RUMINANT NUTRITION II

1651 (T264) In vitro assessment of *Saccharomyces cerevisiae* cell fractions (YCF) using bovine epithelial cells and macrophages. Z. Li[*1], Q. You[1], F. Ossa[2], P. Mead[1], and N. A. Karrow[3], *[1]University of Guelph, Guelph, ON, Canada, [2]Lallemand Inc., Montreal, QC, Canada, [3]Dep. of Animal and Poultry Science, University of Guelph, ON, Canada.*

Since yeast *Saccharomyces cerevisiae* and its cell fractions (yeast cell fractions) are being used for the prevention and treatment of enteric diseases in different species, they may also be useful for preventing Johne's disease, a chronic inflammatory bowel disease of ruminants caused by *Mycobacterium avium* ssp. *paratuberculosis* (MAP). In this study, the adhesion of mCherry-labeled MAP to bovine mammary epithelial cells (Mac-T) co-cultured with CFs from two specific yeast strains (A and B)from the Lallemand culture collection was investigated. Additionally, bovine macrophages (BoMacs) were used to assess potential immunomodulatory properties of these yeast CFs by measuring BoMac viability, reactive oxygen species (ROS) production, and phagocytosis of mCherry-MAP. The Mac-T cells were treated for 6 h with the two CFs at different concentrations (0.25, 0.5, 1, 2, 4, 8, and 16 mg/ml). The highest concentration of CFs that did not affect the Mac-T cell viability was 4 mg/ml for the strain A, and 2 mg/ml for strain B. Non-cytotoxic concentrations of yeast CFs from both strains reduced MAP adhesion to Mac-T cells in a concentration-dependent manner. BoMac cell viability was also assessed after a 6-hour treatment with both yeast CFs, and concentrations $\leq$ 4 mg/ml were deemed non-cytotoxic. BoMac ROS production was measured at non-cytotoxic yeast CF concentrations, and a dose-dependent increase in ROS production was found for both yeast CFs, with strain A being more potent than strain B. Finally, BoMac phagocytosis of m-Cherry-MAP, assessed after 6 h, was prevented by co-culture with non-cytotoxic concentrations of yeast CFs. In summary, yeast CFs may be useful for preventing MAP adhesion to the gastrointestinal epithelium and for stimulating macrophage antimicrobial ROS production.

Key Words: prebiotic, immunomodulation, bovine mammary epithelial cells (Mac-T)

Table 1652. Digestibility of the diet of grazing Nellore bulls receiving concentrated supplementation with or without additives

	Treatments			
Item, %	Control	Lipomax	CV (%)	*P*-value
CDEE1	79.0a	67.9b	7.19	0.004
CDCP2	77.8	75.2	7.46	0.359
CDNDF3	68.2	67.8	7.88	0.817
CDNFC4	74.7	73.8	11.4	0.949
ME5 (Mcal/Kg)	2.488	2.395	4.68	0.187

[1] CDEE is the coefficient of digestibility of ether extract
[2] CDCP is the coefficient of digestibility of CP.
[3] CDNDF is the coefficient of digestibility of NDF.
[4] CDNFC is the coefficient of digestibility of non-fiber carbohydrates.
[5] ME is the metabolizable energy of the diet.

1652 (T265) Digestibility of the diet of grazing Nellore bulls receiving concentrated supplementation with additives. J. A. C. Lima[*1,2], H. J. Fernandes[2], M. F. Paulino[1], E. P. Rosa[2], L. S. Caramalac[2], K. A. Silveira[2], B. D. D'auria[2], and A. Aguiar[3], *[1]Federal University of Viçosa, Brazil, [2]State University of Mato Grosso do Sul, Aquidauana, Brazil, [3]University of Florida, Gainesville.*

The objective of this study was to evaluate the effect of a commercial concentrate supplement with additives in the digestibility of the nutrients on grazing bulls, during the dry/rainy transition season in Aquidauana–MS, Brazil. Twelve Nellore bulls (initial body weight of 370 ± 15 kg) were randomly assigned to 12 *Brachiaria decumbens* Stapf pastures (1.0 ha/pasture; one bull/pasture) on a completely randomized design. Treatments were: 1) concentrate supplement Lipomax with homeopathic additives (Convert H, Sodo 100, Figotonus) and Virginiamicina (Lipomax treatment), and 2) concentrate supplement with a similar protein content (18% CP), and without additives (Control treatment). Animals were feed daily at rate of 0.5% of the animal's body weight. After 45 d, when the animals achieved body weight closed to 420 kg, the digestibility trial started. Digestibility was estimated using the enriched and purified lignin (LIPE) as marker for fecal excretion estimation, and the indigestible neutral detergent fiber as internal marker. Forage nutritive value was estimated by hand-plucked sampling, and supplement intake was measured directly for each animal. A significance level of 5% was adopted. The coefficients of digestibility (CD) of the nutrients were obtained by the intake and composition of the forage and the supplement, and by analysis of feces, which was collected for five consecutive days. A significance level of 5% was adopted. The digestibility of the ether extract differed ($P < 0.05$), was greater in the Control treatment (Table 1652) and no other differences were significant. The similarity in composition between concentrated supplements, and the fact that the concentrate represented just around 10% of the diet of the animals influenced these results. The additives appears to work just in the animal's metabolism, without affecting the diet digestibility.

Key Words: additives, digestibility, grazing bulls

1653 (T266) Pre- and post-weaning performance and health of calves fed 24% crude protein and 20% fat milk replacer at different feeding rates.

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In our previous work, calves fed greater amounts of milk replacer (MR) and CP demonstrated improved growth. The current study was to evaluate the pre- (d 1 to 42) and post- (d 43 to 56) weaning performance and health of calves fed a 24% CP and 20% fat MR at different feeding rates (FR). One hundred four (1- to 5-d-old) individually fed Holstein heifer calves (40 ± 0.69 kg) were randomly assigned to one of four treatments in a randomized complete block design. The same all milk MR was fed at 14.7% solids with treatments being 1) Control (MR57): MR fed at 0.284 kg in water twice daily for 35 d; 2) MR71: MR fed at 0.34 kg twice daily from d 1 to 7 and at 0.34 kg twice daily from d 8 to 35; 3) MR85: MR fed at 0.34 kg twice daily from d 1 to 7 and at 0.43 kg twice daily from d 8 to 35; and 4) MR99: MR fed at 0.34 kg twice daily from d 1 to 7 and at 0.497 kg twice daily from d 8 to 35. All treatments were fed once daily MR from d 36 to weaning at d 42 with water and an 18% CP texturized calf starter (CS) offered free choice. Pre-weaning and overall ADG (0.78, 0.82, 0.83 and 0.85 kg/d for MR57, MR71, MR85, and MR99, respectively) were higher ($P < 0.05$) for MR99 calves vs. MR57 calves with other calves being intermediate. Overall d 1 to 56 CS intakes were higher for MR57 calves vs. other calf groups. There were no differences ($P > 0.05$) in total DMI. Pre-weaning gain/feed was lowest ($P < 0.05$) for MR57 calves. Gain/feed d 1 to 56 (0.49, 0.52, 0.52 and 0.54 kg/kg DM) was higher for MR99 vs. MR57 calves with other calves being intermediate. This study demonstrated that feeding higher FR of a 24:20 MR resulted in higher ADG's and feed conversions (gain/feed).

Key Words: milk replacers, feeding rate, calf performance

1654 (T267) Pre- and post-weaning performance and health of calves fed milk replacers with two protein concentrations and two feeding rates.

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One hundred eight (1- to 5-d-old) Holstein heifer calves (39.3 ± 0.66 kg) were randomly assigned to one of four milk replacers (MR) to evaluate pre- (d 1 to 42) and post- (d 43 to 56) weaning performance in a 2 × 2 factorial design of crude protein (CP) concentrations (20% (CP) and 24% (HP)) with feeding rates (FR; 0.57 (1) and 0.68 (2) kg/d). Treatments were MR fed at 15% solids of: 1) Control (CP1): a 20% CP:20% fat MR fed at 0.284 kg 2x/d for 35 d; 2) CP2: the 20:20 MR fed at 0.34 kg 2x/d for 35 d; 3) HP1: a 24:20 MR fed at CP1 rate; and 4) HP2: the 24:20 MR fed at CP2 rate. All MR's were fed at 1x/d from d 36 to weaning at d 42 with water and 18% CP texturized calf starter (CS) offered free choice through d 56. No significant ($P > 0.10$) interactions of CP by FR were detected for growth parameters. During d 1 to 14, calves fed CP2 and HP2 had the greatest ADG (0.36, 0.44, 0.36, and 0.45 kg/d for CP1, CP2, HP1 and HP2, respectively) compared to calves fed CP1 and HP1, but the interaction was nonsignificant ($P > 0.10$). Pre-weaning ADG's (d 1 to 42) were similar ($P > 0.10$). Calves fed HP2 had numerically greatest overall ADG d 1 to 56 compared to calves fed CP1 and HP1 with CP2 being intermediate. Intake of CS from d 1 to 56 was similar ($P > 0.10$) for calves fed MR with different CP concentrations (0.77 and 0.78 kg/d), while CS intake (0.81 and 0.74 kg/d) was reduced ($P < 0.05$) for calves fed higher MR FR. Feed conversions from d 1 to 56 were similar for calves fed different CP concentrations (0.54 and 0.55 kg/kg), but were improved when fed higher MR FR (0.53 and 0.56 kg/kg). However, a trend ($P < 0.11$) of CP by FR interaction from d 43 to 56 demonstrated calves fed CP2 having greater feed conversions (0.46, 0.53, 0.46 and 0.49 kg/kg for C-, C+, HP-, and HP+, respectively) compared CP1, HP1 and HP2 calves. Thus, indicating a carryover effect on post-weaning performance for CP2 calves. The results demonstrate calves fed a conventional MR at different FR with different CP concentrations performed similarly. Calves fed higher CP MR at higher FR had numerically the greatest ADG.

Key Words: milk replacers, protein concentration, feeding rate

1655 (T268) The effect of dietary supplementation of artificial sweetener on performance of milk-fed calves.

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The small intestine contains nutrient receptors that react to changes in the composition of ingested feed. The feed additive Sucram (Pancosma, Switzerland) is an artificial sweetener that has been shown to increase absorption of glucose from the small intestine by activating sweet taste receptors in swine, this response results in improved animal performance. Recently, it was reported that a similar increase in glucose absorption was observed in calves supplemented with Sucram; however, it was unclear if there is a corresponding improvement in calf performance. Therefore, the current experiment was per-

formed to determine the effect of Sucram on performance of milk-fed calves. Sixteen male Holstein calves were assigned to two treatments (n = 8 per treatment): control (no additive), or Sucram (daily supplementation of 400 mg g Sucram per kg dry matter of milk replacer). All calves received 2 feeding/d of 2 L of milk replacer plus ad libitum commercial concentrate until weaning (50 d of age). Calves were weighed at the beginning and at the end of the experiment. Individual calf concentrate intake was measured weekly. Blood samples were collected the last day of the trial before feeding to analyze levels of insulin and glucose. Feed efficiency was calculated for each animal (total weight gain/average weekly concentrate intake from wk 2 to 5). Data were subjected to analysis of variance using the PROC MIXED of SAS. For body weight and concentrate intake, data for wk 1 were used as a covariate in the analysis. There were no effect of Sucram on final body weight (67.0 *vs.* 67.3 kg; P = 0.93), but there was a decrease in feed intake of Sucram calves (6.5 vs. 5.7 kg/wk; P = 0.10). Therefore, efficiency of feed was higher in animals supplemented with Sucram (gain/feed = 4.8 vs. 5.71; P = 0.10). There was no effect of Sucram on the concentration of serum insulin (0.23 vs. 0.21 µg/L; P = 0.74) or glucose (78.8 vs. 82.6 mg/dL; P = 0.45). We conclude that supplementation of milk-fed calves with artificial sweetener improves feed efficiency. However, additional experiments are needed to determine the mechanism underlying this response. The use of Sucram in milk replacer represents a potential management tool for dairy producers to increase feed efficiency of milk-fed calves and decrease the cost of animal rearing on commercial farms.

Key Words: sweetener, performance, milk-fed calves

1656 (T269) The effect of supplementation with a blend of capsicum, carvacrol, and cinnamaldehyde on performance of milk-fed calves. A. Siurana*[1], E. H. Wall[2], M. Rodríguez[1], L. Castillejos[1], A. Ferret[1], and S. Calsamiglia[1], *[1]Animal Nutrition and Welfare Service, Dep. of Animal and Food Sciences, Universitat Autònoma de Barcelona, Bellaterra, Spain, [2]Pancosma, Geneva, Switzerland.*

Plant extracts have antimicrobial properties that may reduce the risk of disease and improve the health and performance of young animals. The objective of this experiment was to study the effect of an essential oil feed additive (EO; XT-6930; Pancosma, Switzerland) on the performance of milk-fed calves. Eight male Holstein calves were randomly assigned to one of two treatments (n = 4 per treatment): control (no additive) or EO (115 mg/calf/d of XT-6930 added to milk replacer). Calves were housed in individual hutches and received 2 feeding/d of 2 L of milk replacer (22.4% CP, 20.6% fat) plus ad libitum access to commercial concentrate (16.9% CP; 5.3% crude fiber) until weaning (50 d of age). Calves were weighed at the start and the end of the experiment and concentrate intake was measured individually once a week. Feed efficiency was calculated for each calf as the ratio of body weight gain to average concentrate intake during the experimental period (wk 2 to 5). Blood samples were collected from the jugular vein on the last day of the experiment before feeding to analyze insulin and glucose concentrations. Average daily weight gain was higher (P = 0.02) in EO calves (0.83 kg/d) compared with control (0.63 kg/d) and feed intake was also higher (P = 0.01) in EO compared to control calves (7.23 vs. 5.71 kg/wk, respectively). The efficiency of feed conversion was not affected by treatment (gain/feed = 4.11 vs. 4.09 for EO and control calves, respectively; P = 0.95). There was no effect of treatment on serum concentrations of insulin (0.80 vs. 1.69 µg/L for control and EO, respectively; P = 0.31) or glucose (91.6 vs. 106.2 mg/dL for control and EO, respectively; P = 0.29). We conclude that supplementation of milk replacer with EO increased concentrate intake of milk-fed calves. Although there was no effect on feed efficiency, the increase in average daily weight gain has implications for decreasing costs associated with animal rearing. In addition, the increase in the intake of starter grain may enhance development of the rumen and subsequent animal performance.

Key Words: plant extracts, performance, calves

1657 (T270) Effect of milk replacer solids content on intake, growth and fecal characteristics of Holstein calves. J. D. Quigley*, T. M. Hill, H. G. Bateman, II, J. M. Aldrich, and R. L. Schlotterbeck, *Provimi North America, Brookville, OH.*

Increased energy intake during cold weather is required to maintain adequate calf growth. Many producers have limited ability to increase volume of liquid offered to calves; therefore, increasing solids content (SC) of the MR solution can increase energy content of milk replacer (MR). Common SC are 12 to 13%, but calves may be fed MR with SC up to 18% in some situations. It is unclear whether changing SC may affect performance, intake or health of young calves fed MR. Our objective was to compare different SC in calves fed MR to 56 d. Holstein bull calves (n = 48; initial BW = 45.4 ± 4.0 kg; 2 to 3 d of age) were assigned randomly to receive a commercial MR (Nurture Plus EZ, Provimi North America, Brookville OH) at 0.625 kg of MR powder from 0 to 39 d, then 0.313 kg/d until weaning at d 42. The MR (23% protein and 21% fat, DM basis) was diluted to 10.0, 12.5, 15.0, or 17.5% SC and offered twice daily in open pails. Amount of reconstituted MR offered was 6.25, 5.00, 4.17 and 3.57 kg/d for 10.0, 12.5, 15.0 and 17.5% SC, respectively. Texturized calf starter (CS; 20% CP, DM basis) and water were available for ad libitum consumption throughout the study. Data were analyzed as a completely randomized design using a repeated measures ANOVA. Orthogonal polynomials were used to determine linear and quadratic effects of SC. Pen was the experimental unit. There was no effect (P > 0.10) of SC on average daily gain (0.57 ± 0.027 kg/d), CS intake (0.74 ± 0.06 kg/d), MR intake (0.603 kg/d to weaning),

gain to feed ratio (0.48 ± 0.017 kg ADG/kg DM intake), or hip width change (0.1 ± 0.01 cm/d) from d 0 to 56. Number of abnormal fecal days and medical days preweaning declined linearly ($P < 0.05$) with increasing SC. Number of preweaning abnormal fecal days were 0.22, 0.13, 0.13 and 0.07 ± 0.039 and preweaning medical days were 0.32, 0.25, 0.19 and 0.08 ± 0.056, respectively, for calves fed 10.0, 12.5, 15.0, and 17.5% SC. Increasing milk replacer SC reduced abnormal fecal days and number of treatments.

Key Words: calves, milk replacer, growth

1658 (T271) Pre- and post-weaning performance and health of dairy calves fed all-milk protein milk replacers or partially replacing milk protein in milk replacers with plasma, wheat proteins and soy protein concentrate. D. Ziegler[*1], H. Chester-Jones[1], B. Ziegler[2], D. Schimek[2], M. Raeth-Knight[3], and D. L. Cook[4], *[1]University of Minnesota Southern Research and Outreach Center, Waseca,, [2]Hubbard Feeds Inc., Mankato, MN, [3]University of Minnesota, St. Paul, [4]Milk Products, Chilton, WI.*

One hundred five (2- to 5-d-old) individually fed Holstein heifer calves (39.8 ± 0.73kg) were randomly assigned to one of four treatments to evaluate pre- (d 1 to 42) and post weaning (d 43 to 56) calf performance and health when fed milk replacers (MR) with alternative protein sources. Calves were assigned to non-medicated MR with 1) All milk protein (AM), 2) 50% of total protein from wheat and plasma (WPL), 3) 50% of total protein from soybean protein concentrate (SPC) and plasma (SPL), and 4) 50% combination of wheat, SPC and plasma (SWP). All calves were fed a non- medicated 20% fat:20% CP MR at 0.284 kg in 1.99 L water (12.5% solids) 2x/d for the first 35 d and 1x/d d 36 to weaning at 42 d. Day 1 to 14, 1:1 neomycin:oxytetracycline was added to the MR solution to provide 22 mg/kg BW/d. Calf starter (CS; 18% CP) and water were fed free choice from d 1. Osmolality of the MR were 469, 421, 395, and 412 mOsm/L for AM, WPL, SPL, and SWP, respectively. There were no pre- ($P = 0.11$) or post ($P = 0.30$) weaning ADG differences. Calves averaged 0.74 kg/d gain for the 56-d study. There were no differences in CS ($P = 0.22$) or total DMI ($P = 0.33$) intake, which averaged 55.3 and 77.08 kg for the 56-d study, respectively. Pre-weaning gain/feed was higher ($P < 0.05$) in calves fed WPL vs. those fed SPL and SWP but similar to AM calves. There were no overall 56-d differences in gain/feed ($P = 0.19$). Across treatments, calves doubled their initial BW and gained > 10.2 cm in frame growth. Fecal scores d 1 to 14 and overall were higher ($P < 0.05$) for AM fed calves compared to WPL, SPL, and SWP treatments. The number of scouring d pre-weaning were also higher ($P < 0.05$) for AM calves vs. those fed SPL and SWP with WPL calves being intermediate. There were no differences in health treatment costs. Under the conditions of this study, replacing 50% of the total milk protein in MR with alternative sources resulted in calf performance and health similar to all milk protein.

Key Words: calf performance, milk replacers, alternative proteins.

1659 (T272) Effect of Radix Bupleuri herbal supplementation on diversity of the bacterial community and cellulolytic bacteria in the rumen of lactating dairy cows analyzed by DGGE and RT-PCR. L. Pan, D. P. Bu*, J. Q. Wang, J. B. Cheng, X. Z. Sun, and W. Liu*, State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China*.

Numerous studies have been completed on use of herbal medicine in substitute for chemical feed additives to modify rumen fermentation. This experiment was conducted to investigate effects of *Radix Bupleuri* herbal supplementation (RBH) on diversity of the bacterial community and cellulolytic bacteria including *Fibrobacter Succinogenes, Ruminococcus albus* and *Ruminococcus flavefaciens* in the rumen of lactating dairy cows analyzed by DGGE and RT-PCR. Forty Holstein cows were assigned to one of 4 groups ($n = 10$) according to milk yield (37.5 ± 1.8 kg/d), day in milk (75 ± 15) and parity (1.7 ± 0.4) in a completely randomized block design. Four treatment diets consisted of supplemental RBH at 0, 0.25, 0.5 or 1.0 g/kg based on dry matter, which were randomly assigned to one of 4 groups. Cows were individually fed the treatment diets, and the experiment lasted for 10 wk in Shanghai. Rumen fluid samples were collected at 2 h post-feeding using stomach-tube on wk 6 of the trial. Rumen samples were strained through four layers of cheesecloth and frozen at -20°C until being analyzed. Rumen microbial DNA was extracted with CTAB plus bead beating and analyzed by DGGE with subsequent cluster and optimal density of the bands analysis. The copy number of rumen cellulolytic bacteria was detected by quantitative RT-PCR with species-specific PCR primers amplifying partial 16S rDNA regions. Diversity index values and data of copy numbers of 16s rDNA were analyzed using GLM procedure of SAS 9.2. DGGE profiles showed that the quantity of bands was similar, while the optimal density was different between control and treatment. The dendrogram of the DGGE fingerprint showed that they were assigned to different clusters by different supplemental levels with DGGE fingerprint similarity less than 0.54 overall. Shannon-Weiner index decreased ($P < 0.05$) especially with 1.0 g/kg RBH, while the dominance index increased ($P < 0.05$) especially at 0.25 and 0.5 g/kg levels compared with the control. RT-PCR revealed no difference in cellulolytic bacteria among groups. In total, RBH supplementation proved little effects on diversity of the bacterial community and cellulolytic bacteria in the rumen of lactating dairy cows potentially owing to gradual adaptation of rumen bacteria to the RBH supplementation.

