller grain.** Y. L. Li\*<sup>1</sup>, W. Z. Yang<sup>1</sup>, and L. E. Armentano<sup>2</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Research Center, Lethbridge, AB, Canada,* <sup>2</sup>*University of Wisconsin, Madison.*

Corn-based distiller grains (DG) from ethanol plant are derived either from fermentation of whole kernel (traditional) or only endosperm (fractional). The objective of this study was to investigate whether intestinal digestibility of ruminal undegraded protein (RUP) varies with source of DG and duration of incubation in the rumen. Eleven samples with 7 traditional DG with solubles (TraDGS), 1 fractional DG with solubles (endosperm DGS), 2 fractional DG without solubles (endosperm DG) and 1 mixture of bran and syrup (MBS) were tested using the original

three-step in vitro procedure. The 7 TraDGS were collected from 4 plants; the endosperm DGS was from 5<sup>th</sup> plant; and endosperm DG and MBS were from 6<sup>th</sup> plant. Rumen residues were produced by incubating nylon bags in the rumen of three lactating dairy cows for 8 h, 13 h and 18 h. The bag residues were pooled by animal and by ruminal incubation time. Samples were exposed to a shaking incubator and a pepsin (1 hr, 38°C, pH=1.9)-pancreatin (24 hr, 38°C, pH=7.8) enzymatic solutions to mimic digestion in the small intestine. There was no interaction ( $P>0.05$ ) of DG with ruminal incubation time. The ruminal incubation time did not affect in vitro intestinal digestibility of RUP which was 80%, 81% and 81% for 8 h, 13 h and 18 h, respectively. The RUP digestibility of TraDGS from the 1<sup>st</sup> plant (86%) was similar to that of the 2<sup>nd</sup> plant (83%), but was higher ( $P<0.05$ ) than that from the 3<sup>rd</sup> (79% and 81%) and the 4<sup>th</sup> plant (76% and 77%). The RUP digestibilities of endosperm DGS (84%) and endosperm DG (84%) were the same, but different ( $P<0.05$ ) from that of TraDGS from the 4<sup>th</sup> plant. The lowest digestibility of RUP was observed for the MBS (66%) due to likely the low digestion of corn bran. The results indicate that RUP digestibility of DG is variable depending on source of sample (i.e., plant) rather than the kernel processing prior to ethanol fermentation. In addition, ruminal retention time between 8 h and 18 h have little effect on measurement of the intestinal digestibility of RUP.

**Key Words:** distiller grains, intestinal digestion, in vitro

**M267 Effects of diets containing elevated levels of modified wet corn distillers grains with solubles (DGS) on performance and carcass characteristics of beef steers.** J. M. Carmack<sup>\*1</sup>, P. M. Walker<sup>1</sup>, R. L. Atkinson<sup>2</sup>, S. W. Reader<sup>2</sup>, and B. R. Wiegand<sup>3</sup>, <sup>1</sup>*Department of Agriculture, Illinois State University, Normal*, <sup>2</sup>*Animal Science, Food and Nutrition, Southern Illinois University, Carbondale*, <sup>3</sup>*Division of Animal Science, University of Missouri, Columbia*.

Little data is available regarding the effects of DGS inclusion rates above 50% in feedlot diets. The objectives of this study were to: 1) determine the effects of diets containing 70% DGS on feedlot performance and carcass characteristics of beef steers, 2) compare isocaloric and isonitrogenous diets to diets containing 40% DGS to clarify DGS effects as protein or energy. The treatments (DM %) were: 80 shelled corn/5 soybean meal/15 corn silage (CON), 40 DGS/45 shelled corn/15 corn silage (40 DGS), 40 DGS fed 56 d switched to 70 DGS/15 shelled corn/15 corn silage (40-70), 70 DGS/15 shelled corn/15 corn silage fed 56 d switched to 40 DGS (70-40), CON + soybean meal iso-nitrogenous to 40 DGS (N40) and CON + corn oil isocaloric to 40 DGS (E40). Angus cross steers ( $n=208$ ;  $425 \pm 5.0$  kg BW) were stratified by weight to 32 pens, with unequal replication. Three steers in each pen were harvested on d 106 when estimated low choice or higher quality grade. All remaining steers were harvested on d 142 when 80% were estimated low choice or higher quality grade. Significant differences were observed: N40 steers had lower harvest wt and DMI, and CON and E40 steers had higher G:F. No significant differences in carcass wt, ribeye area, marbling score, yield grade and KPH % were observed. Liver abscess scores were higher ( $p=0.05$ ) for CON than 40 DGS, 70-40 and N40. No significant differences in rib fat thickness were observed between CON, 40-70 and E40 but 40 DGS and 70-40 had less ( $p=0.02$ ) rib fat than CON, 40-70 and E40 while 40 DGS and N40 were similar ( $p=0.08$ ). The results of this study suggest DGS can be included in feedlot diets up to 70% of DMI and the energy contribution of DGS may have more impact than the protein contribution.

**Key Words:** carcass characteristics, feedlot performance, elevated levels of wet distillers grains

**M268 Effects of high levels of distillers grains and composition of distillers grains on performance and carcass characteristics in steers.** J. M. Carmack<sup>\*1</sup>, P. M. Walker<sup>1</sup>, R. L. Atkinson<sup>2</sup>, S. W. Reader<sup>2</sup>, and B. R. Wiegand<sup>3</sup>, <sup>1</sup>*Department of Agriculture, Illinois State University, Normal*, <sup>2</sup>*Animal Science, Food and Nutrition, Southern Illinois University, Carbondale*, <sup>3</sup>*Division of Animal Science, University of Missouri, Columbia*.

Few studies have been conducted comparing modified wet corn distillers with solubles (DGS) and dried distillers grains with solubles (DDGS) on feedlot performance and carcass characteristics when fed at greater than 50% of diet DM. Data of two companion studies were pooled and analyzed as one study. Dietary treatment pen and their interactions were independent variables. Steer performance data were dependent variables. The objective of the studies were to: 1) determine the effects of diets containing 70% DGS or DDGS on feedlot performance and carcass characteristics of beef steers, 2) compare isocaloric and isonitrogenous diets to diets containing 40% DGS or DDGS to evaluate protein and energy effects of distillers grains. The dietary treatments (DM%) were: 80 shelled corn/5 soybean/15 corn silage (CON), 40 DGS or DDGS/45 shelled corn/15 corn silage (40), 40 fed in tandem with 70 DGS or DDGS/15 shelled corn/15 corn silage (40-70), 70 DGS or DDGS/15 shelled corn/15 corn silage fed in tandem with 40 (70-40), CON + soybean meal isonitrogenous to 40 (N40) and CON + corn oil isocaloric to 40 (E40). Harvest weights were lower ( $p=0.001$ ) for N40 steers compared to 40 and compared to all other treatments ( $p=0.02$ ). No differences ( $p=0.22$ ) in ADG were observed between treatments. Steers fed CON and E40 had greater ( $p=0.01$ ) G:F compared to 40-70 and 70-40 but were similar to 40 and N40. No significant differences in carcass measurements between treatments were observed but CON, N40 and E40 tended to result in greater rib fat ( $p=0.06$ ) and higher yield grades ( $p=0.08$ ) than DGS/DDGS. Analyses of these data found little difference in performance for steers fed either wet or dry distillers grains and similar performance for steers fed up to 70% distillers grains.

**Key Words:** high levels distillers grains, steer performance

**M269 Effect of varying ratios of corn to wheat grain in ethanol production on fermentation of ethanol by-product in batch culture.** W. Z. Yang<sup>\*1</sup>, J. J. Mckinnon<sup>2</sup>, T. A. McAllister<sup>1</sup>, K. A. Beauchemin<sup>1</sup>, and D. J. Gibb<sup>1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*, <sup>2</sup>*University of Saskatchewan, Saskatoon, SK, Canada*.

The blend of corn and wheat with variable ratios of both grains are often used to be cost effective for ethanol production in western Canada. Feed value may be different between corn- and wheat-based dried distiller grains with solubles (DDGS) derived from ethanol production. The objective of this study was to determine the effects of the ratio of corn to wheat in the blend grain on nutrient composition and fermentation characteristics of DDGS. Forty-one DDGS samples varied with ratio of corn to wheat (corn:wheat; 100:0, 70:30, 30:70 or 0:100) were measured in batch culture during 0, 4, 8, 14, 24 and 48 h of incubation. The mean content of OM (95%), NDF (33%) and ADF (11%) were similar among the 4 categories samples. However, variation of individual sample within category could be large and ranged from 28 to 41% for NDF, and 8 to 14% for ADF. Concentrations of total VFA (117 to 127 mM), acetate (65 to 69 mM) and propionate (23 to 26 mM) at 24 h of incubation were not affected ( $P>0.05$ ) by the ratio of corn to wheat, whereas, variation of individual samples was substantial and ranged from 91 to 160 mM for total VFA. Dry matter disappearance (DMD) linearly ( $P<0.01$ ) increased from 20 to 54% with increasing incubation time from 0 to 48 h without having reached a plateau. Mean DMD (average of 0 to 48h)

were similar with values of 37, 40, 38 and 38% for the 100:0, 70:30, 30:70 or 0:100 of corn to wheat DDGS, respectively. The NDF content of original DDGS was moderately correlated ( $r=0.53$ ,  $P < 0.01$ ) with fermentation pH, but was not correlated with DMD. The results indicate that the ratio of corn to wheat in the blend of grain had minimal effects on fiber content, fermentation and DMD of DDGS in batch culture. However, nutrient content and digestibility of individual DDGS sample could vary substantially and thus need to be individually considered for formulating ration.

**Key Words:** distiller grain, fermentation, batch culture

**M270 Effects of feeding glycerol on fermentation kinetics of alfalfa hay.** N. A. Krueger<sup>\*1</sup>, R. C. Anderson<sup>1</sup>, L. O. Tedeschi<sup>2</sup>, W. K. Krueger<sup>2</sup>, and D. J. Nisbet<sup>1</sup>, <sup>1</sup>USDA-ARS-Food Feed Safety Research Unit, College Station, TX, <sup>2</sup>Texas A&M University, College Station.

This study aimed to determine the effect of feeding various levels of glycerol on neutral detergent fiber (NDF) digestibility and volatile fatty acid (VFA) profile using the in vitro gas production technique. This experiment was set up as a completely randomized design with 5 treatment (TRT) levels of glycerol (0, 5, 10, 20, 40% as fed) and 4 replicates (125 ml Wheaton bottles). Each bottle received 0.2 g of substrate, which consisted of ground (2 mm) alfalfa hay plus glycerol. Substrates were inoculated with rumen fluid, from a ruminally cannulated cow consuming bermudagrass hay, and incubated for 48 h. Gas production was measured using a computerized gas monitoring apparatus. A logistic 2-pool model was used to fit the gas production. Treatment differences were analyzed using the PROC GLIMMIX of SAS. Orthogonal contrasts were used to evaluate the effects of glycerol levels on the parameters. Gas fermentation in the first (fast) pool (glycerol fraction) increased linearly ( $P < 0.001$ ; from 8.87 to  $18.4 \pm 0.81$  ml) as the amount of glycerol increased. Additionally, higher levels of glycerol resulted in a quadratic decrease ( $P = 0.012$ ; from 0.18 to  $0.12 \pm 0.02$  1/h) of the first pool fractional rate of fermentation (kd). Even though gas production in the second (slow) pool (NDF fraction) decreased quadratically ( $P = 0.009$ ; from 9.03 to  $4.27 \pm 0.46$  ml), there was no clear relationship when glycerol levels were between 0 and 20%. Glycerol consistently decreased (from 0.06 to  $0.03 \pm 0.004$  1/h) the kd in a linear fashion ( $P = 0.002$ ). The NDF digestibility did not differ ( $P = 0.53$ ) among TRT which is consistent with the lack of change in gas production in the fiber fraction for glycerol levels up to 20%. Increasing amounts of glycerol had a linear effect on acetate ( $P = 0.002$ ) and quadratic effect on propionate ( $P = 0.011$ ) concentrations as well as a quadratic effect on the acetate to propionate ratio ( $P < 0.0001$ ) but did not affect butyrate ( $P = 0.06$ ) and iso-butyrate ( $P = 0.32$ ) concentrations. These results indicated that glycerol supplementation greater than 20% may negatively affect fiber digestion and alter the VFA profile.