Key Words: bacterial community, cellulolytic bacteria, Radix Bupleuri

1660 (T273) The effect of soluble propolis in milk on the performance of Holstein suckling calves.

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This study was conducted to evaluate the effect of added soluble propolis in milk on the dry matter intake, body weight, digestibility and feed efficiency of Holstein suckling calves. Propolis in this experiment was come from Taleghan vicinity (near Tehran). Forty female Holstein calves with average 41 ± 1 kg birth weight were used from 14 to 65 d old. Calves were fed according to completely randomized design with four treatments (rations) and 10 replicates (calves) in each treatment. Treatments included: 1) Control (without Monensin in starter and without propolis in milk), 2) Starter without Monensin and 500ppm soluble propolis powder in milk, 3) Starter without Monensin and 1000ppm soluble propolis powder in milk, and 4) Monensin in starter and without propolis in milk. To reduce the stress of weaning, calves stayed in their boxes after weaning for 9 d. Individual dry matter intake was measured daily, and weight gain was measured each 14 d. Digestibility was measured with fecal sampling after weaning and the marker was acid insoluble ash (AIA). The results showed that dry matter intake had no significant differences among treatments in suckling period. But differences among dry matter intake of calves after suckling period were significant ($P = 0.01$). Means feed intake in whole period for treatments 1 to 4 were 1115.51, 1034.24, 1054.76, 920.81 g/d, respectively, and their differences were significant ($P = 0.04$). Means body weight for treatments 1 to 4 were 64.67, 60.84, 64.89, 62.25 kg, respectively, and there was a significant differences among treatments ($P = 0.01$). The feed efficiency for treatments 1 to 4 were 0.402, 0.393, 0.410, 0.404, and there were no significant differences among treatments ($P = 0.9$). Apparent digestibility of OM (76.76, 76.89, 78.03, and 78.11%), DM (78.97, 76.12, 77.32, and 77.42%) and NDF (57.99, 52.49, 52.89, and 52.60%) for treatments 1 to 4 respectively had no significant differences. The results showed the positive effect of propolis (biological additive) on the both dry matter intake and body weight in compare of Monensin (synthetic additive) which had the lowest dry matter intake and low body weight. Therefore, this study suggested that propolis could improve performance of calves.

Key Words: propolis, performance of calves, Monensin

1661 (T274) Supplementation of lysine and methionine for dairy calves on a step down milk-replacer feeding program.

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The aim of this study was to evaluate the performance of calves receiving starter concentrate or milk replacer supplemented with lysine and methionine to reach daily intakes of 17 g/d and 5.3 g/d, respectively. Forty-five newborn Holstein male calves were used in a randomized blocks experimental design and distributed into three treatments: 1) Control: no amino acid (AA) supplementation; 2) Starter concentrate: supplementation of lysine and methionine in the concentrate starter; 3) Milk replacer: supplementation of lysine and methionine in the milk replacer. Calves were housed in individual shelters, with free access to water, starter concentrate, and received milk replacer (20CP:16EE; 12.5% solids) according to the program: 4 L/d, until wk 2 of life; 8L/d from the 2 to 6 wk of life; and 4L/d from the 6 to 8 wk, when they were weaned. Calves were followed until the 10 wk of life. Starter concentrate and milk replacer intakes, as well as fecal scores were monitored daily. Body weight, withers height, heart girth and hip width were weekly measured. Supplementation of amino acids in the milk replacer resulted in lower total dry matter after weaning, which resulted on lower daily gain in the same period.

Key Words: amino acids, growth, weaning

Table 1661. Performance of dairy calves receiving starter concentrate or milk replacer supplemented with lysine and methionine

	Control	Starter concentrate	Milk replacer	SEM	$P <$
Body weight, kg					
Initial	36.3	36.3	37.4	2.06	0.267
At weaning	47.57	47.74	48.80	2.06	0.267
Final	54.55	54.73	56.1	2.07	0.267
Daily gain, g					
Before weaning	193.9	232.0	151.7	34.44	0.275
After weaning	553.5 ab	676.1 a	344.0 b	141.41	0.028
Starter intake, g/d					
At weaning	306.1	348.4	180.2	68.21	0.423
Final	1502.7	1615.61	1235.1	94.4	0.372
Total dry matter intake, g/d					
Before weaning	793.7	850.2	787.6	20.98	0.078
After weaning	1293.5 a	1341.3 a	950.6 b	90.69	0.009
Feed efficiency, daily gain/total intake	0.23	0.24	0.14	0.04	0.120
Fecal score	2.35	1.83	2.02	0.35	0.640
Height withers gain, cm/week	0.64	0.76	0.65	0.41	0.976
Heart girth gain, cm/week	1.09	1.44	0.96	0.18	0.184
Hip width gain, cm/week	0.33	0.30	0.31	0.03	0.889

[ab] means with different letters differ at $P < 0.5$

1662 (T275) Response of newborn calves to injectable vitamins A, D and E. D. B. Snider[*1], J. Gaska[2], D. E. Gockowski[3], and R. L. Stuart[4], *[1]Iowa State University, Ames, [2]Gaska Dairy Health Services, Columbus, WI, [3]North Ridge Veterinary Service, Sturgeon Lake, MN, [4]Stuart Products Inc, Bedford, TX*.

Due to poor placental transfer, newborn calves depend mainly on colostrum and milk to supply fat-soluble vitamin needs. If the dam has not received sufficient fat-soluble vitamins during gestation, colostrum may be deficient in these critically important vitamins resulting in deficiencies in the newborn. Weak-calf syndrome has been shown to be partly due to vitamins E and A deficiencies in calves. Injecting fat-soluble vitamins at birth is a method to enhance fat-soluble vitamin status during the first few weeks after birth. Two experiments were conducted to measure efficacy of a commercial product (VITAL E-Newborn, Stuart Products, Inc.) in newborn beef and dairy calves. The product contained 500 I.U. vitamin E, 50,000 I.U. vitamin A and 50,000 I.U. vitamin D per mL. In experiment 1, newborn beef calves (n = 4) were not injected and calves (n = 4) injected S.Q. with 5 mL VITAL E-Newborn. Serum samples were taken initially and Days 1, 2, and 7 post-injection and analyzed for α-tocopherol, total vitamin A (retinol plus retinyl-palmitate), and 25-OH-D3. In experiment 2, newborn dairy calves (n = 4) were not injected and calves (n = 7) were injected S.Q. with 5 mL VITAL E-Newborn. Serum samples were taken 62 h post-injection and analyzed for α-tocopherol, retinol and 25-OH-D3. For experiment 1, serum α-tocopherol concentrations in non-injected calves were 0.26, 0.46, 0.63, and 1.14 μg/mL; total vitamin A concentrations were 0.077, 0.126, 0.152, and 0.123 μg/mL; and 25-OH-D3 concentrations were 10.0, 9.0, 9.3, and 10.6 hg/mL, for d 0, 1, 2, and 7, respectively. Vitamin-injected calves had serum α-tocopherol concentrations of 0.40, 16.4, 12.6, 5.9 μg/mL; total vitamin A concentrations of 0.053, 0.262, 0.270, and 0.151 μg/mL; and 25-OH-D3 concentrations of 6.0, 23.0, 42.1 and 54.7 hg/mL for d 0, 1, 2, and 7, respectively. All post-injection serum vitamin concentrations between treatments were different (P < 0.001). Experiment 2 had similar results as experiment 1. At 62 h post-injection, average serum α-tocopherol concentrations were 1.30 and 10.20 (P < 0.001); average serum retinol concentrations were 0.128 and 0.154 μg/mL (P < 0.10); and average serum 25-OH-D3 concentrations were 24.2 and 78.6 hg/mL (P < 0.001) for control and injected calves, respectively. Injecting newborn calves with a bioavailable source of fat-soluble vitamins is an excellent method to assure that newborn beef and dairy calves have adequate levels of these critically important vitamins after birth.

Key Words: vitamin A, vitamin E, vitamin D, newborn, injectable

1663 (T276) Fecal scores, hemogasometry and blood metabolites of diarrheic calves fed concentrate containing sugarcane molasses or glucose syrup as a replacement for corn. M. C. Soares[1], G. G. O. Nápoles[1], C. E. Oltramari[2], J. T. Silva[1], M. R. De Paula[1], and C. M. M. Bittar[*1], *[1]University of Sao Paulo, Piracicaba, Brazil, [2]University of Santa Catarina State, Chapecó, Brazil.*

During the milk-feeding period, 32 calves were distributed into four treatments: 1) Control: starter feed containing corn as the main energy source (65% corn; 24% soybean meal; 10% soybean hulls, 1% minerals and vitamins, on dry matter basis); 2) 5SCM: 5% (DM) of sugarcane molasses replacing corn; 3) 10SCM: 10% (DM) of sugarcane molasses replacing corn; 4) 5GS: 5% glucose syrup (DM) replacing corn. Animals were individually housed, with free access to water and concentrate, and received 4 L/d of milk replacer (20:16; 12.5% solids). After the diagnosis of diarrhea, evaluations of fecal score and measurement of respiratory and heart beat rates as well as rectal temperature were performed 3x/d, during three consecutive d. Blood samples were collected for blood cells count, electrolytes, blood gases and biochemical parameters analysis. Concentrate composition had no negative effect (P > 0.05) on fecal score, which were higher than 2.5 during the first 4 wk and decreased thereafter for all treatments. There was a tendency (P < 0.09) for higher rectal temperature (39.1; 39.4; 39.5; 39.1 for Control, 5SCM, 10SCM and 5GS, respectively) and respiratory rate (36.2; 41.9; 46.3; 34.0 breaths/min for Control, 5SCM, 10SCM and 5GS, respectively) for calves fed both levels of molasses. Respiratory rate, heart beat rate and rectal temperature increased during the day, as temperature-humidity index also increased. Replacement of corn by co-products had no effect (P > 0.05) on total erythrocytes (6.87×10^6/μL), mean corpuscular volume (37.9 fL) and hemoglobin (8.99 g/DL), however hematocrit was increased (P < 0.05) as co-products were fed (23.0a; 26.4b; 28.9c; 25.1b for Control, 5SCM, 10SCM and 5GS, respectively). There were no concentrate composition effects on blood pH (7.33), HCO_3 (28.18 mmol/L), PCO_2 (52.6 mmHg), K and Na (4.9 and 135.7 mEq/L, respectively), anion gap (13.38 mmol/L) and base excess (2.33 mmol/L) concentration. Plasma metabolites were also not affected by replacement of corn by co-products in the concentrate, with values of BHBA (0.06 mml/L), glucose (82.5 mg/dL), total protein (6.8 g/dL), PUN (7.1 mg/dL) and total lactate (16.45 mg/dL) within the normal physiological range for dairy calves during the milk-feeding period. Replacement of corn with molasses or glucose syrup in the supplement did not affect animals' metabolism in response to the occurrence of diarrhea and can be used as an alternative for feeding dairy calves.

Key Words: byproducts, metabolic disorders, milk-feeding, starter feed

1664 (T277) Fecal scores, hemogasometry and blood parameters of diarrheic calves fed concentrate containing citrus pulp as a replacement for corn. M. C. Soares[1], C. E. Oltramari[2], J. T. Silva[1], M. R. De Paula[1], M. P. Gallo[1], and C. M. M. Bittar[*1], [1]*University of Sao Paulo, Piracicaba, Brazil,* [2]*University of Santa Catarina State, Chapecó, Brazil.*

During the milk-feeding period, 24 calves were distributed into three treatments: 1) Control: starter feed containing corn as the main energy source (64% corn; 26% soybean meal; 6% wheat meal; 3% limestone; 1% minerals and vitamins, on dry matter basis); 2) 50CP: 50% (DM) of citrus pulp replacing corn, 3) 100CP: 100% (DM) of citrus pulp replacing corn. Animals were individually housed, with free access to water and concentrate, and received 4 L/d of milk replacer (20:16; 12.5% solids). After the diagnosis of diarrhea, evaluations of fecal score and measurement of respiratory and heart beat rate and rectal temperature were performed 3x/d, during three consecutive days. Blood samples were collected for blood cells count, electrolytes, blood gases and biochemical parameters analysis. Concentrate composition had no negative effect ($P > 0.05$) on fecal score, which were higher than 2.5 during the first 4 wk and decreased thereafter. Respiratory and heart beat rates were not affected ($P > 0.05$), as well as rectal temperature, however values were always lower at 7 h as compared to 12 h and 19 h evaluations, suggesting high impact of environmental conditions for sick calves. Inclusion of citrus pulp in concentrate had no effect ($P > 0.05$) on hematocrit (23.9%) and total erythrocytes (6.93×10^6/μL), but affected the mean corpuscular volume, with the highest value for animals fed 50CP (40.3fL). Increase of total leukocytes and neutrophils suggests the occurrence of an infectious instead of an alimentary diarrhea. Blood gases, electrolytes and biochemical data did differ ($P > 0.05$) nor resulted in dehydration, acidosis, or any other metabolic disturbance in animals. There were no concentrate composition effects on blood pH (7.36), HCO_3 (27.16 mmol/L), PCO_2 (52.3 mmHg), K and Na (4.6 and 134.1 mEq/L, respectively), anion gap (12.2 mmol/L) and base excess (4.7 mmol/L). Plasma metabolites such as BHBA (0.057mml/L), glucose (85.6 mg/dL) and PUN (7.96 mg/dL) were not affected; however, total lactate and D-lactate were lower ($P < 0.05$) for calves fed 50CP (16.0; 9.17 mg/dL respectively), as compared to control (20.8; 14.7 mg/dL) and 100CP (23.8; 14.4 mg/dL); while L-lactate lowest for 100CP (9.42; 6.8; 6.1 mg/dL for 100CP, 50CP and control, respectively). Replacement of corn by citrus pulp in the concentrate did not affect animals' metabolism in response to the occurrence of diarrhea, being an alternative for feeding dairy calves.

Key Words: byproducts; metabolic disorders; milk-feeding; starter feed

1665 (T278) Effect of diet particle size on sorting, eating rate, rumen ph and digestibility in dairy heifers. F. H. Pino*, A. J. Heinrichs, and C. Castro, *Pennsylvania State University, University Park.*

Eight cannulated dairy heifers (19.3 ± 0.8 mo of age and 524.51 ± 10.01 kg of BW) were fed either long (62.7mm; LCS) or short (6.1mm; SCS) cut corn silage at 1.65% BW in individual stalls to determine eating behavior and digestion parameters. Diets consisted of 70% corn silage, 11% ground corn, 8% citrus pulp, 6% canola meal, 2% soy bean hulls, 1.2% Optigen and 2% mineral/vitamin mix fed once daily. Heifers were subject to a cross over design study with 18-d periods; 14 d adaptation 4 d sampling. Particle size of theTMR was measured at 0 and 2 h after feeding. Feces were collected (d 14 to 18) to determine DM digestibility. Rumen contents were sampled (d 17 to 18) to measure pH at 0, 1, 2, 4, 8, 12, 16, 20, and 22 h after feeding. Data were analyzed with PROC MIXED of SAS 9.4. The LCS ration had an increase of 91% of long (> 19 mm) feed particles 2 h after feeding with no change in feed particles on the SCS diet. Feed particles retained on the eight 4-mm and pan sieves decreased 7, 30, and 35%, respectively. The overall rate of eating was not different between treatments (2.75 vs. 2.37 kg/h SCS and LCS, respectively; $P = 0.47$). Rumen pH changed throughout the day from 7.1 to 4.7 from feeding to 8 h post feeding but was not different between treatments ($P = 0.55$). It is likely that these variables were not different because the heifers were fed a restricted diet (8.73 ± 0.19 kg of DMI) that was consumed by 4 h after feeding. The DM digestibility of diets (75.24 ± 2.2%) was not different ($P = 0.37$). In conclusion, there are no differences in rumen pH, eating rate and DM digestiblity with different particle size diets. Differences in the TMR particle size 2 h after feeding suggest that heifers sort the diets indicating selective consumption of the small particles and selective refusal for the long feed particles. This sorting could promote competition and selective consumption of feed particles by the more dominant heifers, which could lead to inappropriate and variable nutrition for heifers with group fed animals.

Key Words: heifers, sorting, DM digestibility

1666 (T279) Fatty acid profiles of *Longissimus dorsi* from Nellore cattle on pasture supplemented with crude glycerin and whole cottonseed. J. T. Zervoudakis[*1], A. J. Possamai[2], L. K. Hatamoto-Zervoudakis[1], A. S. Oliveira[3], L. B. D. Freiria[1], R. P. D. Silva[1], A. C. Barboza[2], and J. W. Koscheck[4], [1]*Federal University of Mato Grosso, Cuiaba, Brazil,* [2]*UFMT, Cuiabá, Brazil,* [3]*UFMT, Sinop, Brazil,* [4]*UNESP, Jaboticabal, Brazil.*

There is interest in the composition of fatty acids (FA) in beef for reduction of short-chain FA, with increment of medium-chain and omega-3 FA, by their anticarcinogenic and

immune-stimulatory effects. Nutritional strategies to improve meat quality should be studied to possibility better meat FA profile in this products. The aim of this experiment was to evaluate whole cottonseed and crude glycerin association in multiple supplements for 50 Nellore cattle in the fattening phase at *Brachiaria brizantha* pastures on longisssimus dorse FA profile. Animals were supplemented with 4 kg/d (21% of crude protein). The experiment was performed in a 2 × 2 factorial design (two levels of crude glycerin (0 and 15%) and two levels of whole cottonseed (0 and 25%). Orthogonal contrasts were used to evaluated the effect of crude glycerine, whole cottonseed and the interaction, adopting 0.05 to the critical level of probability. Inclusion of whole cottonseed reduced the quantity of hypercholesterolemic FA: C14:C19 ($P = 0.049$), C16:0 ($P = 0.038$), C16:C19 ($P = 0.006$) and C17:0 ($P = 0.028$). However, inclusion of crude glycerin increased C17:0 ($P = 0.002$) and C17:1 ($P = 0.003$). The cottonseed promoted an increase in the concentration of C18:0 ($P < 0.001$) possibly due to extensive biohydrogenation of isomers C18:1, C18:2 and C18:3 ($P < 0.001$). The glycerin promoted an increase in C18:2c9*t*11 conjugated linoleic acid ($P = 0.046$) due to reduction in lipolysis of FA in the rumen, with limited biohydrogenation. The C20:1 ($P = 0.02$) was reduced by feeding of cottonseed, due to the low concentration of this fatty acid in the ingredient. There was no influence of the inclusion of glycerin and/or cottonseed on the total of saturated FA, monounsaturated or polyunsaturated FA, as well as their relations ($P > 0.05$). The supply of glycerin and whole cottonseed modify the FA profile, because of ruminal biohydrogenation modulation by glycerine, for healthy meat production.

Key Words: meat quality, supplementation, stearic acid

1667 (T280) Performance and carcass attributes of Nellore heifers fed with zilpaterol hydrochloride.

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Greater efficiency of production is mandatory in modern beef cattle industry, and use of feed additives, such as β-adrenergic agonists, have demonstrated positive results with *Bos taurus* cattle. However, there are no consistent data on the effects of these substances in Nellore (*Bos indicus*), which accounts for more than 70% of the Brazilian beef cattle. Therefore it was the objective of this study to evaluate the effects of zilpaterol hydrochloride (Zilmax) on the performance and carcass attributes of Nellore heifers. Seventy-two animals with 267 kg of BW and 18 mo of age were fed in a feedlot system for 135 d. Heifers were separated into two treatment groups: Control (C) and Zilpaterol (Z), which received the same diet containing 14% of crude protein, and formulated with corn silage, ground corn, soybean meal and mineral premix. The Z group received Zilmax at 8.3 mg/kg dry matter. Heifers were allotted to 18 pens ($n = 9$) and assigned in a completely randomized design. Animals were weighed at 21-d intervals after 16-h fasting to evaluate growth performance. Zilmax was administrated during the last 30 d of feeding, allowing 3 d of withdraw before slaughter. All animals were slaughtered in a commercial plant, according to proper welfare guidelines. Hot carcass weight, carcass yield, kidney, pelvic and abdominal fat weight were measured. Twenty-4 h later, longissimus muscle area and backfat thickness were measured at the interface of the 12th and 13th ribs. Zilpaterol administration increased ($P < 0.01$) final body weight (404 vs. 387 kg), average dairy gain (1.46 vs. 1.14 kg/d), hot carcass weight (224 vs. 208kg), and dressing percentage (56 vs. 54%) compared with control. However, no effects ($P > 0.10$) were noted in the longissimus muscle area (73.1 vs. 83.5 cm^2) and subcutaneous fat depth (5.2 vs. 4.8 mm) between C and Z group, respectively. In addition, there was a reduction in kidney and pelvic fat by zilpaterol administration compared with C (4.6 vs. 5.7% of hot carcass weight). In conclusion, zilpaterol treatment improved the performance and carcass characteristics of Nellore heifers in feedlot system.

Key Words: heifers, Nellore, zilpaterol

1668 (T281) Carcass characteristics of Nellore steers fed whole corn diets containing feed antibiotics.

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The objective was to investigate the effects of feed antibiotics on carcass characteristics of feedlot steers fed whole corn diets. Ninety-seven Nellore steers (302 ± 47 kg of BW and 24 mo of age) were assigned to a randomized complete block design experiment with four blocks (based on initial BW) and five treatments (Mon30: monensin 30 ppm; Virg25: virginiamycin 25 ppm; Mon20+Virg25: monensin 20 ppm + virginiamycin 25 ppm; Fla40: flavomycin 40 ppm; Mon20+Fla20: monensin 20 ppm + flavomycin 20 ppm). Pen was the experimental unit. The steers were slaughtered after a 100-d period of feeding. Steers were fed TMR (88.2% DM, 12.5% CP, 71.5% TDN) with 85% whole grain corn and 15% pelleted protein concentrate on a DM basis. Feed was supplied ad libitum. Steers were weighed after a 16-h fast on d 100 of the experimental period to determine final body weight. Hot carcass weight was determined after skinning and evisceration. Hot carcass yield was obtained at the time of slaughter. Subcutaneous fat thickness (FT) was measurement in *Longissumus dorsi*muscle at 12th rib. No carcass characteristic measures of feedlot Nellore steers fed whole corn diets were affected by the different feed antibiotics (Table 1668). Carcass characteristic values were higher than data reported previously for Nellore steers fed high-concentrate diets based on corn (267.0 kg HCW, 54.6% HCY), except by FT (3.9 mm) (Silva, 2009).

A relatively short number of animals ($n = 97$) was used in this experiment. It is not known if a higher number would have affected the variables studied.

Key Words: beef cattle, feedlot, finishing

Table 1668. Final body weight (BWf), hot carcass weight (HCW), hot carcass yield (HCY) and subcutaneous fat thickness (FT) of Nellore steers fed whole corn diets containing feed antibiotics

	Feed antibiotics						
Variable	Mon30	Virg25	Mon20 +Virg25	Fla40	Mon20 +Fla20	SEM	P Value
No. of pens (steers)	4 (19)	4 (20)	4 (19)	4 (19)	4 (20)	–	–
BWf (kg)	539	534	537	544	539	4.38	0.618
HCW (kg)	309.1	306.1	309.5	309.5	303.7	2.62	0.455
HCY (%)	57.4	57.3	57.6	56.9	56.2	0.45	0.267
FT (mm)	3.2	3.4	2.9	3.4	3.5	0.18	0.158

1669 (T282) Fatty acids ratio of loin from lambs fed with increasing levels of crude glycerin in feedlot.

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The crude glycerin (CG) has been successfully used in ruminant nutrition as energy concentrate substitute. The objective of the study was to evaluate the effect of increasing levels of CG on loin fatty acids (FA) ratio. Lambs (24) with a mean body weight of 20.0 kg were used. Animals used in the study belong to a group of native sheep of the State of Mato Grosso do Sul, Brazil, called Pantaneiros. The experiment was conducted in a completely randomized design with four treatments: 0, 2.5, 5.0, and 7.5% of CG inclusion as a % of diet dry matter (DM). Diets were formulated to be isonitrogenous and isocaloric only varying the inclusion of CG to replace coarse ground corn, to provide an average gain of 250 g/day. Oat hay was used as roughage and concentrate was composed of corn and/or CG, soybean meal, ground soybean and mineral mix, with a roughage:concentrate ratio of 25:75. Body condition (BC) was used as slaughter criterion. As soon animals had a BC between 3.0 and 3.5 slaughter was performed. After 24 h of chilling at 4°C, loin cuts obtained from deboned *Longissimus* between first and least lumbar vertebra of left side of the carcasses were used to determine FA profile (% of total FA) and ratio. There was no effect ($P = 0.1052$) of CG level on polyunsaturated (PUFA), monounsaturated (MUFA), saturated fatty acids (SFA), and ω6 percentages and on PUFA:SFA, and MUFA:SFA ratio. As CG increased, there was a linear decrease in unsaturated fatty acids (UFA) percentage ($P = 0.0304$; $R^2 = 0.16$; RSD = 2.49), and a linear decrease in ω3% ($P = 0.0084$; $R^2 = 0.26$; RSD = 0.13). UFA:SFA decreased linearly with the CG inclusion ($P = 0.0321$; $R^2 = 0.10$; RSD = 0.09) while ω6:ω3 had a linear increase ($P = 0.0289$; $R^2 = 0.18$; RSD = 1.58).

Key Words: crude glycerin, fatty acids ratio, lamb loin

1670 (T283) Performance and carcass yield of finishing lambs fed diets with safflower meal.

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Studies about oilseed meals are important due to its relationship with fatty acids content and nutritive value of meat. So far, information is scarce about levels of fatty acids in tissues of lambs fed safflower meals. Therefore, the objective of this experiment was to evaluate the effect of a concentrated diet (30% sorghum, 30% corn grain, 15% alfalfa hay; 14.5% CP and 2.98 Mcal EM) plus three levels (treatments) of safflower meal: 0% (control), 10% and 15%, fed to 24 Dorper lambs (22.18 ± 2.6 live BW) housed in metabolic cages during 60 d. The experimental design was completely randomized with three treatments and eight replications. Data were analyzed using GLM procedure (SAS v9.2) and treatments means were compared with Tukey test ($P \leq 0.05$). Variables evaluated were daily dry matter intake (DDMI, g), average daily gain (ADG, g), feed conversion (FC), dry matter digestibility (DMD, %) and carcass yield (CY, %). Safflower meal (0, 10, and 15%) changed ($P \leq 0.05$) ADG (328^b, 367^a, 365^a g), DDMI (1534^b, 1621^a, 1573^b g) and CY (47.8^b, 51.0^a, $51.2\%^a$); however, it did not affect ($P > 0.05$) FC (4.68, 4.42, 4.30 g) neither DMD (65.87, 66.74, 64.89%). These results allow concluding that safflower meal increased average daily gain and carcass yield in finishing lambs.

Key Words: lambs, safflower meal, performance and carcass yield

1671 (T284) Quality traits of *Longissimus* muscle of two genetic groups fed with crude glycerin.

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Quality traits of *Longissimus* muscle of two genetic groups: Nellore (NE) and F1 Red Angus x Nellore (NA), with 18 mo

of age, fed diets containing 5 and 15% of crude glycerin for 84 d, were evaluated. Higher concentration of blood glucose was observed in NE (P = 0.0097) than in F1 cross, and it was not affected by diet (P = 0.9573). No effects of genetic group (P = 0.0908) and crude glycerin (P = 0.0733) were observed on serum insulin, carcass pH and final temperature, frequency of muscle fiber type and size of type IIB fiber, beef color, shear-force, myofibrillar fragmentation index, purge loss, ether extract, ashes, and moisture content. The size of type I muscle fiber did not differ (P = 0.0521) among genetic groups and was larger in muscle from animals fed 15% of crude glycerin (P = 0.0244). The size of type IIA muscle fibers was greater in *Longissimus* muscle of F1 cross (P = 0.0002) than NE cattle, and in *Longissimus* muscle from animals fed 15% crude glycerin (P = 0.0068) compared to those fed diets with other levels evaluated. Collagen solubility was greater in meat of F1 cross (P < 0.0001) compared to NE cattle and was not affected by diet (P = 0.1146). There was interaction among genetic group and diet on total collagen amount (P = 0.0002) in beef. Greater crude protein level was observed on beef from animals fed 15% of crude glycerin (P = 0.0468). However, crude protein was not affected (P = 0.2197) by genetic group. The inclusion of crude glycerin in diets does not affect beef quality traits. These data show that it is possible to produce beef with desirable quality traits by using F1 Red Angus x Nellore and Nellore cattle.

Key Words: collagen, fiber, insulin

1672 (T285) Effects of corn processing method and dietary starch level on finishing performance of Nellore bulls.

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The objective of this study was to evaluate flint corn processing method (CPM) and level of starch for finishing Nellore bulls with high-concentrate, corn-based diets. Nellore bulls (n = 112; 378.25 ± 21.28 kg) were used in a randomized complete block design in a 4 × 2 factorial arrangement. Four starch levels (30, 35, 40, and 45% of diet DM) were evaluated for two CPM: high moisture corn (HMC) and finely ground dry corn (FGC). Animals were offered ad libitum access to diets delivered twice daily in individual pens. Flint corn had 77.2% vitreousness, and corn geometric particle sizes were 1.30 and 5.84 mm for FGC and HMC, respectively. Bulls were adapted to the finishing diet over a 18 d period and fed a total of 75 d. To determine fecal starch (FS) concentration, each animal was sampled by rectal palpation on d 47 of the feeding period. The first derivative was solved of a second order polynomial to determine optimal dietary starch level (DSL). Interaction between CPM and DSL was observed for G:F (P = 0.04). Animals fed HMC 35% up to 45% DSL were more efficient than those fed HMC 30% DSL. However, G:F for bulls fed FGC 30% up to 45% DSL had no difference. DMI was 13.6% greater for FGC than those fed HMC (P < 0.01), but the final BW and ADG was not affected by CPM. Increases in the DSL resulted quadratic decreases in the DMI (P = 0.02) and linear decreases in the ME intake (P < 0.01). Interactions between CPM and DSL were found (P = 0.02), bulls fed HMC showed a linear increase in NEm (P = 0.02), NEg (P = 0.02) and ME (P = 0.02) when the DSL increased. However, NEm, NEg and ME for bulls fed FGC were not different with inclusions of DSL. Bulls fed HMC showed 2.75 times lower FS than those bulls fed FGC (P < 0.01), consequently the fecal pH was greater for HMC than FGC (P < 0.01). Fecal DM were 31.4% greater for FGC than HMC (P < 0.01), consequently the density was greater for FGC feces than HMC (1.120 vs. 1.098 g/mL; P = 0.02). In conclusion, HMC improved growth efficiency of Nellore cattle and the proportion of DSL required to optimize performance was dependent on CPM.

Key Words: feedlot, starch, Zebu

1673 (T286) Effect of wheat dried distillers grains with soubles inclusion and fibrolytic enzyme supplementation on ruminal fermentation and digestibility in beef heifers fed backgrounding diet.

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A metabolic study was conducted to evaluate the effects of wheat dried distillers grain with solubles (DDGS) inclusion and fibrolytic enzyme (FE) application on digestibility, ruminal pH and fermentation in beef heifers. Six ruminally cannulated Angus heifers (averaged BW 794 kg) were used in a 6 × 6 Latin square design with 2 × 3 factorial arrangement. Treatments were control (CON; 50% barley silage, 10% grass hay, and 40% barley grain-based concentrate) and WDG (CON diet substituting 15% DDGS for barley grain) diets combined with 3 FE dosages (0, 1, and 2 mL FE/kg diet DM). Ruminal digestibility of wheat DDGS, barley silage and grass hay was measured using in situ technique and total digestibility was determined using Yb as external digesta marker. Heifers were fed at restriction of 90% ad libitum. Statistical analyses were conducted using the PROC MIXED of SAS with model including fixed effects of diet, FE and their interaction. In situ ruminal DM disappearance (DMD) of DDGS and grass hay

did not differ between WDG and CON after 12, 24, or 48 h of incubation, whereas in situ ruminal DMD (34.0 vs. 36.9%; $P = 0.01$) of barley silage was greater in heifers fed WDG than CON after 24 h of incubation. Increasing FE application quadratically ($P = 0.04$) changed in situ DMD (61.1, 63.1 to 59.3%) of DDGS after 24 h of incubation and linearly ($P = 0.03$) increased in situ NDFD of barley silage (14.9 to 18.9%) after 24 h of incubation. There was no interaction between diet and FE dosages on total digestibility and ruminal pH and VFA concentration. Inclusion of DDGS increased the digestibility (CON vs. WDG) of CP (58.9 vs. 67.6%; $P < 0.01$), NDF (32.7 vs. 37.4%; $P = 0.04$) and ADF (25.0 vs. 31.0%; $P = 0.03$). Increasing FE linearly ($P = 0.03$) increased CP digestibility from 61.8, 63.5 to 64.5% without affecting the digestibility of other nutrients. There were no effects of DDGS inclusion and FE dosages on ruminal pH and VFA concentration except the concentration of propionate was greater ($P = 0.04$) with WDG (19.5 m*M*) than CON (18.5 m*M*). These results indicate that inclusion of wheat DDGS or supplementation of FE in barley silage-based background diet improved ruminal and total digestibility of NDF and CP, and had potential to improve feed efficiency in beef cattle.

Key Words: backgrounding beef heifers, fibrolytic enzyme, wheat distillers grain

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1674 (T287) Increasing condensed corn distillers solubles affects gene expression in rumen epithelial tissue. J. C. McCann[*1], S. Alqarni[1], J. R. Segers[2], D. W. Shike[1], and J. J. Loor[1], *[1]University of Illinois, Urbana, [2]University of Georgia, Tifton, GA.*

Five ruminally-fistulated steers were used in a 5 × 5 Latin square design to determine the effects of increasing dietary fat from corn distillers solubles (CDS) on the gene expression within rumen epithelial tissue. Treatments included a corn-based control (CON), and four levels of CDS (0, 10, 19, and 27%) in a coproduct-based (corn gluten feed and soybean hulls) diet. Fat concentrations were formulated to 3, 5, 7, and 9%, respectively, for diets containing CDS, and all steers were fed to ad libitum intake once daily. After 18 d of adaptation to the diet, ruminal epithelium tissue was collected and frozen in liquid N. Real-time quantitative PCR was used to determine dietary effects on expression of genes related to fatty acid oxidation, ketogenesis, transcriptional regulation, and monocarboxylic transporters. Data were analyzed using the PROC MIXED of SAS with treatment and period as fixed effects and steer as the random effect. Pairwise comparisons were implemented to separate means. Genes associated with long chain fatty oxidation (CPTIA, ACADS, and ACADS) were affected by treatment ($P \leq 0.01$). Steers fed 10% CDS diet had the least epithelial mRNA expression of CPTIA and ACADSB compared with all other treatments ($P < 0.01$). ACADS epithelial mRNA expression was decreased in epithelial tissues of steers fed 0 and 10% CDS diets. Among genes related to ketogenesis, HMGCS2 was affected by treatment ($P = 0.02$); epithelial mRNA expression remained similar for CON, 0%, 19%, and 27% CDS, but HMGCS2 was downregulated for steers fed 10% CDS diet. Although ACAT1 was affected by treatment ($P = 0.04$), CON and 10% CDS had less expression compared to 19% CDS treatment ($P \leq 0.01$). Expression of transcriptional regulation-associated genes (PPARA and RXRA) in rumen epithelium was not consistent. PPARA mRNA expression was the greatest for 27% CDS treatment and alternatively the least for 10% CDS. However, RXRA was affected by treatment ($P = 0.04$); epithelial mRNA expression was decreased at 10, 19, and 27% inclusion of CDS compared with the greatest expression for steers fed CON diet. SLC16A1, a monocarboxylic transporter-related gene, expression was increased for steers fed 0% CDS compared with 10 and 27% CDS treatments. Results indicate different concentrations of CDS alter the rumen epithelium transcriptome.

Key Words: rumen, epithelium, gene expression

1675 (T288) Crude glycerin as an energy source in finishing beef diets. P. Del Bianco Benedeti[*1,2], P. V. R. Paulino[3], M. I. Marcondes[1], A. Faciola[2], I. França Smith Maciel[1], and M. Custódio da Silva[1], *[1]Federal University of Viçosa, Viçosa, Brazil, [2]University of Nevada, Reno, [3]Nutron Alimentos Ltda., Campinas, Brazil.*

The objective of this study was to evaluate the effects of replacing dry ground corn with crude glycerin (CG) on DMI, digestibility, performance, and carcass characteristics of finishing beef bulls. An experiment in a completely randomized design with 25 d for adaptation and 95 d for sample collection was conducted, in which 3640 Nellore bulls (367 ± 37 kg) were blocked by BW and assigned to 20 pens. Animals were randomly assigned to one of four treatments: 0, 5, 10, and 15% (DM basis) CG in diet. All diets contained 85% concentrate and were formulated to meet NRC (2000) recommendations. Diets were isocaloric, isonitrogenous, and allowed 1.4 kg/d BW gain. Initially, 20 animals were slaughtered to serve as reference to estimate initial empty BW, which allowed carcass gain calculation. Bulls were weighted at the beginning and end of the experiment for performance calculation. Measurements of ribeye area (RA), back fat (BF) and rump fat (RF) were obtained by ultrasound. Data were analyzed using the PROC MIXEDs in SAS, and results are reported in the Table 1675. Intake of DM decreased linearly ($P < 0.01$) with CG inclusion. A quadratic effect was observed ($P < 0.01$) for DM and TDN digestibility. However, CG inclusion did not change ($P > 0.10$) ADG, final BW, carcass gain, carcass dressing, feed:gain ratio, RA, BF, and RF. These results suggest that CG may be included in finishing beef cattle diets without affecting performance and carcass characteristics.

Key Words: glycerin, feedlot, performance

Table 1675. Effects of replacing dry ground corn with crude glycerin on DMI, digestibility, performance, and carcass characteristics in finishing beef bulls

	Crude Glycerin (%)					P-value	
	0	5	10	15	SEM	L	Q
DMI, kg/d	10.5	10.1	10.2	9.6	0.15	< 0.01	0.60
DMI, % BW/d	2.4	2.4	2.3	2.22	0.14	< 0.01	0.42
DM Digest., %	62.6	60.2	64.1	69.7	0.86	–	< 0.01
TDN Digest., %	69.9	67.2	71.1	75.8	0.78	–	< 0.01
ADG, kg/d	1.41	1.37	1.35	1.34	0.02	0.20	0.77
Final BW, kg	510.1	498.7	503.8	497.1	2.18	0.19	0.45
Carcass gain, kg	89.2	84.2	82.7	83.1	1.41	0.33	0.07
Carcass dressing, %	56.9	56.7	56.6	56.5	0.33	0.64	0.92
Feed:gain	7.5	7.5	7.6	7.2	0.11	0.47	0.42
RA, cm3	83.0	82.2	82.1	80.9	0.40	0.06	0.88
BF, mm	4.6	4.4	4.4	4.5	0.08	0.04	0.04
RF, mm	6.6	6.4	6.4	6.4	0.06	0.09	0.25

1676 (T289) Ruminal fermentation of steers fed crude glycerin replacing starch- vs. fiber-based energy ingredients at low or high concentrate diets.

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Twelve ruminally cannulated Nellore steers (401.0 ± 41.5 kg) and 24 mo were used in a replicated truncated Latin Square arrangement of treatments with six animals in six treatments and four periods to evaluate the effect of crude glycerin (CG; 80.34% of glycerol) replacing starch- or fiber-based energy ingredients in the concentrate on ruminal pH, ammonia-N concentration and VFA's production of the steers fed in feedlot. Experimental periods were 15 d (14 d for adaptation and 1 d to sampling). Diets were: CO, without CG and corn as ingredient of concentrate; CGC, inclusion of CG (10% of DM) replacing corn in the concentrate; and CGSH, inclusion of CG (10% of DM) replacing soybean hulls (SH) in the concentrate. All three diets were offered at a low (LC) or high concentrate (HC; 40 or 60%). Ruminal contents were obtained at 0, 2, 4, 6, 8, 10, and 12 h after 0700 h feeding. Data were analyzed as a truncated Latin square using the PROC MIXED of SAS. The pH, ammonia-N and VFA, were analyzed as a repeated measurements. The least-squares means were generated and compared ($P \leq 0.05$) using Tukey's test. The pH was lower to animals fed HC diets than pH from animals fed LC diets ($P < 0.01$). No differences were detected in pH when animals were fed with CGC or CGSH. Animals fed diets CGSH had lower ammonia-N concentration than animals fed diets without CG or CGC ($P < 0.01$). The propionate concentrations ($P < 0.01$) and A:P ratio ($P < 0.01$) were affected by inclusion of CG in diets replacing corn or SH in the concentrate. Animals fed diets CGC or CGSH had higher propionate concentrations and lower A:P ratio in ruminal fluid ($P < 0.05$). There was an interaction between concentrate level and the diets for acetate ($P = 0.03$) and butyrate concentrations ($P = 0.05$). The decrease in acetate concentrations were observed in animals fed CGC or CGSH in LC than animals fed LC diets without CG. Butyrate concentrations were greater in diets CGC or CGSH, mainly in LC diets ($P = 0.05$). The inclusion of CG in diets did not alter the ruminal pH, but increase butyrate and reduces the A:P ratio as a result of increases of propionate concentrations.

Key Words: glycerol, propionate, ruminal pH

1677 (T290) Supplements containing different crude glycerin concentration does not affect the intake and digestibility of Nellore grass-fed beef.