**Key Words:** glycerol, ruminant, digestion

**M271 Performance of post-weaned Holstein heifer calves fed grain mixes with glycerol as an energy source.** G. Golombeski<sup>\*1</sup>, M. Raeth-Knight<sup>1</sup>, B. Ziegler<sup>2</sup>, R. Larson<sup>2</sup>, D. Ziegler<sup>3</sup>, H. Chester-Jones<sup>3</sup>, and J. Linn<sup>1</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>Hubbard Feeds, Mankato, MN, <sup>3</sup>University of Minnesota, Southern Research and Outreach Center, Waseca.

Ninety dairy heifers ( $86.1 \pm 0.86$  kg BW) were used in a 112-d study to evaluate feed intake and performance from 9 to 25 weeks of-age. Heifers

were housed in 9.14 x 4.57 m pens (6 heifers/pen) within a naturally ventilated bedded-pack pole barn and randomly assigned to 1 of 3 grower diets among 5 replicated pens/treatment. Treatments were 1) 18.6% CP (DM) pelleted grain mix fed at 2.72 kg/d (CON); 2) 18.8% CP pelleted grain mix with 3.0% glycerol fed at 2.72 kg/d (3%GLY); 3) 19.2% CP pelleted grain mix including 6.0% glycerol fed at 2.72 kg/d (6%GLY). From d 85-112 all heifers were fed (2.27 kg/d) a common whole corn and pellet grain mix (18.7% CP). All heifers had access to a 16.5% CP hay free choice for the duration of the trial. Data were analyzed as repeated measures using the PROC MIXED procedure of SAS and contrasts were used to compare treatment affects. Under the conditions of this study, heifers fed 6%GLY had improved daily gain through d 84, compared to heifers fed CON or 3%GLY. Feeding 3%GLY or 6%GLY improved feed efficiency compared to those heifers fed CON. The study suggested that up to 6% glycerol can effectively replace corn in grain mixes fed to post-weaned heifers.

**Table 1.**

Item	Treatments			SEM	Contrasts	
	CON	3%GLY	6%GLY		linear	quadratic
Day 1 to 84						
ADG, kg/d	0.96	0.97	1.00	0.01	0.05	NS
Grain DMI, kg/d	2.46 <sup>a</sup>	2.41 <sup>b</sup>	2.43 <sup>c</sup>	0.01	0.01	<0.001
Total DMI, kg/d	3.80	3.75	3.73	0.04	NS	NS
Feed/gain, kg	3.92 <sup>a</sup>	3.86 <sup>b</sup>	3.71 <sup>c</sup>	0.04	0.001	NS
Day 1 to 112						
ADG, kg/d	0.96	0.97	0.99	0.02	NS	NS
Grain DMI, kg/d	2.36 <sup>a</sup>	2.32 <sup>b</sup>	2.34 <sup>c</sup>	0.01	0.03	0.001
Total DMI, kg/d	4.14	4.10	4.12	0.04	NS	NS
Feed/gain, kg	4.36	4.27	4.12	0.09	0.08	NS

<sup>a,b</sup>Means within a row without common superscripts are different at  $P < 0.05$ .

**Key Words:** dairy heifers, glycerol, performance

**M272 Effects of replacing starch or sugar with glycerol in diets for dairy cows on production and blood metabolites.** D. E. Rico<sup>\*</sup>, Y.-H. Chung, C. M. Martinez, T. Cassidy, K. S. Heyler, and G. A. Varga, Department of Dairy and Animal Science, The Pennsylvania State University, University Park.

The objectives of this experiment were to evaluate the effects of glycerol as a feed ingredient replacing starch or sugar in the diet of dairy cows on dry matter intake (DMI), milk yield and blood metabolites. Nine multiparous Holstein cows ( $DIM = 112 \pm 8.6$ ) were used in a 3 x 3 replicated Latin square design. Glycerol (42.5% food grade glycerol) was fed at 4% of ration DM replacing equivalent amounts of pure corn starch or sugar (sugar cane molasses) in the diet. The trial had 3 experimental periods 14 d each and d 1 through 9 were used for adaptation. Daily DMI and milk yield were measured and milk samples were taken on d 13 of each period. Blood samples were drawn from the jugular vein post-feeding for 4h on the last day of each period. Dry matter intake did not differ among treatments and averaged 27.7 kg/d. There was a numerical trend ( $P = 0.08$ ) for higher milk yield for cows provided the molasses vs. glycerol (43.1 vs. 40.8 kg/d). Milk yield for cows provided the starch treatment (41.4 kg/d) did not differ from those fed glycerol. Milk protein was lower for glycerol ( $P < 0.01$ ) than for molasses or starch and the values were 2.94, 3.03, 3.02%, respectively. Other milk components were not different among treatments. Blood concentrations

of glucose and  $\beta$ -hydroxybutyrate were not affected by treatment and averaged 69 mg/dL and 747  $\mu$ mol/L, respectively. Blood concentration of insulin was greater ( $P < 0.05$ ) for cows fed glycerin than those cows fed molasses (0.72 vs. 0.4 ng/ml), however this did not differ from cows fed starch. At the level of inclusion used in this experiment, glycerin did not affect DMI or milk yield.  $\beta$ -hydroxybutyrate values do not suggest significantly increased butyric acid in the rumen due to glycerin fermentation. These results indicate that glycerin can replace starch or molasses in the diet without negative effects on performance and can be considered in dairy rations when prices are favorable.

**Key Words:** glycerin, milk production, blood metabolites

**M273 Effects of increasing concentrations of dietary glycerol on ruminal environment and digestibility in lactating dairy cows.** J. Boyd\*, J. W. West, and J. K. Bernard, *University of Georgia, Tifton.*

A study was conducted to evaluate effects of increasing concentrations of dietary glycerol on rumen environment, blood metabolites, and nutrient digestibility. Six rumen cannulated Holstein cows averaging 70 DIM and 37.9 kg/d of milk were used in the study. The study was conducted from May to July 2008. Experimental design was a 3x3 Latin square with a 3wk adjustment period followed by a 1wk collection period. Cows were blocked into groups of 2 and progressed through the three 4wk periods until exposed to all treatments. Diets were corn silage based and balanced to be iso-caloric and iso-nitrogenous. Treatments were control (C), 200g glycerol h/d (G2), and 400g glycerol h/d (G4). DMI was higher for C ( $24.17 \pm 0.29$ ) compared with G2 ( $22.99 \pm 0.29$ ) versus G4 ( $22.96 \pm 0.29$ ) at ( $P < 0.01$ ). Milk yield was greater ( $P < 0.01$ ) for C ( $37.8 \pm 0.47$ ) than G4 ( $35.83 \pm 0.47$ ), but G2 ( $37.2 \pm 0.47$ ) was not significantly different. Milk protein percentage was lower ( $P < 0.001$ ) for C and G2 than for G4 (2.75%, 2.75%, and 2.8%). Milk fat percentage was lower ( $P < 0.01$ ) for G2 ( $3.31 \pm 0.03$ ) and G4 ( $3.35 \pm 0.03$ ) compared with C ( $3.46 \pm 0.03$ ). A significant effect ( $P < 0.04$ ) for ECM was noted between C ( $40.0 \pm 0.34$ ) and G4 ( $38.8 \pm 0.34$ ), but G2 ( $39.4 \pm 0.34$ ) was not effected. A trend ( $P < 0.18$ ) for improved efficiency (ECM/DMI) was noted for G2 and G4 ( $1.73 \pm 0.02$ ) versus C ( $1.68 \pm 0.02$ ). No effect on ruminal pH and ammonia (mean 6.06 and 11.19 mg/dl) was observed. No effect on DM, NDF, ADF, or CP digestion or on blood glucose (63 mg/dl) was noted. A trend for lower plasma urea N ( $P < 0.09$ ) was seen for G4 (20.5 mg/dl) versus C and G2 (21.7 and 21.8 mg/dl). Molar proportions of propionate tended to increase whereas acetate tended to decrease with G4 versus C. The decrease in milk fat percentage between G2 and G4 versus C and the increase in milk protein percentage with G4 versus C supports the ruminal data. The addition of glycerol to the diet may alter ruminal VFA profile and improve efficiency in dairy cows.

**Key Words:** dietary glycerol, ruminal environment, efficiency

**M274 Response of dairy cows to the complete substitution of corn by crude glycerin.** O. F. Zacaroni<sup>1</sup>, N. M. Lopes<sup>1</sup>, S. Siécola Júnior<sup>1</sup>, G. S. Dias Júnior<sup>1</sup>, L. L. Bitencourt<sup>1</sup>, B. F. Carvalho<sup>1</sup>, J. R. M. Silva<sup>2</sup>, R. A. N. Pereira<sup>3</sup>, and M. N. Pereira\*<sup>1</sup>, <sup>1</sup>Universidade Federal de Lavras, Lavras, MG, Brazil, <sup>2</sup>Centro Federal de Educação Tecnológica, Januária, MG, Brazil, <sup>3</sup>Better Nature Research Center, Ijaci, MG, Brazil.

This trial evaluated the complete replacement of finely ground mature corn by the biodiesel byproduct crude glycerin. Eighteen Holsteins ( $227 \pm 88$  DIM, five primiparous) received a sequence of three treatments, in six 3x3 Latin Squares, with 28-day periods and 21 days of adaptation.

Only the contrast Control vs. Glycerin will be presented. Diets contained (% of DM): Corn silage (27.7), tifton hay (6.1), citrus pulp (19.4), whole cottonseed (8.6), Megalac (1.2) and a mineral-bicarbonate premix (3.5). The Control TMR contained 14.8% of corn and 18.6% of soybean meal, replaced in Glycerin by 12.3% of crude glycerin and 21.3% of soybean meal. The substitution of corn by glycerin tended to increase the total tract apparent digestibility of DM (DM D) and had no effect on rumen pH 12 hours post feeding. Daily ingestion time was reduced by glycerin, but the intake rate was increased. Crude glycerin reduced milk secretion without affecting feed intake, resulting in lower ratio of milk yield to DMI. *Funded by Nutron/Provimi.*

**Table 1.**

	Glycerin	Control	SEM	P
Milk yield	21.3	23.4	.58	.02
DMI	16.7	16.8	.37	.85
Fat yield	.750	.797	.027	.24
Protein yield	.680	.736	.024	.13
Lactose yield	.942	1.050	.028	.01
Fat %	3.53	3.43	.097	.48
Protein %	3.24	3.15	.063	.32
Lactose %	4.42	4.46	.070	.63
Milk energy (Mcal/d)	14.41	15.58	.435	.07
Milk yield/DMI	1.30	1.40	.037	.05
Rumen pH	6.53	6.41	.074	.29
DM D (%)	73.8	70.1	.47	.10
Ingestion time (min/d)	228	254	9.0	.05
Ingestion time (min/DMI)	12.6	14.2	.49	.03

**Key Words:** glycerol, glycerin, starch

**M275 Glycerol supplementation to corn silage- or cottonseed hull-based diets for lactating dairy cows.** J. H. Shin\*<sup>1</sup>, S. C. Kim<sup>1,2</sup>, D. Wang<sup>1</sup>, A. T. Adesogan<sup>1</sup>, and C. R. Staples<sup>1</sup>, <sup>1</sup>Department of Animal Sciences, University of Florida, Gainesville, <sup>2</sup>Department of Animal Science, Gyeongsang National University, Jinju, Gyeongsangnam, South Korea.

Objective was to evaluate the effect of glycerol supplementation to corn silage (CS)- or cottonseed hull (CSH)-based diets on DMI, milk yield (MY), blood metabolites, and ruminal fermentation of lactating cows. Cows (n=24; days in milk  $116 \pm 13$ ) were assigned to 6 dietary treatments for 3 consecutive 27-d periods (14 d adaptation and 13 d collection). Treatments were arranged in a 2 by 3 factorial design: 2 forage sources (CS at 37% and alfalfa hay at 10% of dietary DM vs. CSH at 25% and bermudagrass hay at 10% of dietary DM) and 3 concentrations of glycerol (0, 5, and 10% of dietary DM). Additionally, 4 ruminally cannulated cows arranged in a 4 by 4 Latin square design were assigned to 4 treatments (CS vs. CSH and 0 vs. 10% glycerol) in a 2 by 2 factorial design (20-d periods of 14 d adaptation and 6 d collection). Glycerol (90% DM; donated by West Central) replaced ground corn in the diet. Cows were milked twice daily and milk sampled at a.m. and p.m. on d 19, 20, 26, and 27 of each period. Blood was taken via coccygeal vessels on 16 d of each period. Ruminal fluid from cannulated cows was collected hourly for 12 h on d 16 and measured for pH. Body weight (BW) was measured for 2 consecutive days at the start and end of each period. Cows fed CSH had greater DMI (29.7 vs. 24.4 kg/d; 4.26 vs. 3.58% of BW), MY (36.9 vs. 35.2 kg/d), milk fat (1.2 vs. 1.1