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The aim of this work was to evaluate the effect of crude glycerin (CG)- 80% of glycerol- inclusion as a substitute to corn grain in the intake and digestibility (DM, OM, CP, NDF and TDN) of Nellore steers on pasture, supplemented in the dry season. Ten rumen-cannulated Nellore steers, with average body weight of 427 ± 15.76 kg were randomly assigned in double Latin square 5 × 5. The animals were distributed in five paddocks, of 0.4 ha each (two animals per paddocks). Treatments were constituted by five concentrations of CG in the supplement: 0, 70, 140, 210, and 280 g/kg dry matter of CG. Animals were supplemented individually, daily in a proportion of 300 g/100 kg of BW. The supplement was constituted of corn grain, soybean meal, urea, gluten meal and commercial premix, containing 300 g/kg DM of crude protein. Each experimental period lasted 14 d, so the first 10 d were for animal's adaptation and the remaining days to collect

samples. Intake and nutrient digestibility were estimated using two markers: isolated, purified and enriched lignin (LIPE) and indigestible neutral detergent fiber (iNDF), used for estimation of fecal excretion and forage intake, respectively. Fecal samples were collected directly from the rectum, 2x/d for 3 d, totaling six samples, with an interval of 2 h between collections. Data were analyzed in two simultaneous 5 × 5 latin squares by PROC MIXED of SAS (version 9.1), the effects of treatments were considered significant at $P < 0.05$. There was no statistical significance among the treatments, for intake of DM ($P = 0.239$), OM ($P = 0.183$), CP ($P = 0.076$), NDF ($P = 0.179$) and TDN ($P = 0.218$) with mean values of 7.59, 7.05, 1.24, 3.9 and 3.88, respectively. The inclusion of glycerin had no effect in the digestibility for DM ($P = 0.286$), OM (0.315), CP ($P = 0.339$) and NDF (0.270), with mean values of 44.26, 51.50, 57.20 and 43.04, respectively. The inclusion of crude glycerin until the level of 280 g/kg DM in the supplement did not affect the intake and digestibility of Nellore steers fed on tropical pasture in the dry season.

Key Words: pasture, co-product, biodiesel, glycerol

1678 (T291) Whole cottonseed and crude glycerin for Nellore cattle on pasture: Intake and digestibility of nutrients.

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Use of by-products in the beef cattle diets have important function to reduce production costs and needs to be evaluate in different production systems. The aim of this experiment was to evaluate intake and digestibility of nutrients in beef cattle diet with associations of whole cottonseed and crude glycerin in multiple supplements for Nellore cattle in the fattening phase at *Brachiaria brizantha* pastures in the rainy season. Animals were supplemented with 4 kg/d (21% of crude protein). The experiment was performed in a 5 × 5 (five supplements and five periods) Latin square design and structured in a factorial design 2 × 2 + 1 [two levels of crude glycerin (0 and 15%), two levels of cottonseed (0 and 25%) and supply of mineral mix (control)]. Orthogonal contrasts were used to evaluate effect of crude glycerine, whole cottonseed and interaction, adopting 0.05 to the critical level of probability. The supplementation increased dry matter intake at 2.25 kg/day ($P = 0.037$), due largest apparent digestibility of dry matter in function of fed supplements (65.83%) in relation to the control treatment (55.69%) ($P < 0.05$). Multiple supplements increased intake of ether extract (0.370 vs. 0.170 kg/d) ($P < 0.05$), crude protein (1.380 vs. 0.720 kg/d) ($P < 0.001$), and no fiber carbohydrates (3.715 vs. 2.07 kg/d) ($P < 0.001$), due to higher content of these nutrients in supplements when compared with only forage/mineral mix. Ether extract intake was still affected by the inclusion of whole cottonseed in supplement ($P < 0.05$) due high concentration of oil in this ingredient. Apparent digestibility of ether extract in the diets evaluated was affected by supplementation ($P < 0.05$) and whole cottonseed inclusion ($P < 0.05$) and assigning it lower contribution of endogenous excretion of ether extract when their content is high in diet. Intake and digestibility of neutral detergent fiber were not affected ($P > 0.05$), evidencing that extra supply of nutrients did not affect the cellulolytic microbiota, with appropriate digestibility of most abundant energy unit in grazing production system. By-products that reduce diets costs and improve voluntary dry matter intake are important in nutritional formulations because are responsible for most of the variations in productive performance.

Key Words: by-products, Nellore, pastures

1679 (T292) Crude glycerin in multiple supplements for beef cattle in grazing: pH and ammoniacal nitrogen.

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Objective was evaluate the pH and concentration of ruminal ammoniacal nitrogen (NH_3–N) in beef cattle receiving multiple supplementation in grazing, with increasing levels of crude glycerin, in the rainy season. It has been utilized five Nellore beef cattle, male, non-castrated. The pastures were divided into five picket of 0.25 ha each, covered with *Brachiaria brizantha* cv. Marandu. The experiment was divided into 5 × 5 Latin square design, composed by five experimental periods of 19 d each and five animals. The strategy adopted was to provide 4 kg/animal/day of multiple supplements with four levels of crude glycerin (0; 8; 16 and 24%) and the mineral mixture (MM) was offered ad libitum(control). Ruminal liquid samples were collected for measuring the pH and quantification of NH_3–N by gavage, in two times (0 and 4 h after supplementation). The pH values for the time 0 and 4 h did not differ between the supplements ($P > 0.05$) (Table 1679), with average value of 6.83 and 6.59, respectively. It was verified decrease in measuring 4 h after the supplementation in comparison to time 0 ($P < 0.01$), demonstrating that there is a normal diurnal variation in the pH value without it being influenced by the multiple supplementation, important fact in the maintenance of ruminal fermentation. The content of NH_3–N has not been influenced by the supplementation before the concentration being supplied ($P > 0.05$) with average between the treatments of 4.98 mg/dL. It was observed at time four the raise in the content of NH_3–N for multiple supplementation regardless the formulation utilized ($P < 0.01$), while the control has not promoted such effect

($P > 0.05$). The average values of NH_3–N from animals receiving multiple supplementation was of 11.08 mg/dL, adequate for microbial development and ruminal fermentation.

Key Words: Nellore, rainy season, supplementation

Table 1679. Mean values of pH and concentration of NH3-N (mg/dL) in ruminal fluid

	Supplements					
Times	MM	0% GLYC[1]	8% GLYC[1]	16% GLYC[1]	24% GLYC[1]	SEM[2]
	Ruminal pH					
T 0	6.85^{Aa}	6.88^{Aa}	6.86^{Aa}	6.80^{Aa}	6.80^{Aa}	0.10
T 4	6.68^{Ab}	6.61Ab	6.65^{Ab}	6.51^{Ab}	6.53^{Ab}	0.14
	NH3-N					
T 0	3.72^{Aa}	6.08^{Ab}	5.68^{Ab}	5.03^{Ab}	4.40^{Ab}	1.57
T 4	5.46^{Ba}	15.64^{Aa}	11.57^{Aa}	12.25^{Aa}	10.50^{Aa}	3.73

Means followed by the same small letter in the column and same uppercase letter in row do not differ at 5% probability by SNK test.

[1] levels of crude glycerin.

[2] standard errors of the mean.

1680 (T293) Grain processing methods and concentration of corn silage NDF in the finishing diet of Nellore bulls.

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Grain processing methods disrupt the protein matrix of starch granules and increase surface area allowing more starch to be digested and higher animal performance of cattle fed high concentrate diets. There are some interaction of grain processing and NDF concentration. Inadequate fiber concentration could result in metabolic disturbs decreasing animal performance. This study evaluated two grain processing methods (coarsely ground and steam flaked corn) and these methods interaction with four corn silage NDF concentrations (4, 7, 10, and 13%) on animal performance. Two hundred thirty-seven Nellore bulls (336 kg BW ± 1.53) were fed diets containing corn silage; corn; soybean meal; urea and a mineral and vitamin premix. The animals were blocked by initial BW and randomly allocated to 24 pens in groups of six animals and to eight pens in groups of 12 animals. The parameters evaluated were DMI, ADG and FE. The experiment lasted 117 d and the data was analyzed using PROC MIXED of the SAS package. Block was considered the random effect. Grain processing method, NDF concentration and grain processing method X NDF concentration were considered fixed effects. Linear and quadratic effects of NDF concentration were tested for each grain processing method. Animals fed flaked corn had higher FE than animals fed ground corn. From all concentrations of corn silage NDF, 7 and 4%, had higher FE for treatments containing ground corn and flaked corn, respectively. It was concluded that corn flaking is an efficient way to improve performance of Nellore cattle in feedlot in comparison to ground corn and that 4 to 7% of NDF from corn silage are efficient concentrations to obtain good results on animal performance.

Key Words: grain processing, NDF concentration, Nellore

1681 (T294) Effect of corn processing methods and dietary concentrations of sugarcane bagasse fiber on finishing Nellore bulls performance.

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The objective of this experiment was to evaluate processing methods of flint corn grain (ground corn, particle size: 3.18 mm and steam-flaked corn with bulk density of 360 g/L) combined with dietary contents of 4, 7, 10 or 13% roughage NDF (DM basis) using sugarcane bagasse as source of fiber on performance of Nellore bulls finished in feedlot. Two hundred forty Nellore bulls (initial BW = 350 ± 2.4 kg) were fed diets containing 76 to 86% corn and were randomly allocated to 32 pens in a factorial arrangement of 2 × 4. Animals were blocked based on initial BW. The parameters evaluated were dry matter intake (DMI), average daily gain (ADG), feed efficiency (ADG/DMI) and final BW after 120 d on feed. The data were analyzed using PROC MIXED of SAS and means were compared by F test considering the block as random effect and corn grain processing method, roughage NDF and corn grain processing method * roughage NDF effects. There

Table 1680. Performance of cattle receiving diets with two grain processing methods and different concentrations of corn silage NDF

Grain processing method	Ground corn						Flaked corn					
	Corn silage NDF concentrations				Contrast		Corn silage NDF concentrations				Contrast	
	4	7	10	13	L	Q	4	7	10	13	L	Q
IBW, kg	344.0	344.1	343.9	343.9	NS	NS	343.8	343.9	344.1	343.9	NS	NS
FBW, kg	512.1	518.2	527.2	517.6	0.05	0.001	520.3	517.5	521.1	535.7	0.01	0.001
DMI, kg	8.55	8.85	9.45	9.5	0.01	0.12	8.48	8.75	8.8	9.68	0.01	0.001
ADG, kg	1.44	1.49	1.57	1.48	0.05	0.002	1.51	1.48	1.51	1.64	0.01	0.001
ADG/DMI	0.168	0.169	0.166	0.157	0.01	0.15	0.181	0.172	0.172	0.169	0.04	0.38

was no interaction between the concentrations of sugarcane bagasse NDF and processing methods. Cattle fed steam-flaked corn diets presented less ($P < 0.05$) DMI (8.57 vs. 9.31 kg.d^{-1}), 26.3% greater ($P < 0.05$) final BW (509 vs. 493.3 kg), 12.3% greater ($P < 0.05$) ADG (1.37 kg.d^{-1} vs. 1.22 kg.d^{-1}) and 21.97% greater ($P < 0.05$) feed efficiency (0.161 vs. 0.132) than cattle fed coarsely ground corn. Increasing roughage NDF content of the diets caused a quadratic response ($P = 0.01$) for DMI (8.37, 9.13, 9.02 and 9.25 respectively), had no effect ($P > 0.05$) on cattle final weight (496.8, 506.3, 498.4 and 503.9 kg, respectively) and cattle ADG (1.26, 1.34, 1.28 and 1.31 kg.d^{-1}respectively) and it caused a linear decrease ($P = 0.04$) in feed efficiency (0.150, 0.148, 0.142 and 0.144 respectively). In conclusion, steam flaking of flint corn improved performance of finishing Nellore bulls in comparison to ground corn with particle size of 3.18 mm. Nellore bulls were mor efficient when diets containing 4% sugarcane bagasse NDF were fed compared to diets with greater roughage NDF contents.

Key Words: ground corn, steam-flaked corn, feedlot

1682 (T295) Predicting ruminal and total tract starch digestion as influence by changes in density of steam-flaked corn: Flake thickness, enzymatic reactivity, fecal starch. M. A. Franco[*1], J. F. Calderon-Cortes[2], L. Corona[1], A. Plascencia[2], and R. A. Zinn[3], *[1]UNAM, México City, [2]UABC, Mexicali, México, [3]University of California–Davis, El Centro.*

Six Holstein steers (153 kg ± 11) with cannulas in the rumen and proximal duodenum were used in a 6 × 6 Latin square design experiment to compare flake density (FD, kg/L), flake thickness (FT, mm), amyloglucosidase reactivity (AGR, %), and fecal starch (FS, %) as predictors of ruminal (RSD, %) and total tract (TSD, %) starch digestion. Based on FD, RSD = 92.5– 36.6FD ($r^2 = 0.76$) and TSD = 96.5 + 30.2FD– 68.6FD^2 ($r^2 = 0.99$). Based on FT, RSD = 88.9– 4.45FT ($r^2 = 0.83$) and TSD = 97.1 + 3.77FT– 1.43FT^2 ($r^2 = 0.99$). Based on AGR, RSD = 72.0 + 0.43AGR ($r^2 = 0.94$) and TSD = 90.9 + 0.695AGR– 0.0138AGR^2 ($r^2 = 0.91$). Based on FS, RSD = 85.9– 2.88FS + 0.204FS^2 ($r^2 = 0.97$) and TSD = 100.0– 0.40FS ($r^2 = 1.00$). Measures of fecal starch were the best single predictor of ruminal and total tract starch digestion in catte fed steam-flaked corn-based diets. Fecal starch has the additional advantage of being equally effective when data for dry rolled corn are included in the dataset. Whereas AGR was a good predictor of ruminal starch digestion, it was the least effective of the measures for estimation of total tract starch digestion. Due to the ease of its determination, flake thickness may be the more convenient and reliable measure for assessment of day-to-day process adequacy.

Key Words: starch, maize, digestion

1683 (T296) Intake and performance of crossbred dairy calves fed spineless cactus in transition. R. Gomes[1], M. F. S. Queiroz[*2], S. Gonzaga Neto[3], R. G. Costa[4], J. S. Oliveira[3], G. O. Mendes[4], R. L. Galati[2], and G. R. Beltrão da Cruz[4], *[1]University of Paraiba, CCA/UFPB, Areia, Brazil, [2]University of Mato Grosso–DZER/UFMT, Cuiabá, Brazil, [3]University of Paraiba–CCA/UFPB, Areia, Brazil, [4]University of Paraiba–CCHSA/UFPB, Bananeiras, Brazil.*

A study was conducted to evaluate the intake and performance of crossbred calves (Holstein x Zebu) in the transition from a liquid diet to a solid diet fed spineless cactus replacing Tifton 85 hay. Sixteen crossbred calves with initial body weight of 50.04 ± 6.3 kg were used. Calves were housed in individual hutches, and suckled artificially with 4 L of milk x d^{-1}until 30 d of life. After completing 31 d the experimental period was initiated in which the calves began to receive the liquid diet in the same amount (4 L) also solid foods according treatment. Treatments consisted of the replacement of Tifton 85 hay diet by spineless cactus (*Opuntia ficus indica*, MILL) as follows: T1 (DPA): 70% concentrate + 30% Tifton hay, T2 (SPV): 70% concentrate + 15% Tifton hay + 15% spineless cactus, T3 (STV): 70% concentrate + 30% spineless cactus, T4 (SCV): 50% concentrate + 17% Tifton hay + 33% spineless cactus. The experiment was analyzed as a completely randomized design with ANOVA being conducted with the GLS procedure of SAS and the averages compared by Tukey's test at 5% probability. The DMI, BW, body measurements, body score and fecal score were performed weekly until 67 d of life. The DMI (0.48 kg x d^{-1}), final BW (55.9 kg), body measurements (wither height: 84.2 cm; hip height: 88.0 cm and heart girth: 88.4 cm) and body score (2.4) of the animals were not affected by treatments ($P > 0.05$). The average daily weight gain was influenced ($P < 0.01$) by the treatments, the greatest gains were observed in the treatment SPV (421 g x d^{-1}), the DPA and SCV (388 g x d^{-1}) treatments were no longer different from other while the smaller ADG were obtained in treatment STV (289 g x d^{-1}). The fecal average scores observed during the entire experimental period shows that there was no incidence of diarrhea in animals. In conclusion the use of spineless cactus replacing the Tifton hay as roughage in the diet of crossbred calves in the transition phase from a liquid diet to a solid diet is indicated assisting in early weaning without affecting the growth and development of these animals.

Key Words: average daily gain, body score, body weight

1684 (T297) Carcass characteristics of crossbred dairy calves fed spineless cactus in transition. R. Gomes[1], M. F. S. Queiroz[*2], R. G. Costa[3], S. Gonzaga Neto[4], J. S. Oliveira[4], G. O. Mendes[3], G. R. Beltrão da Cruz[3], and J. Jordão Filho[3], *[1]University of Paraiba, CCA/UFPB, Areia, Brazil, [2]University of Mato Grosso–DZER/UFMT, Cuiabá, Brazil, [3]University of Paraiba–CCHSA/UFPB, Bananeiras, Brazil, [4]University of Paraiba–CCA/UFPB, Areia, Brazil.*

A study was conducted to evaluate the carcass characteristics of crossbred calves (Holstein x Zebu) in the transition from a liquid diet to a solid diet fed spineless cactus replacing Tifton 85 hay. Sixteen crossbred calves with initial body weight of 50.04 ± 6.3 kg were used. Calves were housed in individual hutches, and suckled artificially with 4 L of milk.d^{-1} until 30 d of life. After completing 31 d the experimental period was initiated in which the calves began to receive the liquid diet in the same amount (4 L) also solid foods according treatment. Treatments consisted of the replacement of Tifton 85 hay diet by spineless cactus (*Opuntia ficus indica*, MILL) as follows: T1 (DPA): 70% concentrate + 30% Tifton hay, T2 (SPV): 70% concentrate + 15% Tifton hay + 15% palm, T3 (STV): 70% concentrate + 30% palm, T4 (SCV): 50% concentrate + 17% Tifton hay + 33% palm. The experiment was analyzed as a completely randomized design with ANOVA being conducted with the GLS procedure of SAS and the averages compared by Tukey's test at 5% probability. The DMI, BW, body measurements, BS and fecal score were performed weekly until 67 d of life, when these animals were slaughtered to evaluate carcass yield. There was no significant difference ($P > 0.05$) in final BW (55.9 kg), hot carcass weight (30.4 kg) and chilled carcass weight (30.0 kg) with the replacement of Tifton by spineless cactus. As the treatments did not affect ($P > 0.05$) hot carcass yield (55.8%) and chilled carcass yield (54.1%). Measures of carcass, carcass length (72.4 cm), leg length (50.8 cm) and perimeter of cushion (44.4 cm) were not affected ($P > 0.05$) by treatments. Average of 20.9 cm for the areas of rib eye area, and 0.96 cm in the fat thickness were observed, both without influence of treatments ($P > 0.05$). In conclusion the use of spineless cactus replacing the Tifton hay in the diet of crossbred calves is indicated without affecting the carcass characteristics of these animals.

Key Words: forage cactus; rib eye area; veal

1685 (T298) Effect of chitosan and soybean oil combination on ruminal fermentation and milk yield and composition of dairy cows. *T*. A. Del Valle[*1], F. C. R. D. Santos[1], P. G. D. Paiva[2], E. F. Jesus[2], F. Zanferari[1], M. K. Kametani[1], A. G. B. V. B. Costa[1], and F. P. Rennó[1], *[1]School of Veterinary Medicine and Animal Science, University of São Paulo, Pirassununga, Brazil, [2]School of Agricultural and Veterinary Sciences of UNESP, Jaboticabal, Brazil.*

The aim of this study was to evaluate the effects of chitosan addition in mid-lactating dairy diet without or with soybean oil on ruminal fermentation and milk composition. Twenty-four Holstein cows (four ruminally cannulated), averaging 174.7 ± 53.1 DIM, were randomly assigned in six Latin square design with a 2 × 2 factorial arrangement of treatments. The diets contained Chitosan (150mg/kg of body weight) and soybean oil (3.3% of the diet DM). Each experiment period had a 14-d adaptation period and a 7-d for collection data. Sampling of milk was done on Days 16, 17, and 18 of each period to evaluate the composition. On d 21 of each period, rumen fluid samples were collected from cannulated cows in seven times to evaluate the effect of the diets on ruminal fermentation. The results of milk composition were subjected to analysis of variance, while fermentation data were analyzed as repeated measures, both by PROC MIXED of SAS. There was no interaction effect ($P > 0.05$) of factors and the time on ruminal fermentation. The addition of soybean oil in the diet increased the concentration of propionate and decreased acetate and the total concentration of short chain fatty acids (SCFA) in mmol.L^{-1}, however the ratio acetate:propionate was decreased. Those diets decreased ($P < 0.05$) the levels of milk fat in 5 g/kg on average. The addition of chitosan in the diet reduced the total concentration of SCFA, although ruminal fermentation and milk composition was not altered significantly. The protein contents in milk were on average 3.06% and were not affected by diets. There was interaction ($P < 0.05$) of the factors for milk yield. Milk yield was same in control and chitosan diets and was higher in diet with soybean oil than diet with chitosan and soybean oil, with averages of 33.87, 32.85, 32.86 and 31.26, respectively. In conclusion, the use of chitosan as a feed additive for dairy cattle was positive in increasing the milk production, when in diet of low lipids level, not altering, however, ruminal fermentation and milk composition.