kg/d), milk protein (1.1 vs. 1.0 kg/d and 2.99 vs. 2.87%), BW change (0.68 vs. 0.06 kg/d), blood urea nitrogen (16.5 vs. 13.8 mg/dl), ruminal fluid pH (6.5 vs. 6.1), ruminal solids (8.7 vs. 12.3 kg DM), and liquid passage rate from rumen (0.16 vs. 0.13/h) than those fed CS, but lower milk efficiency (FCM/DMI; 1.10 vs. 1.24). Milk fat concentrations and DMI were greatest whereas feed efficiency (MY/DMI) was lowest for cows fed 5% glycerol diets. Concentration of blood urea nitrogen decreased linearly as intake of glycerol increased (16.1, 15.5, and 13.8 mg/100 ml). Glycerol supplementation did not affect blood glucose, ruminal fluid pH, or rumen solids volume. Feeding glycerol tended to increase MY of cows fed CS but tended to decrease MY of cows fed CSH (forage by glycerol interaction).

**Key Words:** glycerol, dairy

**M276 The effects of feeding glycerol on rumen fermentation and bacteria.** R. B. Potu<sup>\*1</sup>, A. A. AbuGhazaleh<sup>1</sup>, D. Hastings<sup>1</sup>, S. Abo El-Nor<sup>2</sup>, and S. Ibrahim<sup>3</sup>, <sup>1</sup>*Southern Illinois University, Carbondale*, <sup>2</sup>*Egyptian National Research Center, Cairo, Egypt*, <sup>3</sup>*North Carolina A&T State University, Greensboro*.

The effects of substituting corn with glycerol with respect to feed digestibility, fermentation, bacterial DNA concentration and rumen fatty acids (FA) were investigated using continuous fermenters. Four fermenters were used in a 4 x 4 Latin Square design with four 10 d consecutive periods. Four (T1, T2, T3, T4) treatment diets (60:40 forage to concentrate) were fed at 45 g/d dry matter (DM) in three equal portions. The forage consisted of alfalfa pellets. The grain mix contained corn, SBM, soy hulls, minerals and vitamins. Glycerol replaced corn in the grain mix at proportions of 0% (T1; control), 15% (T2), 30% (T3) and 45% (T4). On days 8, 9, and 10 of each diet processing period, 25% of the overflow was collected from each fermenter and analyzed for chemical composition. On day 10 of each period, additional rumen samples were collected from each fermenter at 3 and 6 hr after the morning feeding and analyzed for VFA, NH<sub>3</sub>, FA, and microbial DNA concentration. Results showed that NDF digestibility was lower ( $P < 0.05$ ) for T3 and T4 compared to T1 and T2. Glycerol had no effects on rumen pH, NH<sub>3</sub> concentration, and DM and ADF digestibility. Acetate levels were lower ( $P < 0.05$ ), while butyrate, valerate and isovalerate levels were higher ( $P < 0.05$ ) for the T3 and T4 compared to T1 and T2. DNA concentrations for *Selenomonas ruminantium* were lower ( $P < 0.05$ ) with the T3 and T4 compared to the T1 and T2. In addition, the DNA concentrations for *Butyrivibrio fibrisolvens* and total bacteria were lower ( $P < 0.05$ ) with T4 compared to the other diets. No significance differences for the DNA concentrations for *Ruminococcus albus* were observed. The concentrations of C18:1 and C18:2 were higher ( $P < 0.05$ ) with T1 compared to the other diets. Concentrations of C18:1 trans also were higher ( $P < 0.05$ ) with T1 compared to T3 and T4. In conclusion, these results suggest that glycerol at proportions of up to 15% could be used to replace corn in ruminant animals' diet without adversely affecting fermentation or ruminal bacteria. Higher levels may adversely affect fiber digestion and bacterial population and negatively impact acetate production.

**Key Words:** glycerol, fermentation, microbial

**M277 Effects of replacing corn starch or sugar with glycerin on ruminal fermentation during continuous culture.** D. E. Rico<sup>\*</sup>, Y.-H. Chung, C. M. Martinez, T. Cassidy, K. S. Heyler, and G. A. Varga, *Department of Dairy and Animal Science, The Pennsylvania State University, University Park*.

The objective of this experiment was to evaluate the effects of glycerin as a feed ingredient replacing starch or sugar in the diet on ruminal fermentation using a single effluent continuous culture system. A 3 x 3 Latin square design was used with glycerin as the treatment and pure corn starch and sugar as 2 separate controls such that glycerin (42.5% food grade glycerol) was fed at 4% of ration DM replacing equivalent amounts of pure corn starch or sugar (sugar cane molasses) in the diet. The trial had 3 experimental periods of 9 d each, using the first 6 d for adaptation and the last 3 d for sampling. Fermenter effluent were collected daily and subsampled for analysis of volatile fatty acids (VFA), ammonia and dry matter (DM) content. Fermenters (1015 to 1040 ml in volume) were incubated with ruminal fluid (1 L) and ruminal digesta (25 g) from a cow receiving a diet with a 55:45 forage to concentrate ratio. Fermenters were fed 25 g DM of the experimental diets three times per day and the solids retention time was set at 24 h. Replacing starch or molasses with glycerin, did not affect total VFA concentration (90.8 mmol/L) however, there was a numerical trend ( $P = 0.07$ ) for higher acetate to propionate ratio when fermenters were provided glycerin vs. molasses (2.8 vs. 2.5). Butyrate molar proportion was lower ( $P < 0.01$ ) for glycerin compared to starch or molasses (13, 16, and 18% of total VFA, respectively). Ammonia was highest ( $P < 0.01$ ) for glycerin compared to molasses or starch and concentrations were 24.9, 8.8 and 11.8 mg/L, respectively. Dry matter digestibility was lower ( $P < 0.05$ ) for glycerin than for starch (39 vs. 42%) but was not different from the molasses treatment (39%). These results suggest that diet digestibility is reduced by replacing some of the dietary starch with glycerin under the present experimental conditions. In addition, higher ammonia concentrations and lower butyrate in fermenters fed glycerin perhaps reflect changes in bacterial populations and inefficient use of nitrogen as ammonia compared to sources of starch or sugar; however, this requires further verification.