Key Words: additive, milk fat, rumen

1686 (T299) Growth performance and total tract nutrient digestion for Holstein heifers precision-fed diets high in distillers grains with different forage particle size. R. D. Lawrence*, J. L. Anderson, T. J. Vanderwerf, A. K. Manthey, K. F. Kalscheur, and D. P. Casper, *South Dakota State University, Brookings.*

This study evaluated dairy heifer growth performance and total tract nutrient digestion when fed diets high in dried distillers grains with solubles (DDGS) with different forage particle size, achieved by utilizing alfalfa hay that was processed differently. An 8-wk randomized complete block design study was conducted using twenty-two Holstein heifers (123 ± 32 d of age; initial body weight (BW) of 140 ± 23.5 kg). Treatments were either 15% chopped (CHOP) or 15% pelleted (*P*ELL) alfalfa hay on a dry matter (DM) basis. Both diets also contained 30% DDGS, 53.75% corn silage, and 1.25% mineral mix. Rations were precision-fed for a dry matter intake (DMI) of 2.3% of BW. Frame sizes, BW, and body condition scores (BCS) were taken on two consecutive days during wk 0, 2, 4, 6, and 8. During wk 8, titanium dioxide was fed and fecal grab samples were collected to measure total tract nutrient digestion. Heifer DMI increased ($P < 0.01$) when fed CHOP versus PELL (4.42 and 4.19 kg/d for CHOP and PELL, respectively). Body weights (167.4 and 164.0 kg) and average daily gain (0.83 and 0.96 kg/d) were similar ($P > 0.05$) between treatments. Gain to feed was less ($P < 0.01$) in CHOP versus PELL (0.21 and 0.25). Hip height (110.7 and 110.9 cm), wither height (106.7 and 106.6 cm), and body length (95.1 and 94.9 cm) were similar between treatments. Paunch girth (153.6 and 150.4 cm), heart girth (122.4 and 120.4 cm), and hip width (30.2 and 29.6 cm) were greater ($P < 0.05$) for CHOP versus PELL. Body condition score was less ($P < 0.01$) for CHOP compared to PELL (3.03 and 3.09). For growth measurements there were no significant treatment by week interactions or differences in average daily changes. Total tract digestibility of DM (67.5 and 67.3%), neutral detergent fiber (51.2 and 50.1% of DM), and crude protein (68.3 and 67.9% of DM) were similar between treatments. Heifers fed diets containing 30% DDGS with 15% chopped or pelleted alfalfa hay had similar total tract nutrient digestion and growth performance, with some very minor differences in frame growth and feed to gain. Overall, this study demonstrated that feeding dairy heifers diets with different forage particle sizes, achieved by inclusion of chopped or pelleted alfalfa hay, does not affect utilization of DDGS.

Key Words: dairy heifer, distillers grains, particle size

1687 (T300) Comparison of efficiency of energy use in Holstein and Jersey dairy cows offered diets containing reduce fat distillers grains RFDDGS. G. Garcia Gomez*[1], A. Foth[1], P. J. Kononoff[1], T. Brown-Brandl[2], and H. C. Freetly[2], [1]*University of Nebraska, Lincoln,* [2]*ARS–USDA, Clay Center, NE.*

Fifty six energy balances were completed with eight Holstein (H) and eight Jersey (J) multiparous lactating cows to examine the effect of breed on the efficiency of milk production and energy use. Two dietary treatments were fed in a repeated switch back design to compare breeds. Dietary treatments consisted of 24.5% corn silage, 18.4% alfalfa hay, 6.9% grass hay, with either 22.9% rolled corn and 14.8% soybean meal or 4.51% rolled corn, 0% SBM, and 14.5% RFDDGS (dry matter basis). Diets were offered ad libitum for a 28-d adaptation period and 95% ad libitum for a 4-d collection period. During the collection days, ration digestibility and energy use was measured, indirect calorimeter respiration head boxes were used to determine heat production. Across the two treatments, Holstein cows had a significantly higher intake of gross energy (GE) (30 ± 3.96 Mcal/d; $P = < 0.01$), and higher energy output in feces, urine, methane, heat production (HP), and milk energy (6.5 ± 1.24, 0.11 ± 0.11, 1.2 ± 0.15, 8.95 ± 0.74, and 8.54 ± 1.27 Mcal/d, respectively; $P = < 0.01$) than did Jersey cows. Jersey cows produced milk with higher fat content (4.96% vs. 3.69% ± 0.19 for Jersey and Holstein, respectively; $P = < 0.01$), protein (3.75% and 3.20% ± 0.1 for Jersey and Holstein, respectively; $P < 0.01$), and energy concentrations, compared with those of the Holstein cows. Metabolizable energy (ME) and digestible energy (DE) intake as a proportion of GE intake were significantly higher for Holstein cows (0.03 ± 0.01 and 0.03 ± 0.007, respectively; $P = < 0.01$ and 0.02). However, breed had no significant effects on ME/DE (0.88 ± 0.01), HP/ME (0.56 ± 0.02), DE/DMI (2.78 ± 0.06), ME/DMI (0.45 ± 0.06), methane energy/DE (0.08 ± 0.004), and urine energy/DE (0.04 ± 0.002). No significant interaction was found between breed and treatment for any of the ratios of energy use examined. In addition, no significant differences in energy partitioning between milk (milk energy/ME intake) (0.40 ± 0.18), and body tissue (retention energy/ME intake) (0.04 ± 0.0034) were found between Holstein and Jersey dairy cows. In conclusion, breed had no effect on the overall production efficiency of dairy cows in terms of efficiency of ME use for lactation, and energy partitioning between milk and body tissue.

Key Words: energy efficiency, Holstein, Jersey.

1688 (T301) Effects of feeding canola meal (CM) and wheat dried distillers grains with solubles (W-DDGS) as the major protein source in low or high crude protein diets on ruminal nitrogen utilization, omasal nutrient flow, and milk production in dairy cows. T. Mutsvangwa[*1], and K. Doranalli[2], *[1]University of Saskatchewan, Saskatoon, Canada, [2]Evonik (SEA) Pte. Ltd., Singapore.*

The objective was to determine the effects of feeding CM or W-DDGS as the major source of protein in diets varying in CP content on ruminal N utilization, omasal flows, and milk production. Eight Holstein cows (109 ± 36 DIM) were used in a replicated 4 × 4 Latin square design with 28-d periods. Four cows in one Latin square were ruminally-cannulated to facilitate ruminal and omasal sampling. Treatments were: 1) source of protein (CM vs. W-DDGS); and 2) dietary CP content (15 vs. 17%). Interactions between source of protein x CP content were nonsignificant. Dry matter intake and milk yield were unaffected by diet ($P > 0.05$). Feeding CM increased milk lactose content compared to feeding W-DDGS ($P = 0.003$). Milk urea-nitrogen ($P < 0.001$) and ruminal NH_3–N ($P = 0.05$) concentrations were greater in cows fed the high CP compared to those fed the low CP diet. Dry matter apparently digested in the rumen was greater in cows fed the high CP compared to those fed the low CP diet, with the difference in DM apparently digested in the rumen being greater in cows fed W-DDGS as compared to those fed CM (interaction, $P = 0.02$). The RDP supply was greater in cows fed the high CP when compared to those fed the low CP diet when diets contained CM, whereas RDP supply was lower in cows fed the high CP when compared to those fed the low CP diet when diets contained W-DDGS (tendency for interaction, $P = 0.08$). The omasal flow of NH_3–N was greater in cows fed CM when compared to those fed W-DDGS ($P = 0.03$). The RUP supply was greater in cows fed the low CP when compared to those fed the high CP diet when diets contained CM, whereas RUP supply was lower in cows fed the low CP when compared to those fed the high CP diet when diets contained W-DDGS (tendency for interaction, $P = 0.06$). Omasal flows of threonine and tryptophan were greater ($P \leq 0.03$), whereas that of histidine and lysine tended ($P \leq 0.08$) to be greater, in cows fed CM when compared to those fed W-DDGS. In conclusion, when diets are formulated to contain 15 or 17% CP, CM or W-DDGS can support similar levels of milk production when used as the major protein source.

Key Words: canola meal, milk production, wheat dried distillers grains with solubles

1689 (T302) Performance, digestibility, and blood acid-base balance of dairy cows in response to the replacement of corn by crude glycerin. O. F. Zacaroni[1], F. F. Cardoso[1], R. A. N. Pereira[2,3], and M. N. Pereira[*1,3], *[1]Universidade Federal de Lavras, Brazil, [2]Empresa de Pesquisa Agropecuaria de Minas Gerais, Lavras, Brazil, [3]Better Nature Research Center, Ijaci, Brazil.*

This experiment evaluated the response of late lactation dairy cows to the partial replacement of corn by methanol rich, crude glycerin. The tallow derived glycerin contained 70.2% DM and 7.3% methanol on an as-fed basis. Twelve Holsteins (219 ± 57 DIM), three primiparous, were assigned to 35-d periods, 3 × 3 Latin squares. The isonitrogenous diets (15.8% CP) contained (DM basis): 11.8% finely ground mature corn and 17.2% soybean meal (T0); 4.9% glycerin, 5.9% corn, and 18.3% soybean meal (T5); or 9.7% glycerin and 19.4% soybean meal (T10). Other ingredients were: 31.9% corn silage, 28.2% sugarcane silage, and 6.2% high moisture corn. Statistical analysis was performed with PROC MIXED of SAS, with a model containing the random effect of cow and the fixed effects of period and treatment. Two contrasts were evaluated: Linear = T0 vs. T10, and Quadratic = T5 vs. (T0+T10). The replacement of corn by glycerin induced linear decreases in milk (22.2, 21.1, 20.0 kg/d, $P < 0.01$) and lactose secretions ($P < 0.01$), without affecting DMI (17.8 kg/d, $P = 0.53$), reducing feed efficiency ($P < 0.01$). Milk contents of fat (4.11, 4.33, 4.37%, $P = 0.01$) and protein (3.47, 3.64, 3.73%, $P < 0.01$) were linearly increased by glycerin, but daily secretions were similar ($P > 0.86$). Milk urea nitrogen was similar (13.8 mg/dL, $P = 0.51$), as well as chewing activity ($P > 0.32$), except the daily ingestion time, reduced by glycerin ($P = 0.05$). Total tract apparent digestibility of the non-NDF organic matter was linearly increased by glycerin (90.3, 91.4, 93.2% of intake, $P = 0.05$), but the intake of digestible organic matter was similar (10.6 kg/d, $P = 0.66$). The ratio of the daily milk energy secretion to the intake of digestible organic matter was linearly reduced by glycerin (1.58, 1.55, 1.42 Mcal/kg, $P = 0.05$). Rumen pH 12-h post feeding was similar (5.67, $P = 0.72$). The intake of crude glycerin was 1.24 kg/d in T5 and 2.5 kg/d in T10, methanol intake was 134 mg/kg of BW in T5 and 269 mg/kg of BW in T10. Health disorders were not observed. However, glycerin reduced the partial pressure of CO_2 ($P = 0.02$) and increased the saturation of hemoglobin with O_2 ($P = 0.05$) in jugular blood samples obtained 6-h post feeding, suggesting an induction of hyperventilation. Venous blood pH, bicarbonate level, base excess, and the partial pressure of O_2 were not affected by treatment ($P > 0.64$). The replacement of corn by crude glycerin reduced milk yield, feed efficiency, and the response was associated to low milk lactose secretion.

Key Words: digestibility, glycerin, methanol

1690 (T303) Effects of crude glycerin supplementation on fatty acids composition of milk fat from primiparous lactating cows on irrigated tropical pasture. M. C. A. Santana*[1], H. A. Santana Junior[2], M. P. Figueiredo[3], E. O. C. Santana[4], G. A. Filho[4], C. B. Figueiredo[2], M. S. Maciel[2], and J. I. Simionato[5], *[1]Emater, Goiânia, Brazil, [2]Universidade Estadual do Piauí, Corrente, Brazil, [3]Universidade Estadual do Sudoeste da Bahia, Vitória da Conquista, Brazil, [4]Universidade Estadual do Sudoeste da Bahia, Itapetinga, Brazil, [5]Universidade Estadual de Londrina, Brazil.*

The objective of this study was to evaluate the effect of different levels of crude glycerin suplementation on fatty acids composition of milk fat from primiparous lactating cows grazing on irrigated tropical pasture. The experiment was conducted at Rancho Santana farm, located in Jequié city, Bahia, Brazil, in the period from Dec. 21, 2010, to March 16, 2011. Ten 3/4 Holstein × 1/4 Dairy Gyr lactating primiparous cows, with 109 ± 24 d of lactation and a mean age of 30 ± 6 mo and mean body weight of 426.2 ± 68.29 kg were distributed into five treatments, using two simultaneous 5 × 5 Latin squares. Treatments consisted of inclusion levels (0, 94, 191, 289, 389 g/kg dry matter basis) of crude glycerin (CG) in the supplement. Fatty acid methyl esters were analyzed by Thermo Finnigan Trace-GC-Ultra gas chromatography. Results were statistically analyzed by variance and regression analyses at 0.05 probablity. Results showed effects on milk fat saturated fatty acids— caproic (6:0), caprylic (8:0), capric (10:0), lauric (12:0), pentadecanoic (15:0) and stearic (18:0)— when the crude protein concentrations in supplement increased. The increase of CG level in the supplement did not differ the polyunsaturated fatty acids ($P < 0.05$). To determine the ratio between pro- and anti-atherogenic acids, the atherogenic index (IA) and thrombogenic index (IT) were calculated, and difference was verified only for IA ($P < 0.05$). Treatments affected a few of the saturated and monounsaturated fatty acids. Overall, this data indicated that the addition of glycerin did not cause effects on the variables that express the milk quality, so the recommended crude glycerin level could be increased to 389 g (171 g glycerol) per kg of supplement.

Key Words: glycerol, biohydrogenation, biodiesel

1691 (T304) Effect of grain processing and fat supplementation on ruminal pH dynamics of cows grazing a tropical pasture. J. D. Souza*, F. Batistel, E. Miqueo, P. D. Andrade, M. M. V. Silva, C. Sitta, and F. A. P. Santos, *University of Sao Paulo, Piracicaba, Brazil.*

The objective of this experiment was to investigate the effects of grain processing and fat supplementation to dairy cows grazing a tropical pasture on ruminal pH dynamics and incidence of acidosis. Four rumen cannulated lactating cows (165 ± 32 DIM) were used in a Latin square design and subjected to the following treatments: a) fine ground corn without fat (FGC); b) fine ground corn + 400 g calcium salts of palm oil cow^{-1} d^{-1} (FGCCS); c) steam-flaked corn without fat (SFC); d) steam-flaked corn + 400 g of calcium salts of palm oil cow^{-1} d^{-1} (SFCCS). The fine ground corn had a particle size of 1.3 mm and steam-flaked corn a density of 360 g/L. Treatment periods were 24 d in length and cows grazed paddocks of *Pennisetum purpureum* and received 6.0 kg cow^{-1} d^{-1} (DM) of concentrate twice daily. Ruminal pH was continuously measured using a LRC pH measurement system. The in-dwelling electrode measured and recorded the ruminal pH every 10 min over the measurement period. Each electrode was standardized using pH 4.0 and 7.0 standards at the beginning and end of each period. The pH data were first summarized by day and then averaged across each measurement period as mean, maximum, and minimum pH and time in which pH was below 6.2, 6.0, and 5.8 as an index of severity of ruminal acidosis. Data were analyzed as repeated measures using a PROC MIXED model with period and animal as random effect and grain processing, fat supplementation and grain processing × fat supplementation as fixed effects. The means were compared by Tukey test at 5%. The mean pH, minimum pH and maximum pH were not affected by treatments. The mean pH was 6.63, 6.73, 6.68 and 6.64 for FGC, FGCCS, SFC and SFCCS, respectively. The minimum pH was 6.02, 6.10, 6.02 and 6.15 and the maximum pH was 7.04, 7.12, 7.02 and 7.06 for FGC, FGCCS, SFC and SFCCS, respectively. No pH measurements below 5.8 were observed. The time that the pH was below 6.0 was greater in steam-flaked compared with fine ground corn (5.2 vs. 2.6 h/d), and the time that pH was below 6.2 was also greater in steam-flaked diets (14.0 vs. 11.4 h/d). In conclusion, steam-flaked corn diets decreased the ruminal pH, but not below 5.8, which suggest no acidosis occurrence in dairy cows grazing a tropical pasture.

Key Words: steam-flaked corn, fat, tropical pasture

1692 (T305) Grain processing and fat supplementation on milk yield and milk composition of dairy cows grazing a tropical pasture. F. Batistel*, J. D. Souza, M. R. R. Soares, C. S. M. Motta, E. Miqueo, and F. A. P. Santos, *University of São Paulo, Piracicaba, Brazil.*

The objective of this experiment was to investigate the effects of grain processing and fat supplementation to early lactation dairy cows grazing a tropical pasture on milk production and composition. Forty early lactation cows (15 ± 4 DIM) were used in a randomized block design and subjected to the following treatments: a) fine ground corn without fat; b) fine ground corn + 400 g calcium salts of palm oil cow^{-1} d^{-1}; c) steam-flaked corn without fat; d) steam-flaked corn + 400 g of calcium salts of palm oil cow^{-1} d^{-1}. Treatment periods were 90 d in length and cows grazed paddocks of *Pennisetum purpureum* and received

9 kg cow^{-1} d^{-1} (DM) of concentrate twice daily. Milk yield was measured every 2 d and milk composition was analyzed every 6 d. Data were analyzed as repeated measures using a mixed model with block as random effect and grain processing, fat supplementation and grain processing × fat supplementation as fixed effects. The means were compared by Tukey test. Steam-flaked corn increased (P = 0.001) milk yield compared with fine ground corn (23.9 vs. 22.2 kg/d) and supplementation with fat also increased (P = 0.0001) milk production (24.7 vs. 21.3 kg/d). Milk fat content was reduced (P = 0.01) in steam-flaked corn in comparison with fine ground corn diets (3.22 vs. 3.30%). There was a pronounced increased (P = 0.0001) in milk protein content in steam-flaked corn compared with fine ground corn diets (3.41 vs. 3.15%). In addition, milk casein content was increased (P = 0.0001; 2.47 vs. 2.33%) and milk urea nitrogen was decreased (P = 0.002; 12.1 vs. 16.3 mg/dL) in steam-flaked diets indicating greater efficiency of N utilization in these treatments. Total solids content was reduced (P = 0.05) by fat supplementation (12.19 vs. 12.05%), which is associated with the tendency of reduction in milk protein content (P = 0.10; 3.29 vs. 3.22%). Milk fat yield was unaffected by grain processing (P = 0.18; 0.75 vs. 0.77 kg/d for fine ground corn and steam-flaked corn, respectively), but fat supplementation increased (P = 0.001) milk fat yield (0.80 vs. 0.71 kg/d). Steam-flaked corn increased (P = 0.001) milk protein yield compared with fine ground corn (0.81 vs. 0.71 kg/d). In grazing dairy cows, steam-flaked corn increased milk yield and milk protein, and fat supplementation increased milk yield and milk fat yield, and when combined (steam-flaked corn + fat) allowed the greatest milk yield, milk fat yield and milk protein yield.

Key Words: palm oil, flaked corn, tropical pasture

1693 (T306) Effect of grain type (corn versus milo), particle size (600 versus 1000 microns) and steam-flaked corn on productive and metabolite responses of early lactating Holstein cows. E. Mahjoubi[1], J. R. Johnson[*2], B. J. Bradford[2], and M. J. Brouk[2], [1]*Dep. of Animal Science, University of Zanjan, Iran,* [2]*Dep. of Animal Sciences and Industry, Kansas State University, Manhattan.*

Ten early lactation Holstein dairy cows (five multiparous and five primiparous) were used in a duplicated Latin square design to evaluate diets that differed in grain type (corn vs. milo) and grain particle size (fine vs. coarse roller-milled); a steam-flaked corn (SF-C) diet was also included for comparison. Periods were 21 d with 17 d for adaptation and 4 d for data collection, and data were subjected to PROC MIXED model analysis with contrasts used to evaluate effects of grain type, particle size, and processing method. Mean particle size of fine and coarse rolled corn, fine and coarse rolled milo and SF-C was 724, 1087, 636, 980, and 3356 microns, respectively. Daily dry matter intake was not influenced (P > 0.05) by treatment (26.6, 26.6, 27.8, 26.6 and 26.4 ± 1.7 kg, respectively), nor was milk yield (41.5, 41.5, 40.5, 40.9 and 41.6 ± 3.2 kg, respectively). Treatment did not affect (P > 0.05) milk component concentrations or yields except that when fed corn, cows yielded greater (P = 0.03) amounts of milk protein due to numerically greater milk yield and milk protein concentration. Efficiencies of milk production, energy correct production and fat corrected production were not impacted by treatment. However, feeding corn resulted in a trend for greater (P = 0.06) milk production efficiency when compared to milo. Milk urea nitrogen (MUN) was decreased (P = 0.05) when feeding corn compared to milo. Similar blood glucose levels were observed pre and post feeding for all treatments. Circulating NEFA was higher (P < 0.05) for rolled corn diets versus SF-C and milo diets. Period changes in body weight and body condition score were unaffected by treatment (P > 0.05). Data demonstrates that rolling corn or milo to 600 or 1000 microns resulted in similar milk production and milk production efficiency as compared to SF-C. Processing corn or milo to a particle size smaller than 1000 microns did not result in increased milk production or efficiency of production suggesting that it is not necessary to reduce particle size of corn or milo below 1000 microns when included in a total mixed ration (TMR) resulting in reduced processing expense. Similar milk production and production efficiency for milo versus corn suggests that relative pricing should be utilized to determine if corn or milo should be included in lactating dairy cow diets when corn or milo is processed to a similar particle size and fed in a TMR.