**Key Words:** glycerin, continuous culture, ruminal fermentation

**M278 Effect of glycerol level in feedlot diets on animal performance.** B. R. Ilse<sup>\*</sup> and V. L. Anderson, *Carrington Research Extension Center, North Dakota State University, Carrington*.

Two separate feedlot trials were conducted (receiving and finishing) to evaluate the effects of increasing levels of glycerol on animal performance. Receiving trial steers ( $n = 198$ ) were allotted by BW ( $283 \pm 15.6$  kg) in a randomized complete block design and sorted into 16 identical pens (four pens per treatment). Treatments were 0, 6, 12, and 18 percent glycerol (70% DM; water was added to reach 70% DM to increase the viscosity and decrease freezing temperature) on a DM basis replacing dry-rolled corn and co-products in the diet (25 Mcal NEg). Dry matter intake was quadratically affected during the 30 d feeding period ( $P = 0.05$ ) with 9.24; 9.56; 9.58; 8.83 kg consumed for 0, 6, 12, and 18 percent glycerol, respectively. Gains were not affected by glycerol level ( $P = 0.78$ ) and feed efficiency was similar ( $P > 0.92$ ) among treatments. Finishing trial heifers ( $n = 132$ ; BW =  $414.3 \pm 15.1$  kg) were blocked by weight and allotted to one of 16 pens, assigned to 0, 6, 12, 18 percent glycerol (85% DM) dietary treatments (28 Mcal NEg). Dry matter intake linearly decreased during the 102 d feeding period ( $P = 0.05$ ; 12.75; 12.68; 12.56; 11.86 kg for 0, 6, 12, and 18 percent glycerol, respectively). Gains were not affected by glycerol level ( $P = 0.26$ ) during any of the four individual 28 d weigh periods or overall. Feed efficiency was also similar ( $P > 0.22$ ) among treatments. If the availability of feed grade glycerol increases with the increase in biodiesel production, glycerol could be a viable alternative to corn in feedlot diets.

**Key Words:** glycerol, beef, feedlot

**M279 Kinetics of fermentation of apple residues.** Y. Castillo-Castillo<sup>1</sup>, O. Ruiz-Barrera\*<sup>1</sup>, A. Elias-Iglesias<sup>2</sup>, C. Arzola-Alvarez<sup>1</sup>, C. Rodriguez-Muela<sup>1</sup>, J. A. Ortega-Gutierrez<sup>1</sup>, O. LaO-Leon<sup>2</sup>, C. Holguin-Licon<sup>1</sup>, and Y. Ricardo-Olive<sup>3</sup>, <sup>1</sup>Facultad de Zootecnia y Ecología, Universidad Autónoma de Chihuahua, Chihuahua, Mexico, <sup>2</sup>Instituto de Ciencia Animal, La Habana, Cuba, <sup>3</sup>Instituto de Investigaciones Agropecuarias Jorge Dimitrov, Bayamo, Granma, Cuba.

Several data indicate that nutritive value of agro-industrial residues may be improved by using solid state fermentation, by the way of promoting growth of beneficial microorganisms and enhancing amount of crude and true protein, linked to degradation of lignocellulosic compounds. Most solid state fermentation (SSF) studies are conducted under aerobic environments, but knowledge concerning the effects of non-aerobic conditions is limited. The objective of this study was to evaluate fermentative pattern, microbial growth, and chemical composition of apple waste under partial aerobic conditions using four times of incubation (0, 24, 48, 72 h) and a complete random design with four repetitions in every time of incubation. Apple waste was added with urea (1.5%), ammonium sulphate (0.2%) and mineral and vitamin salts (0.5%) and fermented in serum flasks at 32° C during three days. A significant reduction on pH ( $P \leq 0.007$ ) was shown (4.13, 3.85, 3.86 and 3.81) during time of incubation; meanwhile, lactic acid concentration increased ( $P \leq 0.0001$ ) (22.24, 22.50, 22.87 and 23.75  $\mu\text{g/g DM}$ ) as well as ammonium nitrogen (N-NH<sub>3</sub>) (1.92, 1.95, 1.98 and 2.00 mmol/g DM) ( $P \leq 0.0001$ ). Total bacteria, lactobacilli and yeast counts (expressed in log<sub>10</sub>) was drastically reduced ( $P \leq 0.0001$ ) during time (7.14, 5.96, 4.73 and 4.55 ufc/ml-1; 8.60, 8.14, 8.73 and 8.53 ufc/ml-1; 7.42, 7.35, 6.0 and 4.80 ufc/ml-1, respectively). Crude protein was not affected by time of incubation (36.19, 36.02, 35.57 and 35.47) ( $P \geq 0.05$ ), however, true protein (16.89, 21.15, 19.5 and 18.12) showed statistical difference, decreasing after the 24 h ( $P \leq 0.03$ ). Neutral detergent fiber (%) was not affected by time of incubation, but acid detergent fiber concentration (%) was significantly decreased (41.57, 41.45, 38.8 and 39.42) ( $P \leq 0.0001$ ). We conclude that pH had a big impact on SSF, affecting total counts of microorganisms, probably due to the metabolic activity produced during growth of lactic bacteria. On the other hand, SSF was efficient on the improvement of chemical composition parameters.

**Key Words:** apple waste, fermentation, microorganisms

**M280 Feeding behavior of yearling bulls fed a finishing diet containing low pectin wet citrus pulp silage.** J. O. Sarturi\*<sup>2</sup>, L. G. Nussio<sup>1</sup>, M. Zopollatto<sup>1</sup>, J. T. Vasconcelos<sup>2</sup>, and J. G. M. Munoz<sup>1</sup>, <sup>1</sup>University of São Paulo, São Paulo, SP, Brazil, <sup>2</sup>University of Nebraska, Scottsbluff.

The objective of this study was to evaluate the feeding behavior of animals fed finishing rations containing low pectin wet citrus pulp silages (LPWCPS). Fifty-four yearling bulls (Nelore/Angus or Nelore/Santa Gertrudis x Braunvieh crosses; BW = 389 ± 32kg) were assigned to a complete randomized block design (18 pens, 3 bulls per pen). Cattle were fed the following diets: C (control diet, without LPWCPS); A (diet with LPWCPS and which received the additive Sodium benzoate during ensiling); B (diet with LPWCPS without additive). Diets were composed of (DM basis) sugar cane bagasse fine chopped (15.04%), pelleted citrus pulp (75.35 or 52.75%), cottonseed meal (5.18%), urea (2.05%), sodium bicarbonate (0.96%), mineral-vitamin mix (1.68%) and LPWCPS (0 or 22.6%). Diets were formulated to be isoproteic (13.5%) and with a positive balance of DIP and MP (NRC, 1996; level 1). Evaluations were carried out at intervals of 10 min., during 24 h, consecutively, at approximately d 60. Data were analyzed using the PROC MIXED procedure of SAS. Means were compared using the Tukey test, with

5% significance. Cattle fed C spent more time ( $P < 0.05$ ) ruminating and chewing per NDF unit when compared to other treatments (36, 25, and 23; 54, 44, and 41 min/kg of NDF, for C, A and B, respectively). Diet C had lower ( $P < 0.05$ ) NDF content (38.9, 47.9, and 47.2%, for C, A, and B, respectively). There were no differences ( $P > 0.05$ ) between treatments for rumination time/d, rumination time/kg of DM, intake/d, intake/kg of NDF, intake/kg of DM, chewing time/d, chewing time/kg of DM, water intake/d and resting time/d (321, 282 and 247; 14, 12 and 11; 160, 201 and 202; 18, 18 and 19; 7, 9 and 9; 481, 483 and 449; 21, 21 and 19; 10, 9 and 13; 948, 948 and 977 min, for C, A and B, respectively). The lower time spent ruminating and chewing per unit of NDF of cattle fed the diet with LPWCPS (with or without additive during the ensilage process) is a good indicator of the low physical effectiveness of the fiber present in this byproduct.

**Key Words:** byproduct, benzoate, additive

**M281 Feeding behavior of yearling bulls fed a finishing diet containing low pectin wet citrus pulp.** J. O. Sarturi\*<sup>2</sup>, L. G. Nussio<sup>1</sup>, M. Zopollatto<sup>1</sup>, J. T. Vasconcelos<sup>2</sup>, and L. J. Mari<sup>1</sup>, <sup>1</sup>University of São Paulo, São Paulo, SP, Brazil, <sup>2</sup>University of Nebraska, Scottsbluff.

The aim of this trial was to evaluate the feeding behavior of animals fed finishing diets containing low pectin wet citrus pulp (LPWCP) or not. Forty-eight bulls (24 Nelore and 24 Canchin; BW = 448 ± 45kg) were randomized by blocks in a 2 x 2 factorial (breed and diet) arrangement with 16 pens (3 bulls per pen). Cattle were fed the following diets: C (control diet without LPWCP) and B (diet with LPWCP). Diets were composed of (DM basis) sugar cane bagasse fine chopped (15%), pelleted citrus pulp (75.2 or 52.6%), soybean meal (5%), urea (2.1%), sodium bicarbonate (1%), mineral-vitamin mix (1.7%), and LPWCP (0 or 22.6%). Diets were formulated to be isoproteic (13.5%) and with a positive balance of DIP and MP (NRC, 1996; level 1). Behavioral evaluations were carried out at intervals of 10 min., during 24 h, consecutively, at approximately d 60. Data were analyzed using the PROC MIXED procedure of SAS. No interactions ( $P > 0.05$ ) were observed for breeds and diets. Means were compared with LSMEANS, using 5% level of significance. Cattle on diet C spent more time ( $P < 0.05$ ) ruminating per NDF unit (66 vs. 46 min/kg of NDF) and had greater ( $P < 0.05$ ) chewing activity per NDF unit (125 vs. 99 min/kg of NDF) when compared to cattle fed diet B. The diet C, however, had lower ( $P < 0.05$ ) NDF content when compared to diet B (36.1 vs. 45.3%). There were no differences ( $P > 0.05$ ) between dietary treatments for rumination time/d, rumination time/kg of DM, intake/d, intake/kg of NDF, intake/kg of DM, chewing time/d, chewing time/kg of DM, water intake/d and resting time/d (187 vs. 163; 24 vs. 20; 168 vs. 180; 60 vs. 53; 21 vs. 23; 355 vs. 343; 45 vs. 43; 22 vs. 26; 1061 vs. 1070 min, for C and B, respectively). The lower time spent ruminating and chewing per unit of NDF for the diet with LPWCP can be a strong indicator of the low physical effectiveness of the fiber present in this byproduct. The addition of LPWCP increased of the NDF level of the diet B, but animals had shorter rumination and chewing time per unit of NDF.

**Key Words:** rumination, byproduct, chew

**M282 Dry matter and nutrient intake of sheep fed with different levels of cashew nut in the diet.** E. S. Pereira\*, P. G. Pimentel, J. G. L. Regadas Filho, M. S. S. Carneiro, and I. S. G. Maia, Universidade Federal do Ceará, Fortaleza, Ceará, Brasil.

The objective of this study was to evaluate the effect of different levels of cashew nut on the dry matter and nutrient intake of sheep. Eight Santa Ines wethers, averaging 25 kg BW, were allotted in a replicated X 4 Latin square, and maintained in metabolic cages. Cashew nut was fed in the concentrate at the levels of 0; 10; 20 and 30%; the forage portion of the diet was Tifton hay. The diets were offered once daily in 60:40 forage:concentrate ration. Periods were 16 d long; the first 10 d of each period were for dietary adaptation, with weight and samples of diets and refusals taken during day 11 to 16 of each period to determine the consumption of dry matter and nutrients. Meals were offered to allow 10% refusals according to the calculated diet consumed on the previous day. The samples were analyzed for dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), ash (Ash), neutral detergent fiber (NDF), acid detergent fiber (ADF) and total carbohydrates (TC). The ether extract content of the experimental diets was, respectively, 2.97; 4.35; 5.95 and 7.78%, to the levels 0; 10; 20 and 30% of cashew nut inclusion. The intake of the diets without cashew nut and at the level of 30% varied of 1004.29 to 794.24; 929.04 to 730.39; 152.68 to 120.30; 75.25 to 63.85; 453.77 to 340.99; 246.69 to 193.00 and 745.65 to 489.48 g/day, respectively, for DM, OM, CP, Ash, NDF, ADF and TC, showing quadratic behavior ( $p=0.05$ ). Dry matter intake as percentage of live weigh was not affected by the treatments. Ether extract intake, as expected, increased linearly (30.72; 47.50; 60.85 and 69.18 g/day) with the addition of the byproduct. The high content of lipids in cashew nut possibly altered the dry matter and nutrient intake of sheep diets.