Key Words: grain processing, particle size, sorghum

1694 (T307) Effect of concentrate source (cottonseed vs. barley) on milk performance and fatty acids profile of spring calving Holstein-Friesian cows feeding an indoors silage regime. A. I. Roca-Fernández* and A. González-Rodríguez, *Agrarian Research Centre of Mabegondo, La Coruña, Spain.*

Milk performance and fatty acids (FA) profile of spring-calving Holstein-Friesian cows (n = 36) at end of lactation (200 d in milk) were examined. Cows were fed indoors with a total mixed ration (TMR) containing: 70% silage (grass: maize, 36:64) and 30% concentrate. Two sources of concentrate were investigated: cottonseed (C) at two levels, low (5 kg DM/cow/d) or high (7 kg DM/cow/d), and barley (B) at high level (7 kg DM/cow/d). Animals were randomly assigned to one of three indoor (n = 12) feeding regimes (C5, C7 and B7), during 10 wk in autumn. The B and C concentrates were composed of corn flour (B, 43.1 vs. C, 31.0%), soybean hulls (B, 28.5 vs. C, 34.0%), soybean meal (B, 23.5 vs. C, 20.0%), barley flour (B, 1.4 vs. C, 0%), cottonseed (B, 0 vs. C, 12.0%) amender (B, 1.0 *vs.* C, 1.0%), calcium carbonate (B, 1.5 vs. C, 1.0%) and dicalcium phosphate (B, 1.0 vs. C, 1.0%). Average chemical composition of B and C concentrates was: crude protein (166 vs. 168 g/kg DM), neutral detergent fiber (249 vs. 418 g/kg DM) and crude fat (31 vs. 49 g/kg DM), respectively. Daily

milk yield was higher ($P < 0.001$) at the high level of supplementation (B7, 18.1 and C7, 17.9 kg/cow/d) compared to the low level (C5, 15.7 kg/cow/d), and dairy cows at the high level of concentrate showed higher ($P < 0.05$) body weight values (B7, 605 and C7, 598 kg) compared to those at the low level (567 kg). Milk protein was lower ($P < 0.05$) at the high level of concentrate in the cottonseed (C7, 30.7 g/kg DM) than in the barley treatment (B7, 32.7 g/kg DM). There were no differences among treatments in milk fat and milk urea content. No differences were also found among treatments in short, medium and long chain FA. Despite this, higher ($P < 0.05$) content of polyunsaturated FA and linoleic acid were observed in the C7 compared to the C5 treatment (2.48 and 2.22 vs. 2.16 and 1.92 g/100 g of FA). These results might be explained by alterations in rumen biohydrogenation pathways of milk FA from dairy cows supplemented with cottonseed concentrate at high level. Linolenic acid was, however, higher ($P < 0.01$) in the B7 (0.27 g/100 g of FA) than in the C5 treatment (0.24 g/100 g of FA).

Key Words: dairy cow, lipid feed supplements, milk fatty acids composition

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1695 (T308) Ruminal starch degradation of maize silage affected by ensiling time and dry matter content.

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Quantitative evaluation of rumen degradation of maize silage is relevant for accurate determination of its nutritional value. Our objective was to quantify combined effects of ensiling time and dry matter (DM) at harvesting on effective rumen degradation (ED) of starch, crude protein (CP) and NDF in maize silage. Maize silage (hybrid Nutreka) was harvested at 30, 35 or 40% DM with 2-wk intervals, allowing different maturity to develop in the same crop. Fresh samples were stored at -18°C. 25 L plastic vessels were filled with thin layers of material and compressed manually to remove air. Full vessels were sealed then stored for 4, 8 or 12 mo at ambient temperature. After opening, samples were stored at -18°C. Three fistulated mid-lactation Holstein cows fed a basal ration consisting of maize silage, grass silage, hay and compound feed, were used to incubate nylon bags. Bags (pore size 37 µm) were inserted at 0800 h and removed after 3, 8, 16, 32, 56, 96, and 336 h. All bags were machine washed, freeze-dried and weighed. Outliers were removed using Dixon Q-test. Residues were analyzed by NIRS for DM, starch, CP and NDF using calibration lines specifically developed for maize silage residues. Washable and undegradable fractions were based on residues after 0 and 336-h incubation, respectively. Rate of degradation (k_d) was calculated in SAS using PROC NLIN. ED was calculated as Washable + Degradable x (k_d/(k_d+ passage rate)) and analyzed in SAS using PROC MIXED for significant differences between treatments using ensiling time and DM as fixed factors and cow as random factor. Starch and CP ED increased with increasing time ensiled ($P < 0.0001$) from 63.3 to 85.4% and from 42.2 to 71.4%, respectively. Starch and CP ED decreased with increasing DM ($P < 0.0001$) from 82.3 to 71.7% and from 63.9 to 58.5%, respectively. Higher DM at ensiling led to a more pronounced effect of ensiling time on starch and CP ED ($P < 0.0001$ for interaction time x DM). NDF ED was not significantly affected by ensiling time or DM ($P > 0.10$). It can be concluded that ED of starch and CP in maize silage is affected by combined effects of ensiling time and DM at harvesting. These results can be applied in ration formulation systems for dairy cows to further optimize nutrient utilization and rumen conditions.

Key Words: maize silage, ensiling time, rumen starch degradability

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1696 (T309) Relationship of in vitro starch digestion to corn kernel measurements from farms in Michigan.

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With mature grain, increased kernel vitreousness and prolamin content reduce in vitro starch digestion. Does this apply for grain harvested at corn silage maturity? To answer this question, samples of whole plant corn silage and shelled grain from five Pioneer hybrids at silage harvest were gathered from 15 environmentally diverse locations in Michigan in 2013. Starch availability (7 h in vitro starch disappearance) and nutrient composition were evaluated at a commercial laboratory; vitreousness was appraised as kernel specific gravity by gas displacement. Impacts of hybrid and location on nutrient composition, starch availability, and vitreousness were evaluated by GLM procedures of SAS. Differences ($P < 0.01$) among hybrids were noted for DM, CP, fat, starch, and pycnometer density, and for starch availability ($P < 0.02$). Farm of origin also had an impact ($P < 0.02$) on every component except NDF content of grain. Across all samples, prolamin content was not closely related to in vitro starch availability ($r = -0.06$; $P = 0.63$) but increased as CP content of grain increased ($r = 0.74$; $P < 0.01$). Among all measurements, in vitro starch availability was predicted best but still poorly (R2 = 0.17) by the equation: Starch availability = 38.33– 0.124 × *g*rain DM + 0.585 × *g*rain starch percentage. As harvest DM increased, specific gravity and prolamin content tended ($P < 0.10$) to increase. Starch availability decreased as kernel specific gravity increased ($P < 0.05$). Perhaps because of its high dependence on kernel protein content, prolamin content was not closely related to starch availability of grain samples harvested when corn silage was harvested. Had all grain samples had been obtained from fields equal in N fertility, the relationship of prolamin to starch availability likely would have been closer. The range in starch digestibility among these silage hybrids was less than half the range among farms (2.9 vs. 6.3% points); this questions the accuracy of predicting starch availability from hybrid genetics alone. Low in

vitro starch digestion of dry vitreous hybrids may reflect high prevalence of larger particles from dry coarsely ground grain although other factors (e.g., fine grinding, fermentation) also will impact on in vivo starch availability.

Key Words: prolamin, starch digestion, vitreousness

1697 (T310) Effect of particle size and time of rumen fluid collection on in vitro starch digestibility of corn and sorghum. E. Raffrenato[*1,2], L. J. Erasmus[1], W. A. van Niekerk[1], and C. Engelbrecht[1], *[1]University of Pretoria, South Africa, [2]Stellenbosch University, South Africa.*

Starch digestibility affects rumen health and milk production in dairy cows. Corn and sorghum are among the most common starch sources, but the least digestible when unprocessed. Grinding is the preferred way to increase starch digestibility. However, time of rumen fluid collection is often not considered as source of variation when analyzing in vitro starch digestibility. In addition, interaction between particle size and time of feeding may further bias the digestibility results. Objectives of the study were to assess the effects of: 1) different particle sizes in corn and sorghum, 2) time of rumen fluid collection relative to feeding (ad libitum feeding, i.e., 8 h after first morning feeding, AL vs. collection after 8 h of fasting, FA), and 3) their interaction on in vitro starch digestibility (IVSD). Several cultivars of corn and sorghum were analyzed for starch and CP content and ground at 1, 2, 4, and 6 mm, using an ultra-centrifugal mill. Rumen fluid was collected from two cows fed a lactation diet containing 25% starch. Residual starch of the fermented samples were obtained at 0, 1, 2, 4, 6, 8, 12, and 24 h. Density of grains were also measured for all particle sizes and correlated with IVSD. Rates of starch digestion were computed assuming a first order decay and the parameters were estimated using PROC NLIN in SAS. Rates of digestion were on average higher for the FA rumen fluid ($P < 0.05$) compared to the AL rumen fluid with 0.21 vs. 0.16 and 0.14 vs. 0.10 h^{-1} for corn and sorghum, respectively. Furthermore, interaction between particle size and rumen fluid was highly significant ($P < 0.001$). Finer corn and sorghum had in fact consistently higher rates of starch digestion, increasing with decreasing particle size ($P < 0.001$), only within the AL rumen fluid. When using the FA rumen fluid, particle size did not have any influence on starch digestibility ($P = 0.67$). Both density and CP were also negatively correlated (-0.65 and -0.78, $P < 0.05$) with IVSD. This proves the importance of time of collection of rumen fluid but it could also imply important consequences for rumen health when feeding starch separately, after hours of fasting.

Key Words: in vitro starch digestibility, rumen fluid, rumen health

1698 (T311) Effect of reducing dietary starch on intake, lactation performance, and ruminal parameters of dairy cows: A meta-analysis. S. M. Fredin*, L. F. Ferraretto, and R. D. Shaver, *University of Wisconsin, Madison.*

A meta-analysis was conducted to determine the effect of feeding reduced-starch diets on intake, lactation performance, and ruminal parameters of dairy cows from a data set comprising 131 treatments means from 56 peer-reviewed trials from 1993 to 2014. Reduction in dietary starch was achieved by partially replacing cereal grains with non-forage fiber sources, forages, or sugars. Dependent variables were calculated as the difference between observations on the higher starch (% of DM) diet and observations on the reduced-starch diet(s) within trial. The higher starch concentration was used as a covariate within trial when $P \leq 0.15$. Data were analyzed using PROC MIXED of SAS with treatment as a Fixed effect and trial as a Random effect. Dietary CP and NDF contents (% of DM) were (mean ± SD) 17.8 ± 2.3 and 31.8 ± 5.5%, respectively, across all trials. The higher starch diet and reduced-starch diets contained (mean ± SD) 28.9 ± 5.0% and 21.5 ± 4.8% starch, respectively, across all trials. Dry matter intake was 24.3 ± 2.6 kg/d across all trials, and decreased 0.1 kg/d per %-unit (DM basis) decrease in dietary starch content ($P < 0.001$). Milk yield (kg/d) decreased 0.2 kg/d per %-unit decrease in dietary starch content ($P < 0.001$). Fat- and energy-corrected milk followed a similar pattern ($P < 0.001$). Feeding reduced-starch diets decreased milk fat (7 g/d), protein (9 g/d), and lactose (12 g/d) yields per %-unit decrease in dietary starch ($P < 0.001$). Milk fat concentration was unaffected by reduced dietary starch ($P = 0.60$), whereas milk protein (0.005%) and lactose (0.004%) concentrations were decreased per %-unit decrease in dietary starch ($P \leq 0.01$). There was a trend for lower feed conversion (kg milk/dkg DMI) on reduced-starch diets ($P = 0.06$). Total ruminal VFA concentrations were decreased 0.4 m*M* per %-unit decrease in dietary starch ($P = 0.03$), however, ruminal acetate and butyrate (mol/100 mol) concentrations ($P \geq 0.41$) were unaffected. There was a trend for a decrease of 0.09 mol/100 mol for ruminal propionate concentration on reduced-starch diets ($P = 0.09$), and rumen acetate: propionate ratio was increased ($P = 0.03$) on reduced-starch diets. Rumen ammonia (mg/dL) and pH ($P \geq 0.32$) were unaffected by reducing dietary starch content. Dry matter intake, milk, and component yields were decreased for dairy cows when fed reduced-starch diets.

Key Words: dairy cow, lactation, starch

1699 (T312) Effect of rehydration and silage storage period of corn with medium vitreous endosperm on chemical composition and dry matter in situ degradability. M. A. Arcari, C. Martins, J. Gonçalves, D. Sousa*, T. Tomazi, L. F. P. Silva, and M. Veiga dos Santos, *University of São Paulo, Pirassununga, Brazil.*

The aim of this study was to evaluate the effects of rehydration process and storage period of milled, rehydrated and ensiled corn (MREC) with medium vitreousness (67 ± 3%) on chemical composition and in situ DM degradability. Corn grains were harvested with 83% DM concentration and dried to obtain 87% DM concentration. After dried, corn grains were milled (2 mm), rehydrated to 67% DM, and ensiled (silo density of 880 kg/m^3) in mini-silos. Furthermore, the MREC samples were evaluated in different storage periods (3 to 330 d). The MREC were analyzed for nutrient contents, fermentation products and in situ DM degradability. The data were modeled according to Mehrez and Ørskov (1977), and the effects of MREC storage time on degradability were evaluated by the PROC MIXED of SAS ($\alpha = 0.05$), in a completely randomized design with two replications. No effect of ensiling period was observed for MREC DM and CP content. The ensiling period reduced the MREC starch content ($P < 0.001$). The MREC starch content was 2.4% points lower in the silos with 330 d of storage compared to the silos with 3 d of storage. The MREC with 330 d of storage had greater ($P < 0.001$) concentrations of NH_3–N, ethanol, lactate, acetate, propionate, and butyrate were increased by 8.5, 2.4, 3.45, 4.1, 1.7, and 2.8-folds, respectively. Likewise, the storage time of MREC increased ($P < 0.001$) in situ DM degradability. The percentage of rapidly degradable DM fraction (fraction A), the degradation rate of the slowly degradable DM fraction (fraction C) and the potentially degradable DM (PD) were increased by 3.04, 2.42 and 1.009 folds after 330 d of storage. The C fraction (slowly degradable DM fraction) from the MREC stored for 330 d decreased by 1.91-fold in comparison to the MREC stored for 3 d. The effective DM degradability, which was adjusted for rumen passage rates of 0.02, 0.05 and 0.08%/h, increased ($P < 0.001$) from 81 to 93.3%, from 66.6 to 88.6%, and from 57.6 to 84.9%, respectively. In conclusion, the storage period affected the chemical composition and increased the in situ DM degradability of MREC with medium vitreous endosperm.

Key Words: ensiling, in situ degradability, vitreousness

1700 (T313) Factors affecting 7-hour starch digestibility on conventional corn silage, BMR corn silage, and high moisture corn grain. A. J. Miner*[1], M. Tetreault[2], C. J. Sniffen[3], and R. Ward[4], *[1]Poulin Grain Inc., Newport, VT, [2]Poulin Graing Inc., Newport, VT, [3]Fencrest, LLC, Holderness, NH, [4]Cumberland Valley Analytical Services Inc., Hagerstown, MD.*

Previous research has shown that there appears to be a relationship between time after ensiling and starch digestibility in lactating dairy cows. The objective of this study was to measure how time after ensiling and other factors affect 7-hour starch digestibility in conventional corn silage, BMR corn silage, and high moisture corn grain. Samples were taken monthly on 16 farms in New York and Vermont from November 2010 to October 2011. All samples were sent to Cumberland Valley Analytical Services to have 7-hour starch digestibility and dry matter analysis determined on all samples. Linear analysis was performed on samples grouped by physical characteristics (Conventional vs. BMR vs. High Moisture Corn) comparing impact of time after ensiling and other factors on the 7 h starch digestibility of the starch in the feedstuffs. The analysis of the conventional corn silage demonstrated that time after ensiling has the largest impact on 7 h starch digestibility ($P = 0.0007$) however dry matter and farm that sample was taken from also has an impact. When time after ensiling, dry matter, and farm name was accounted for analysis showed a linear realtionship ($R^2 = 0.17$; $P = 0.11$). For the bmr corn silage there appeared to be a strong relationship for time after ensiling on 7-hour starch digestibility ($P > 0.99$); however, when dry matter and farm were applied to the data, there was a linear relationship ($R^2 = 0.54$; $P = 0.01$). It appears that the farm the sample came from had the biggest impact on the 7-hour starch digestibility of the BMR corn silage ($P = 0.04$). On the high moisture corn grain again there was a time after ensiling effect with a good relationship with 7-hour starch digestibility ($P < 0.01$). Dry matter and farm also have a linear relationship ($R^2 = 0.47$; $P = 0.01$). In conclusion time after ensiling has a significant impact on 7-hour starch digestibility of both the conventional corn silage and high moisture corn grain; it does not have a significant impact on BMR corn silage. The variation that was accounted for by the farm that the samples came from indicates that other factors such as soil type, corn hybrid, amount of processing, and other farm factors can have an impact on 7-hour starch digestibility.

Key Words: starch digestibility, time after ensiling, corn silage

1701 (T314) Glycerol exacerbates effects of sorghum-based tannins extract on in vitro fermentative activity of mixed ruminal microorganisms.

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Tannins have been observed to impact ruminal metabolism, affecting protein degradation, predisposition to bloat, and production of methane and conjugated linoleic acid; however, these effects on rumen modulation and animal performance have not been consistent. Glycerin is a by-product from biodiesel production and is a major component of distiller's grains, and thus is frequently present in diets of finishing cattle. The aim of this work was to evaluate interactive effects of sorghum-derived tannins and glycerol on fermentative activity (in vitro dry matter digestibility, IVDMD; ammonia, NH3; and volatile fat acid, VFA profiles) of in vitro cultures of mixed ruminal microorganisms. Tannins were prepared from sorghum bran by extraction with acetone and lyophilized. For in vitro fermentations, 40 mL of modified McDougall's buffer (no urea) were placed into 100 mL plastic bottles along with 20 mL of strained ruminal fluid and 2 g of substrate. Ruminal fluid was obtained from fistulated cattle fed a diet consisting of approximately 50:50 forage:concentrate (alfalfa hay, corn silage, corn flake, dry distilled grain, mineral mix). Substrate for in vitro fermentations consisted of finely ground (< 1 mm) corn and soybean meal in a 90:10 ratio (C) or partial replacement of corn with glycerol (G; 10% of substrate), tannin (T; 1%) or a mix (TG). After incubating 24 h at 39C, IVDMD and concentrations of NH3 and VFA were measured. Data were analyzed as a randomized complete block design by using the PROC MIXED of SAS, and results are summarized below. Shifts in concentrations of ammonia and VFA in cultures fed glycerol generally were exacerbated by the presence of tannins. The observed interaction between glycerol and tannin may explain the varying results found in studies that use glycerol as a substitute for cereals grains in diets of ruminants.

Key Words: glycerin, tannin, sorghum

Table 1701. Effect of glycerol and sorghum-based tannins extract on in vitrofermentative activity of mixed ruminal microorganisms

	Treatment					
Item	C	G	T	TG	SEM	*P*-value*
IVDMD, %	55.2	53.7	53.1	52.5	0.91	0.104
Ammonia, mM	2.45[a]	2.31[a]	1.96[b]	1.59[c]	0.157	< 0.01
Acetate, mM	34.86[a]	33.74[b]	33.59[b]	32.31[c]	0.55	< 0.01
Propionate, mM	20.69[b]	23.30[a]	20.15[c]	22.92[a]	0.42	< 0.01
Butyrate, mM	6.57[a]	6.50[a]	6.21[b]	6.22[b]	0.16	< 0.01

*Means in the same row without a common superscript letter are different; $P < 0.05$.

1702 (T315) Use of byproducts from corn industry and citric acid on dairy heifer diet.

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The use of byproducts in animal nutrition is an interesting alternative. Besides minimizing cost of livestock production, is a way to absorb part of the growing residue of industrial production, thus improving environmental conditions. Byproducts of sugar production, such as mycelium, precoat, and rafinate have become available for use. The mycelium is composed of cellular material from the fermentation of sugar by the fungus *Aspergillus niger*. The rafinate results from the purification process of the citric acid, the principal product formed from the fermentation of sugar. The precoat filter is derived from the step of glucose syrup production. The aim of this study was to evaluate performance of crossbred dairy heifers fed diets with wet byproducts. Forty heifers weighing on average 240 kg were randomly assigned to four treatments receiving control diet ($n = 10$) and diets containing: precoat ($n = 10$), mycelium ($n = 10$) and rafinate ($n = 10$). The control diet was formulated with sugar cane bagasse, and wet corn gluten feed (WCGF), corn gluten feed (CGF) and cracked corn. The other diets were formulated with the same ingredients, but with the inclusion of byproducts cited in their respective treatments. The average dry matter intake (DMI) was estimated by the difference between dry matter offered and orts, divided by the number of animals in treatment. Samples of offered and orts were collected daily and sent for chemical analysis. The design was randomized and analyzed variables were subjected to statistical analysis, considering significance at 5% probability. There were significant differences in dry matter intake (DMI) ($P < 0.01$), where mycelium showed the highest and control the lowest intake. There were no significant differences in consumption of neutral detergent fiber by the animals, initial and final body weight, total and average daily gains and feed efficiency (FE) of the heifers ($P > 0.05$). Control and rafinate groups showed better FE ($P < 0.01$) compared to the mycelium, whereas precoat performed equally to all treatments. The inclusion of wet byproducts mycelium, precoat and rafinate in the diet of crossbred dairy heifers at 5.5, 3.4 and 4.8% of fresh matter, respectively, provides satisfactory performance of the animals. However, more studies are needed to determine the economic viability of using these byproducts in ruminant diet.

Key Words: mycelium, precoat, rafinate, dry matter intake

1703 (T316) Monensin increases endotoxin concentration in an in vitro rumen fermentation model. N. Reisinger[1], S. Schaumberger[*2], I. Dohnal[1], C. Emsenhuber[1], C. Stoiber[1] and G. Schatzmayr[1], *[1]Biomin Research Center, Tulln, Austria, [2]Biomin Holding GmbH, Herzogenburg, Austria.*

Administration of antibiotics (e. g. Beta-lactam), which effect gram-negative bacteria, can lead to an increased concentration of endotoxins in the rumen. This increase can lead to endotoxin associated effects like inflammation, immune response and diseases risks, e.g. mastitis, endometritis and laminitis. Monensin has a wide range of application indications in ruminants: coccidiosis, ketosis, pulmonal edema, pneumonia, and is even used as growth promoter. This ionophore inhibits the growth of gram-positive bacteria, but there is no literature available on the effects on endotoxin release by increase of gram-negative bacteria. The objective of this study was, therefore, to test the effect of monensin on the ruminal endotoxin concentration in an in vitro rumen fermentation model. Rumen fluid was incubated under anaerobic conditions at 39°C and a continuous flow of synthetic saliva for 336 hours. Fresh feed (50% chopped hay; 50% cereal nutrient) was supplied in nylon bags every 24 hours. Six reactors were treated with monensin (10 mg/L), the other six reactors served as untreated control. Samples of the rumen fluid were taken after 24 and 336 hours. Samples were centrifuged; heat inactivated and filtrated before dilution with endotoxin free water. Endotoxin concentration was measured with the chromogenic *Limulus-Amebocyte* Lysate assay, according to manufacturer's instructions. Total bacterial count was performed with the flow cytometer. There was no significant difference in the endotoxin concentration of the control reactors (895 EU/ml) compared to the monensin treated reactors (1.715 EU/ml) after 24 hours ($P > 0.05$). In contrast, after 336 hours incubation, the endotoxin concentration in monensin-treated reactors (12.485 EU/ml) significantly ($P < 0.05$) increased compared to the control reactors (1.471 EU/ml). The total bacterial count was also significantly increased after 336 hours in the monensin-treated reactors compared to the control reactors ($P < 0.05$). Results of this in vitro experiment showed that monensin led to an increase of endotoxins in rumen fluid. This might be a result of the expected bacterial shift from gram-positive to gram-negative bacteria. Further investigations are necessary to verify these results and to clarify the mechanism of monensin in the in vitro rumen fermentation model. In addition, it will be useful to test other antibiotics, to avoid negative effects on bacterial populations and increase of endotoxins.

Key Words: endotoxins, monensin, rumen

1704 (T317) Effect of a calcareous algae and monensin on feed intake and rumen parameters of cattle fed abruptly high concentrate diets. R. Ferreira Carvalho[1], A. P. S. Silva[1], M. Rezende Mazon[2], C. A. Zotti[1], L. Silva Oliviera[1], S. Luz e Silva[*1] and P. R. Leme[1], *[1]University of Sao Paulo/FZEA, Pirassununga, Brazil, [2]University of Sao Paulo, Pirassununga, Brazil*

Additives are used in high concentrate diets to prevent metabolic disorders. The use of calcareous algae (*Lithothamnium calcareum*), a natural and renewable product, may be an alternative. The effect of a calcareous algae product (Top Buffer Sanphar, Campinas, Brazil) and monensin (Bovensin Phibro, Guarulhos, Brazil) on feed intake, rumen pH, short chain fatty acids, lactate and ammonia nitrogen concentration in the rumen of Nellore steers transitioned abruptly to a high concentrate diet was evaluated.. On d 1, the diet of all animals was abruptly changed from hay to a high concentrate diet (82.41% corn, 7.75% sugar cane bagasse, 6.78%, soybean meal, 1.29% urea and 1.77% mineral mixture). The diet was provided once a day during four periods of 21 days, and treatments consisted of different additives: limestone 7.1 g/kg DM, calcareous algae product 7.4 g/kg DM, limestone and monensin 30mg/kg DM and calcareous algae product and monensin 30mg/kg. Rumen pH was measured continuously from d -3 to d 21 through an indwelling pH probe (Dascor, Escondido, Canada) inserted in the rumen. Rumen samples were taken six hours after feeding on days -1, 4, 7 and 14. Feed intake was adjusted daily, allowing ten percent orts. There was no interaction ($P > 0.050$) between calcium source and monensin for feed intake, ruminal pH and total concentration of short chain fatty acids. There was no influence ($P > 0.050$) of calcium sources on feed intake, total concentration of short chain fatty acids, acetate:propionate ratio, lactate and ammonia nitrogen concentration. Diet with the calcareous algae product resulted in higher ($P = 0.040$) average rumen pH than limestone (6.09 vs. 6.01, respectively) and lower ($P < 0.001$) time bellow pH 5.2 (1hr29min vs. 2hrs43min). Treatments with the presence of monensin resulted in higher ($P = 0.008$) concentration of ammonia nitrogen (4.69 vs. 3.94 mg/dL without monesin) and lower ($P = 0.023$) time bellow pH 5.2 (1hr45min vs. 2hrs27min without monensin). Calcareous algae product was more efficient in controlling rumen pH than limestone without influencing feed intake and the concentration of short-chain fatty acids. Monensin was also beneficial in preventing rumen disorders.

Key Words: Nellore, additives, acidosis

1705 (T318) Effect of post-extraction algal residue supplementation on the rumen microbiome of steers consuming low-quality forage.

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Cattle consuming low-quality forages require protein supplementation to increase forage utilization and ruminal fermentation. Production of algal biomass for biofuel would result in large quantities of post-extraction algal residue (PEAR, 17.9% CP) which has the potential to elicit similar low-quality forage utilization responses to cottonseed meal (CSM, 42.9% CP); however, its effect on ruminal bacterial communities is unknown. Five ruminally and duodenally cannulated Angus steers in a 5 × 5 Latin square had ad libitum access to oat straw (4.5% CP, 80% NDF). Treatments were infused ruminally and consisted of an unsupplemented control (CON), PEAR at 50, 100, and 150 mg N/kg BW, and CSM at 100 mg N/kg BW. Rumen samples were collected 4 h after supplementation on d 14 of each period and separated into liquid and solid fractions. After DNA extraction, amplification of the V4-V6 region of the 16S rRNA gene and 454 pyrosequencing was performed on liquid and solid rumen samples. After denoising, chimera checking, and quality trimming, 8364 ± 2745 sequences were generated per sample. Weighted UniFrac analysis and Morisita-Horn index demonstrated different community composition between liquid and solid fractions. Greater homogeneity was observed within solid samples. At the phyla level, *Bacteroidetes* characterized more than 75% of sequences in the solid fraction, while relative abundance of *Firmicutes* in the liquid fraction increased linearly with PEAR supplementation ($P = 0.02$). *Prevotella* represented over 25% of sequences in all treatments and decreased in the solid fraction with increasing PEAR provision (linear, $P = 0.01$). *Lachnospiraceae*, *Ruminococcaceae*, and *Clostridiaceae* increased in the liquid fraction with greater PEAR supplementation (linear, $P \leq 0.03$). *Fibrobacter* and *Treponema* decreased in the liquid fraction with increasing PEAR (linear, $P < 0.10$). Bacterial community composition was similar between CON and 100 mg N/kg BW CSM treatments. Results suggest increased forage utilization from PEAR supplementation may be linked to changes within the liquid fraction of the rumen microbiome.

Key Words: microbiome, post-extraction algal residue, supplementation

1706 (T319) Effect of concentrate diets contrasting in fatty acid profiles on lamb performance, carcass characteristics, fatty acid composition and wool production.

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Knowledge of the health benefits associated with the consumption of *n*-3 PUFA has led to the selective inclusion of dietary lipids in ruminant diets in attempts to increase tissue incorporation. Increasing the *n*-3 fatty acid content of ruminant tissues requires the inclusion of dietary lipids that contain unsaturated fatty acids capable of withstanding ruminal biohydrogenation. Tasco a commercial algal product manufactured from the brown alga *Ascophyllum nodosum* (TA; 2% DM) was compared to canola (CO), flax (FO) and safflower oils (SO) for effects on performance, fatty acid profiles of skirt muscle, subcutaneous and perirenal adipose tissues and wool yield and quality characteristics of Canadian Arcott lambs. Fifty-six lambs were randomly assigned to four diets. Diets consisted of a pelleted, barley-based finishing diet with lipid sources included at 2% DM. Feed deliveries and orts were recorded daily with lambs weighed weekly and slaughtered once they reached ≥ 45 kg LW. Carcass characteristics and rumen pH were determined at slaughter. Dye-bands were used to determine wool growth, micron and staple length. Data were analyzed using mixed procedure in SAS. No effects were observed on intake, growth, feed efficiency or carcass characteristics. An increase ($P < 0.05$) in staple strength of CO lambs was the only effect observed in wool. Supplementing Tasco at 2% DM in the diet of Canadian Arcott lambs increased ($P \leq 0.002$) the SFA/PUFA ratio in skirt muscle and subcutaneous and visceral adipose tissues in comparison to the supplementation of oils. Additionally, Tasco supplementation did not improve concentrations of long chain *n*-3 PUFA or total *n*-3 concentrations in skirt muscle or adipose tissue when compared to lambs fed canola, flax or safflower oils. In contrast, supplementing FO increased total *n*-3 accumulation and reduced the *n*-6/*n*-3 ratio in all tissues ($P < 0.001$), suggesting that the supplementation of Tasco did not beneficially alter the FA profile of lamb tissues in comparison to other dietary lipids.

Key Words: fatty acids, lambs, micro-algae

1707 (T320) Feed value for ruminants of newly developed black and yellow type of canola seeds.

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Canola is one of the most valuable agricultural crops in world trade and a major oilseed crop in western Canada. The objective was to evaluate the nutritive value of canola seed, for ruminants, in terms of: 1) nutritional profiles, 2) degradation kinetics, 4) in vitro intestinal protein digestibility, and 4) energy values. Yellow (CS_Y) and black (CS_B) canola seeds (n = 4) were collected from two harvest years (2010, 2011). Three dry Holstein cows with rumen cannula were used in an *in situ* trial; then a three-step in vitro procedure was conducted to determine protein intestinal digestibility. According to this procedure the dried ground rumen residues, (contain 15 mg of N) after 12h of ruminal incubation, were exposed to HCl solution containing pepsin. The pH was neutralized with NaOH and phosphate buffer (pH 7.8) containing pancreatin, which were added to the solution and incubated. After 24h incubation, trichloroacetic acid (TCA) was added to precipitate undigested proteins. The samples were centrifuged and the supernatant was analyzed for N. Protein digestibility was calculated as TCA-soluble N divided by the amount of N in the 12h residue sample. The non-protein N (NPN) was analyzed by precipitating of true protein with tungstic acid and calculated as the difference between total N and the N of the residue after filtration. Soluble CP (SCP) was determined by incubating the sample with bicarbonate-phosphate buffer and filtering. The study revealed that the CS_Y was lower in NDF (122.1 vs. 154.5 g kg^{-1} DM, $P < 0.05$), ADF (60.7 vs. 98.6 g kg^{-1} DM, $P < 0.05$), NPN (g kg^{-1} SCP), ADICP (g kg^{-1} DM), soluble protein fraction (28.59 vs. 34.11, $P < 0.05$) and higher (67.28 vs. 59.02, $P < 0.05$) in degradable protein fraction and in vitro intestinal digestibility (56.6 vs. 44.6 g kg^{-1} CP in ruminally incubated residues, $P < 0.05$) than the CS_B. CS_Y contain lower amount of total phenolics compared to CS_B (626.0 vs. 718.0 mg/100g). No significant differences were obtained between the two canola varieties, for the total fatty acids (902.0 vs. 910.7 mg FA/g, SEM 5.17, $P > 0.05$), the CP (g kg^{-1} DM) and the SCP (7.0 vs. 8.5, $P > 0.05$). Total digestible nutrients, metabolizable and digestible energy was higher ($P < 0.05$) for the CS_Y than for the CS_B. Overall, the results demonstrated that the yellow-seeded canola has the potential to be a greater source for energy and protein supply for ruminants compared to the black canola seed.

Key Words: canola, protein supply, ruminal and intestinal digestion

1708 (T321) Could lactic acid treatment decrease in-vitro gas production of barley grain.

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The aim of present study was evaluation the effects of treatment barley grain with lactic acid on gas production characteristics. Rolled barley steeped in an equal quantity (wt/vol) of tap water containing 2.5, 5 and 7.5 mL lactic acid (LA) per liter for 24 h. Treated barley were dried and was ground through a 1-mm screen. Then 300 mg of ground barley pre-loaded into 125-ml serum vials. Ruminal fluid was collected from three fistulated Holstein cows. Cow's ruminal fluid mixed in equal quantity and mixed Menke and sreingass, 1988 buffer solution. Inoculums was dispensed anaerobically (40 ml/vial) under a steam of 0_2–free with co_2, followed immediately by sealing and affixing to incubator at 39 ^{0}c. Triplicate vials containing no substrate were also prepared as blank controls. Gas produced was measured at 2, 4, 6, 8, 10, 12, 24 and 48 h of incubation. Cumulative gas production data were fitted to a model of $Y = b (1\text{-}e^{-ct})$; Y = potential of gas production at time t; b = the asymptotic gas volume (ml); c = gas production constant rate (ml/h); t = incubation time (h). Data analyzed by GLM procedure of SAS (2003). According to the result of this study steeping barley in water containing 7.5 gr LA for 24 h decreased gas volume in the early time of incubation and gas production constant rate in comparison to dry rolled barely. On the other hands, it showed that treated barley grain with 7.5 gr LA decreased barely grain digestibility until 6 h of incubation and may be decrease acidosis in ruminant.

Key Words: rolled barley, lactic acid and steeping

1709 (T322) Microwave irradiation induced changes in protein inherent structure, protein chemical profile, protein subfractions and digestive behavior of different types of new hulless barley in the rumen and intestine of dairy cows.

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The objectives of this study were to evaluate microwave irradiation (MIR) induced changes in nutritive value of three types of hulless barley (*Hordeum vulgare*) in ruminant nutrition, and to quantify the MIR induced changes in protein molecular structures in relation to protein chemical profiles and digestive behavior in the rumen and intestine of the dairy cow. In this study, three barley varieties with in two consecutive years from 2009 to 2010 were chosen. All samples were cultivated and harvested from the university testing farm. The

grains were either kept as raw or irradiated in a microwave, operated at a power of 900 W with irradiation frequency of 2450 MHz, for 3 min (MIR3) or 5 min (MIR5). Mixed procedure of SAS was performed to analyze data with a RCBD model. PROC CRRR was adopted to determine the correlation. Tukey was used to compare treatment means. Significance was declared at $P < 0.05$. Compared to non-irradiated grains, MIR5 markedly decreased (50.8 to 17.6%) soluble protein and increased NDIP (13.3 to 26.2%) and ADIP (1.0 to 5.3%) in total CP ($P < 0.05$). As consequence, the CNCPS CP rapidly degradable fraction substantially decreased (45.2 to 6.4% CP) with a simultaneous increase in the intermediately degradable (35.8 to 56.2% CP), slowly degradable (12.4 to 20.9% CP) and non-degradable (1.0 to 5.3% CP) fractions ($P < 0.05$). The MIR for 5min decreased soluble CP fraction (6.5 to 0.0%) and degradation rate (8.2 to 3.5%/h) of potentially degradable fraction ($P < 0.05$). As a consequence the RDP markedly decreased (55.7 to 34.1% CP) with a concomitant increase (43.3 to 65.9% CP) in RUP supply to the post-ruminal tract ($P < 0.05$). Except the CNCPS rapidly degradable and in situ soluble fraction, the MIR3 did not alter protein chemical profiles, CNCPS subfraction, rumen degradability and intestinal digestibility of RUP. However, the MIR5 decreased (79.4 to 67.9% RUP) intestinal digestibility of RUP. The molecular structure study revealed that MIR for 3 and 5 min consistently decreased the spectral intensities of amide I and II, α-helix and β-sheet, and increased their ratios. The changes in protein spectral intensities were strongly correlated with the changes in protein chemical profiles, CNCPS subfractions and in situ degradation characteristics. Our results showed that MIR for a short period with a lower energy input can improve the nutritive value and utilization of protein in barely grains.

Key Words: different hulless barley, microwave irradiation, nutrient availability, protein molecular structure

1710 (T323) Protein and energy availability of sorghum wet distiller grains without solubles in comparison to the parental grain. M. D. L. A. Bruni[1] and A. I. Trujillo[*2], *[1]Facultad de Agronomia Universidad de la Republica, Paysandu, Uruguay, [2]Facultad de Agronomia, Universidad de la Republica, Montevideo, Uruguay*

Sorghum can be an alternative for ethanol industry in Uruguay and its by-product (SWDG) can be used as animal feed. An accurate characterization of protein fractions and energy is required for ruminant diets formulation. The chemical profile (in % ± standard deviation) of SWDG presented high values of moisture (66.7 ± 2.6), crude protein (CP, 31.4 ± 0.7), fat (11.0 ± 0.7) and neutral detergent fiber (70.2 ± 2.2).The objective of this study was to characterize the protein fractions and estimate energy digestible (ED) content of three batches of SWDG and its parental grain (SG). In addition, intestinal digestible protein (IDP) of SWDG was measured. Protein fractions were assessed according to the Cornell Net Carbohydrate and Protein System (rapidly protein degradable: A+B1; intermediate degradability: B2; slowly degradable: B3 and undegradable fraction: C, as percentage of CP). The rumen undegradable protein (RUP) was evaluated by in situ assay. Pepsin-pancreatin digestion of rumen pre-incubated (12 h) samples was used to estimate IDP. Digestible energy content was estimated using summative equation computed from digestibility's nutrients by chemical (NRC, 2001) or in situ (using 48 h of nutrient disappearance) approach. Data was analyzed with PROC GLM in a completely randomized design and compared with Tukey test. No differences were found between batches, neither in SWDG nor in SG. The SWDG presented lower ($P < 0.005$) values of A+B1 and B2 fractions than SG (2.3 vs. 4.2% and 36.3 vs. 60.5%) respectively; however B3 and C fractions were greater ($P < 0.018$) than SG (27.7 vs. 13.2% and 33.7 vs. 22.1%). The SWDG presented greater ($P < 0.05$) RUP (estimated using passage rate = 2%/h) compared with SG (75.5 vs. 42.2% CP). The IDP of the SWDG was 51.1 ± 4.5%RUP providing an average value of total digestible protein of 63.6%. Digestible energy estimations of SDWG were lower ($P < 0.003$) than SG (3.16 vs. 3.7 and 2.5 vs.3.7 Mcal/kg DM for chemical or in situ approach, respectively). The greatest difference between the two approaches was observed in SWDG which could be probably explained by estimation of truly digestible CP and NDF fractions. The potential supply of protein fractions of the SWDG was modified by the industrial process increasing slowly degradable and undegradable fractions. The potential of absorbable protein of SWDG was around half of a soybean meal while its ED content represent 70-80% of energetic value of SG.

Key Words: distillers grain, nutritive value, intestinal digestibility

1711 (T324) Effect of crude glycerin on dry matter and nutrient digestibility of feed ingredients in dairy cows. F. D. O. Scarpino van Cleef[*1,2], J. M. Bertocco Ezequiel[1], J. Borsari Dourado Sancanari[3] and E. H. C. B. Van Cleef[1,4], *[1]UNESP, Jaboticabal, Brazil, [2]CNPq, Brasilia, Brazil, [3]UCB, Jaboticabal, Brazil, [4]FAPESP, Sao Paulo, Brazil*

Rumen-cannulated Holstein cows ($n = 6$; 587 ± 39 kg BW; 114 ± 29 DIM; 20 ± 1.5 kg milk/d), were used to evaluate the effects of crude glycerin on in vitro digestibility of dry matter, and nutrients (CP and NDF) of feed ingredients. Cows were assigned to a replicated 3 × 3 Latin square. The three isoenergetic and isonitrogenous diets composed of corn silage, cracked corn grain, sunflower meal, corn gluten, urea, mineral premix, and 0 (G0), 15 (G15), or 30% (G30) crude glycerin. The experiment lasted 69 d, with three periods of 23 d each. For in vitro determinations, the Daisy II fermenter was used. The ingredients were ground (1 mm), and placed in F57 bags

(0.5 g/bag; 25 bags/treatment). At d 20 of each experimental period, rumen content was manually collected and strained with cheesecloth. Then, 400 ml of strained rumen content were placed in each fermentation jar, with 1330 ml buffer A and 266 ml buffer B. The jars were purged with CO_2, and incubated at 39°C for 72 h. When the incubation was completed 48 h, 8 g pepsin and 40 ml HCl 6N were added to each jar. The pH and ammonia-N (NH_3–N) were determined at 0, 48, and 72 h of incubation. Data were analyzed as mixed model with fixed effects of diet and period, and random effects of cow (diet) and residuals. Crude glycerin inclusion did not affect pH and NH_3–N concentration (pH = 6.5, 6.4, 3.4; NH_3–*N* = 20.5, 8.3, and 8.5 mg/dl, respectively for 0, 48, and 72 h incubation). The addition of 15% crude glycerin decreased ($P < 0.05$) IVDMD and IVCPD of sunflower meal, and corn grain. When 30% crude glycerin were added, a decrease in IVDMD was observed for corn gluten ($P < 0.05$), and in vitro NDF digestibility for corn silage ($P < 0.01$). No differences were observed on IVDMD and IVCPD of corn silage. The addition of up to 30% crude glycerin in lactating cows diets affected digestibility of feed ingredients. Caution should be taken when combining glycerin with roughages, due to the negative effect on NDF digestibility.