**Key Words:** byproducts, lipids, ruminants

**M283 Antioxidant activity of plasma and carcass characteristics of mature cows fed diets with manzarina.** C. Rodríguez-Muela<sup>1</sup>, S. Romero-Villalobos\*<sup>1</sup>, H. E. Rodríguez-Ramírez<sup>2,1</sup>, A. C. Arzola-Alvarez<sup>1</sup>, A. Flores-Mariñelarena<sup>1</sup>, G. Corral<sup>1</sup>, O. La O-León<sup>3</sup>, and J. A. Grado-Ahuir<sup>1</sup>, <sup>1</sup>Universidad Autónoma de Chihuahua, Chihuahua, Chihuahua, México, <sup>2</sup>Instituto Nacional de Investigaciones Agrícolas Forestales y Pecuarias, Delicias, Chihuahua, México, <sup>3</sup>Instituto de Ciencia Animal, La Habana, Cuba.

The objective of the present study was to evaluate the effect of the inclusion of a fermented feed of apple pomace (manzarina) upon the antioxidant activity of blood plasma and carcass characteristics of mature feedlot cows. Manzarina has a high content of phenolic compounds and yeasts. It is known that some phenolic compounds have antioxidant properties. Twenty-five Angus x Charolais mature cows with an average initial body weight of 407.1±9.3 kg were fed for 75 d. Diets had the same level of CP (9.3%) and energy (NEm 1.7, NEg 1.09 Mcal kg<sup>-1</sup>) on dry matter basis. Control diet (CT) was prepared with corn silage (40.0%), oat hay (14%), steam rolled corn (34.2%), cotton seed (8%), sugar cane molasses (3.0%), salt (0.3%), mineral supplement (0.3%) and calcium carbonate (0.2%)(as fed basis). Manzarina treatment diet had 15% of manzarina in the whole ration (MT). Manzarina replace to the steam corn rolled (7%) and the oat hay (8%) in MT. Variables evaluated were antioxidant activity (AA) of blood plasma (FRAP technique) at the beginning and at the end of the feeding period. Carcass yield (CY), rib eye area (RA) and fat thickness (FT) were measured at slaughter. A complete random design was used for carcass variables using treat-

ment as main effect. AA was analyzed with a mixed model. Treatment (T), sampling moment (SM at the beginning and at the end of the trial) and their interaction were the fixed effects. The cow nested on T\*SM interaction was the random effect. AA of MT cows (4.775±0.08 mM Fe<sub>2</sub> eq.) was higher ( $P<0.05$ ) than AA of CT cows (4.546±0.08). AA of cows plasma at the beginning of feeding period (4.03±0.07) was lower ( $P<0.01$ ) than AA after feeding period (5.29±0.07 mM Fe<sub>2</sub> eq.). There was no effect of diet on the carcass characteristics ( $P>0.05$ ). CY values were 51.4±0.9% and 49.4±0.9% for MT and CT. RA values were 9.5±0.5 in<sup>2</sup> and 9.1±0.5 in<sup>2</sup> for MT and CT. FT value was 0.6±0.1 cm for MT and CT. We conclude that the inclusion of 15% of manzarina in mature cow feedlot diets improves the antioxidant activity of plasma, indicating better animal health without affecting carcass characteristics.

**Key Words:** phenol compounds, antioxidant activity, apple pomace

**M284 Effects of tomato pomace on feed intake and milk production of lactating dairy cows.** R. Safari, R. Valkizadeh\*, A. A. Naserian, and A. M. Tahmasbi, *Department of Animal Science (Excellent Center of Animal Nutrition), Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran.*

The aim of this study was to evaluate the effects of dried and ensiled tomato pomace on feed intake and milk production. Nine primiparous and multiparous Holstein cows within 76 ± 12 (mean ±SD) days in milk were evaluated in a 3 x 3 change over design. The dietary treatments were 1) ordinary diet without dried or ensiled tomato pomace, 2) ordinary diet consisting 40% forage (barley silage and alfalfa hay) and 60% concentrate including 8% dried tomato pomace (DTP), 3) ordinary diet including 8% ensiled tomato pomace (ETP). Tomato pomace was replaced with whole barley silage and protein modified with cotton seed meal. Throughout the experiment, cows were housed in a tie stall and fed three times daily after milking (6:00 h, 14:00 h and 22:00 h). Amounts of feed offered and orts were weighed for each cow separately. Cows were milked three times a day. Milk was sampled at each milking time from day d 14 to 20. Ruminal samples were collected through mouth by a vacuum pump, at 10:00 h on day 21. Ruminal fluid pH was measured immediately after sampling and then mixed with the same amount of HCl 0.2N. Rumen NH<sub>3</sub>-N samples was determined by micro-Kjeldahl analysis. Inclusion of tomato pomace in dried and ensiled forms did not alter ( $p\geq 0.05$ ) DMI of the cow significantly (25.71, 26.39 and 24.36 kg/d for control, DTP and ETP respectively; SEM = 0.92). Ruminal pH was significantly affected by treatments and was lower ( $p\leq 0.05$ ) for the diets containing dried and ensiled tomato pomace (6.67, 6.41 and 6.20 for control, DTP and ETP respectively; SEM = 0.1) possibly due to the low pH of this by-product. Ruminal NH<sub>3</sub>-N% was not significantly ( $p\geq 0.05$ ) affected by dried tomato pomace or ensiled tomato addition. Milk production was significantly increased ( $p\leq 0.05$ ) by tomato pomace addition (40.31, 41.35 and 41.16 kg/d for control, DTP and ETP respectively; SEM = 0.11). The milk fat content (2.76%; SEM = 0.11) was similar ( $p\geq 0.05$ ) for cows fed control diet and those fed dried or ensiled tomato pomace. Milk protein yields were higher for experimental treatments than control (1.24, 1.28 and 1.27 kg/d for control, DTP and ETP respectively; SEM = 0.009).

**Key Words:** tomato pomace, dairy cow, milk yield