Key Words: dairy cow, digestion, glycerol.

1712 (T325) Positive effect of fat supplementation in the early postpartum period can continue throughout lactation after fat supplementation ceases.

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Objective was to determine whether increased milk yield detected during the period of fat supplementation in early lactation would continue throughout lactation after supplemental fat was removed from the diet. Three studies were conducted at the University of Florida dairy farm in which Holstein cows produced more milk in response to fat supplementation in the early postpartum period. Experiments 1 and 2 had the same dietary treatments. Cows consumed a control diet without fatty acid (FA) supplementation, a diet supplemented with mostly saturated free FA (SFA; 1.9% of dietary DM), or a diet supplemented with Ca salts enriched with essential FA (EFA; 2.4% of dietary DM). In the first experiment, cows (n = 74) were assigned randomly to treatments 56 d before calving and treatments were maintained until 90 DIM. In the second experiment, cows (n = 30) were fed the same 3 dietary treatments from 15 to 106 DIM. In experiment 3, Holstein cows (n = 39) were assigned to diets supplemented with a mixture of Ca salts of fish, safflower, and palm oils (1.4% of dietary DM) to create 3 supplemental ratios of 4, 5, or 6 parts of n-6 to 1 part of n-3 FA (R4, R5, and R6). Diets were fed from 15 to 105 DIM. Cows in experiment 2 and 3 had a covariate based on milk produced during the first 6 to 10 DIM. Milk production was recorded through 43 wk of lactation using AFI-MILK system. Orthogonal contrasts were used to test for effects of fat supplements during the fat-feeding period and for the complete lactation. In general, when fat supplementation improved or tended to improve milk production during the fat-feeding period, milk yield also was improved or tended to be improved for the whole lactation. Milk composition was minimally changed. Strategic feeding of FA during early lactation can benefit milk yield after fat is removed from the diet.

Key Words: dairy cow, fatty acids, milk yield

Table 1712.

	Treatments				*P*-value	
	Control	SFA	EFA	SEM	(SFA+EFA) vs. Control	EFA vs. SFA
	— Milk yield, kg/d —					
Experiment 1						
Fat supplement	31.6	31.8	34.3	0.99	0.28	0.06
Full lactation	29.1	28.0	30.6	1.00	0.85	0.05
Experiment 2						
Fat supplement	37.7	39.9	42.8	1.07	0.01	0.07
Full lactation	31.5	34.5	34.1	1.26	0.08	0.84
	Treatments				P-value	
	R4	R5	R6	SEM	Linear	Quadratic
	— Milk yield, kg/d —					
Experiment 3						
Fat supplement	46.4	44.7	43.0	0.98	0.02	0.98
Full lactation	36.7	35.2	33.5	1.33	0.10	0.97

1713 T326) Sources and levels of rumen protected fat on energy balance of dairy cows grazing a tropical pasture.

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The objective of this experiment was to investigate the effects of supplementation lactating cows grazing a tropical pasture receiving two levels of calcium salts of palm oil (CSPO) or calcium salts of soybean oil (CSSO) on energy balance. Five rumen-cannulated cows (115 ± 8.1 DIM) were used in a Latin square 5x5 and subjected to the following treatments: a) control (no fat); b) 400 g CSSO cow^{-1} d^{-1}; c) 700 g CSSO cow^{-1} d^{-1}; d) 400 g CSPO cow^{-1} d^{-1}; and e) 700 g CSPO cow^{-1} d^{-1}. Treatment periods were 24 d in length and cows grazed paddocks of *Pennisetum purpureum* and received 8 kg cow^{-1} d^{-1} (DM) of concentrate. Concentrate of treatment control was composed by ground corn (82.8%), soybean mean (12%), urea (0.2%), sodium bicarbonate (1%) and mineral/vitamin premix (4%) and fat supplementation replaced ground corn. To estimate fecal excretion, cows were orally dosed with titanium dioxide twice daily for 15 d. Forage intake was calculated from total

fecal excretion and feed digestibility. Indigestible NDF (estimated as NDF residue after 240 h of in situ incubation) was used as an internal marker to estimate digestibility. NE_L intake, milk NE_L and NE_L in empty BW gain was calculated according to NRC (2001). Data were analyzed using a mixed model with animal and period as random effects. The means were compared using a Tukey test. Both levels of CSPO increased NE_L intake (27.7 Mcal/d). There was no difference in NE_L intake between control and 400 g CSSO (26.1 vs. 26.0 Mcal/d), but both were greater than 700 g CSSO (25.4 Mcal/d). The milk NE_L (Mcal/d) was greater for 400 g CSPO (13.1) and 700 g CSPO (12.9) in comparison to control (12.1) and 400 g CSSO (11.6). The lowest milk NE_L was observed in 700 g CSSO (10.3), due to the lowest milk yield and milk NE_L per kg of milk observed in this treatment. The NE_L in empty BW gain (Mcal/d) was greater in 700 g CSSO (3.03) compared with 400 g CSSO (2.65), and both levels of CSPO (2.05 and 2.28 for 400 and 700 g, respectively). The control showed the lowest NE_L in empty BW gain (1.63) among the treatments. Dairy cows grazing tropical pasture supplemented with sources of fat increased energy intake with CSPO and the energy consumed was used differently according to the source of fat supplemented.

Key Words: palm oil, soybean oil

1714 (T327) Saturated fat supplementation interacts with dietary forage NDF concentration during the postpartum period in Holstein cows: Energy balance, nutrient digestibility, and metabolism.

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Forty-eight multiparous cows were used in a randomized complete block design experiment with a 2x2 factorial arrangement of treatments. Treatment diets were offered from 1 to 29 d postpartum and contained 20% or 26% forage NDF (fNDF) and 0% or 2% saturated free fatty acid supplement (Energy Booster 100; FAT). The 2% FAT treatment increased total tract digestibility of OM and NDF in the low fNDF diet (67.6% vs. 65.9% and 44.0% vs. 40.1%, respectively), but not in the high fNDF diet (interactions $P \leq 0.08$). Overall, low fNDF vs. high fNDF and 2% FAT vs. 0% FAT increased digestible energy intake (DEI) (67.5 vs. 62.2 Mcal/d and 68.1 vs. 61.6 Mcal/d, respectively; both $P < 0.01$). An interaction between fNDF and FAT with time was detected for net energy balance (NEB): the low fNDF diet with FAT had higher NEB than the other treatments early but treatment differences diminished over time (interaction $P = 0.10$). Overall, low fNDF vs. high fNDF diets and 2% FAT vs. 0% FAT improved NEB (-13.0 vs. -16.3 Mcal/d and -12.0 vs. -17.3, respectively; both $P < 0.05$) but decreased efficiency of utilization of DEI for milk (Milk NE_L/DEI; 0.575 vs. 0.634 and 0.565 vs. 0.643, respectively; both $P < 0.05$). Low fNDF diets increased plasma insulin (0.308 vs. 0.137 µg/L) and glucose concentrations (50.5 vs. 45.7 mg/dL), and decreased concentrations of NEFA (606 vs. 917 µEq/L) and BHBA (9.29 vs. 16.5 mg/dL; all $P \leq 0.001$). The 2% FAT treatment tended to decrease plasma NEFA concentration (695 vs. 827 µEq/L; $P = 0.06$) compared with 0% FAT, but treatment differences diminished over time (interaction $P < 0.05$). The 2% FAT treatment increased maximum plasma insulin concentration during a glucose tolerance test in the low fNDF diet (84.5 vs. 44.6 µIU/mL) compared with the high fNDF diets (40.4 vs. 38.0 µIU/mL; interaction $P = 0.07$). FAT tended to interact with dietary fNDF concentration for insulin area under the curve: 2% FAT increased insulin area under the curve by 64% when included in the low fNDF diet (2586 vs. 1575 min*µIU/mL), but only by 5.1% when included in the high fNDF diet (1307 vs. 1243 min*µIU/mL; interaction $P = 0.12$). Supplementation of FAT and low fNDF diets increased DEI and improved NEB, but decreased apparent efficiency of utilization of DEI for milk production in the postpartum period.

Key Words: energy balance, postpartum, prilled fat

1715 (T328) Production performance parameters of early lactation Iranian Holstein cows fed diets containing high levels of palmitic acid or Ca-salt of unsaturated fatty acids.

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Fat supplements can improve energy balance, feed efficiency, and the yields of milk and milk fat. However, the effects of different FA profiles have not yet been adequately studied. The aim of this study was to evaluate the milk fatty acid profile in early lactating dairy cows supplemented with protected unsaturated fatty acids sources and prilled source of palm fatty acids. Twenty four multiparous Iranian Holstein cows were assigned to diets with different fatty acid profiles and supplemented through 30 days prior to expect calving date to 50 days in milk. Dietary treatments consisted of (1) Prilled Pam fatty acids (PO) [Energizer RP10 , 2 and 2.25% DM in pre- and postpartum, respectively]; (2) Ca-salts of sunflower oil (SO) [Persia Fat- SO]; (3) Ca-salts of fish oil (FO) [Persia Fat- FO] and (4) equal amounts of Persia Fat- FO and Persia Fat- SO. Calcium salts were supplemented as 2.2 and 2.5% of dietary DM in pre- and postpartum period, respectively Milk yield and the dry matter intake were measured daily throughout the experimental period. The milk samples were obtained weekly (2 consecutive days, 3 daily milking, Individual milk samples were analyzed for fat, true protein, and lactose concentration by mid-infrared spectroscopy by the Iranian Dairy Herd Improvement Association. Yields of 3.5% FCM, ECM, and milk components were calculated using milk yield and component concentrations for each milking. Data were analyzed using PROC MIXED of SAS 9.1 according with re-

peated measures in time function. Milk and milk component yields were greater with Persia Fat than with palmitic fatty acid prill. However feed efficiency was not statistically different (1.84 kg FCM/kg DMI vs. 1.89, 1.88 and.86, for treatments 1 to 4, respectively). Cows fed Persia Fat had greater DMI than those fed Palm oil fatty acids (20.17 kg DM vs. 23.56, 22.25 and 22.53, for treatments 1 to 4, respectively). Milk protein concentration was higher for PO compared with Persia Fat (3.27% vs. 3.14, 3.12 and 3.08, for treatments 1 to 4, respectively), but Persia Fat fed cows produced more milk protein per day. Based on results we conclude that different fatty acids have different digestibilities, absorption and/or differing biological effects post absorption.

Key Words: PUFA, palmitic acid, FCM

1716 (T329) Characterization of the role of long-chain fatty acids in the regulation of lipogenic gene expression via LXRα in goat mammary epithelial cells. W. Zhao*[1,2], J. Luo[1], P. Dovc[3] and J. J. Loor[2], *[1]Northwest A&F University, Yangling, China, [2]University of Illinois, Urbana, [3]University of Ljubljana, Domzale, Slovenia*

In dairy cows and goats, liver X receptor α (*LXRα*) is a nuclear receptor considered as a potentially important regulator of de novo long-chain fatty acid (LCFA) synthesis. Previous data in bovine MacT cells indicated that activation of *LXRα* with the agonist T0901317 (T09) up-regulates the expression of some lipogenic target genes, hence, could play a role in de novo FA synthesis regulation. In vitro, long-chain fatty acids (LCFA) could have an agonistic capacity on *LXRα*, thus, serving as an alternate mechanism for regulating milk fat synthesis. In order to characterize the roles of *LXRα* and LCFA in the regulation of lipid synthesis in goat mammary epithelial cells (GMEC), primary mammary cells isolated from mammary gland of Saanen dairy goats cultivated in lactogenic medium were cultured in triplicate and for 12 h with 50 μM of the specific *LXRα* agonist T0901317 (T09) or the specific *LXRα* antagonist GGPP (GP), 100 μM of several LCFA (16:0, 18:0, t10,c12- conjugated linoleic acid (CLA), docosahexaenoic acid (DHA), and eicosapentaenoic acid (EPA)), and a combination of GP with 100 μM of several LCFA (16:0, 18:0, t10,c12-CLA, DHA, and EPA) (for a total of 7 treatments excluding controls). Expression of 17 genes involved in LCFA plus 3 internal control genes was detected using qPCR. Data were statistically analyzed using the GLM of SAS. The multiple comparisons were corrected using Tukey's test and accepted as significant at $P < 0.05$. Although T09 did not alter *LXRα*, data from the cells treated with GP alone revealed that a minimum activation of *LXRα* is essential for the up-regulation ($P < 0.05$) of *INSIG1, LPIN1, FASN, SREBF1*, *AGPAT6,* and *SCD*. The marked up-regulation ($P < 0.05$) of *SREBF1*, *FASN*, *ACACA*, and *SCD* with T09 vs. control suggests their expression is partly controlled by *LXRα* as reported in MacT cells. Expression of *PPARG* did not respond to T09 or GP but when the LCFA were combined with GP, its expression was up-regulated ($P = 0.0001$) by 13-18 fold over the control. Both 16:0 and 18:0 when combined with GP up-regulated ($P < 0.05$) *SREBF1*, *INSIG1*, *SCD*, *ACSS2*, *AGPAT6*, and *LPIN1* but had no effect on *ACACA* or *FASN*. Data obtained with the combination of GP and LCFA revealed a complex scenario. However, data indicate that the LCFA effect could have been driven partly via *PPARG* as demonstrated previously in MacT cells. Overall, data suggest that LCFA could partly act as competitive agonists of *LXRα* in GMEC.

Key Words: nutrigenomics, milk fat synthesis, nuclear receptor

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1717 (T330) Effects of feeding protected unsaturated fatty acids (Persia Fat)on milk fatty acid profile of Iranian Holstein dairy cows. H. Khalilvandi-Behroozyar[1], M. Dehghan Banadaky*[2] and M. Ghaffarzadeh[3], *[1]Department of Animal Science, Urmia University, Urmia, Iran, [2]Department of Animal Science, University of Tehran, Karaj, Tehran, Iran, [3]Chemistry and Chemical Engineering Research Center of Iran, Tehran, Iran*

In recent years, consumer concerns about contribution of milk and dairy products to total intake of saturated fatty acids has driven extensive research about effectiveness of protected fatty acid sources in modification of milk fatty acids. The aim of this study was to evaluate the milk fatty acid profile in early lactating dairy cows supplemented with protected unsaturated fatty acids sources and prilled source of palm fatty acids. Twenty four multiparous Iranian Holstein cows were assigned to diets with different fatty acid profiles and supplemented through 30 days prior to expected calving date to 50 days in milk. Dietary treatments consisted of (1) Prilled Pam fatty acids (PO) [Energizer RP10 , 2 and 2.25% DM in pre- and postpartum, respectively]; (2) Ca-salts of sunflower oil (SO) [Persia Fat-SO]; (3) Ca-salts of fish oil (FO) [Persia Fat- FO] and (4) equal amounts of Persia Fat- FO and Persia Fat- SO. Calcium salts were supplemented as 2.2 and 2.5% of dietary DM in pre- and postpartum period, respectively Milk yield and the dry matter intake were measured daily throughout the experimental period. The milk samples used for evaluating fatty acids profile were obtained weekly (2 consecutive days, each sample coming from the 3 daily milking, and were quantified by gas chromatography (Varian CP-3800, FID detector, 100 m CP-Sil88 column, GLC 463). Data were analyzed using PROC MIXED of SAS 9.1 with repeated measures in time function. Cows fed PO produced milk with higher saturated (69.90 vs. 58.14, 56.45 and 56.74, for treatments 1 to 4, respectively) and lower monounsaturated (23.37 vs. 32.22, 32.54 and 32.36, for treatments 1 to 4, respectively) polyunsaturated (2.80 vs. 7.13, 7.58 and 6.98, for treatments 1 to 4, respectively) fatty acid concentrations than cows fed diets with unsaturated fatty

acid sources. All of the differences between PO and Persia Fat sources were statistically significant, but not between unsaturated fatty acid sources. Feeding Persia Fat increased the milk concentration of C18:0, whereas that of C16:0 was increased by PO supplementation (39.13 vs. 25.92, 23.60 and 23.72, for treatments 1 to 4, respectively). Supplementation with PO significantly increased C16 and < C16 fatty acids, whereas decreased > C16 fatty acids in milk fat. Highest (statistically significant) n-3 and n-6 fatty acids contents were belong to Persia Fat- FO and Persia Fat- SO, respectively.

Key Words: PUFA, palmitic acid, omega-3,omega-6

1718 (T331) Milk yield and milk fat responses to increasing levels of stearic acid supplementation of dairy cows. J. P. Boerman* and A. L. Lock, *Michigan State University, East Lansing*

Dose-dependent effects of a stearic acid-enriched fat supplement on feed intake, production responses, and the maximum amount of stearic acid that can be incorporated into milk fat were evaluated. Multiparous Holstein cows (n = 32; 145 ± 66 DIM) with a wide range in milk yield (25– 70 kg/d) were blocked by milk yield and assigned to replicated 4 x 4 Latin squares. Treatments were diets supplemented with a stearic acid-enriched fat (SA; 87% C18:0) at 0, 0.8, 1.6, or 2.4% of diet DM. Periods were 21 d with the final 5 d used for data and sample collection. The corn silage and alfalfa silage-based diets were formulated to contain 25.8% forage NDF and 17.0% CP. The statistical model included the random effect of cow and the fixed effects of treatment, period, and their interaction. Linear, quadratic, and cubic contrasts were used to determine the effects of increasing doses of SA. Intake of DM increased as SA supplementation increased (28.4, 29.0, 29.5, and 29.9 kg/d; linear, P = 0.02). Milk fat concentration was 3.78, 3.73, 3.74, and 3.82% for increasing doses of SA (quadratic, P = 0.10). Treatment had no effect on milk yield (38.2 kg/d, P = 0.54), milk fat yield (1.41 kg/d, P = 0.75), milk protein yield (1.32 kg/d, P = 0.51), or milk protein concentration (3.49%, P = 0.88). Feed efficiency (ECM/DMI) was 1.43, 1.39, 1.36, and 1.36 for increasing doses of SA (linear, P = 0.0003). Supplementation of SA had no effect on BW or BCS (P > 0.23). The yield of C18:0 plus *cis*-9 C18:1 in milk fat was increased by SA supplementation (linear, P = 0.005); however, the increase from 0 to 2.4% SA was only 17 g/d resulting in no effect of SA supplementation on yield of total preformed milk FA (> 16-carbons, P = 0.69). The yield of de novo (< 16-carbons) and 16-carbon FA in milk fat were also unaffected by SA supplementation (P = 0.72 and P = 0.33, respectively). In conclusion, although increasing SA supplementation increased DMI it had no effect on the yield of milk or milk components. While SA supplementation increased the yield of C18:0 plus *cis*-9 C18:1 in milk fat, it had no overall effect on the yield of de novo or preformed FA in milk.

Key Words: fat supplementation, milk fat, stearic acid

1719 (T332) Effect of different dietary fatty acid profiles on individual milk fatty acid yields by dairy cattle fed diets with less than 3% total fatty acids. C. M. Stoffel and L. E. Armentano*, *University of Wisconsin-Madison, Madison.*

Dietary fatty acid (FA) composition can affect milk fat yield but also relative yields of different FA. This study examined the effects on yield of individual milk FA resulting from different dietary FA profiles at FA levels below 3% of diet dry matter (DM). Trial design and production performance data were discussed in a 2013 ADSA abstract. Briefly, 60 cows were paired (within parity) to form 30 experimental units. Pairs were fed six diets in five 6x6 balanced Latin squares with 21-d periods. There were two control diets: a corn control diet (CC) containing 1.8% FA and a low oil control (LOC) containing 1.2% FA. A portion of the food grade corn starch in LOC was replaced with 1.7% diet DM of a 50/50 blend of corn and high linoleic safflower oils (CO), high oleic sunflower oil (OO), palm oil (PO), or 1.8% diet DM calcium salts of palm FA (ML, Megalac) to create four treatment diets that were enriched in either linoleic (CO), oleic (OO), or palmitic acid (PO and ML). Milk FA composition was measured on d 20, and milk yield and fat concentration were measured for the last 5 d of each period; these data were combined to determine yield of individual milk FA. There were significant treatment effects on the yield of 31 out 53 milk FA measured including 10 out of 14 C18:1 isomers (P < 0.05). Palmitic acid (C16) yield was lower for CO compared to other treatments (P < 0.01) and C18:1 and total C18 yield were higher for OO when compared to PO and ML (P < 0.01, P < 0.01). Trans-10 C18:1 yield was higher for CO when compared to the other treatments (P < 0.01) and for OO compared to PO and ML (P = 0.01). Trans-10, cis-12 yield was also higher for CO when compared to all other treatments (P < 0.01). Linear regression analysis was also conducted to examine the effect on milk FA yield of the increased dietary linoleic, oleic, and palmitic acid concentrations of the treatment diets over LOC. Dietary linoleic decreased short chain (< C16) and C16 FA yield (P = 0.02, P < 0.01), dietary oleic increased total C18 yield (P < 0.01), and dietary palmitic increased C16 yield (P < 0.01). These differences in milk FA profile are consistent with the idea that linoleic acid depresses short chain and C16 FA, resulting in milk fat depression even at dietary FA levels below 3%.

Key Words: biohydrogenation, milk fat depression, milk fatty acid

1720 (T333) Effect of specific essential oil blend on performance of Nellore young bulls in feedlot.

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The European Union has prohibited the use of growth-promoting antibiotics in animal feeds. These restrictions, based around concerns that the use of antibiotics for livestock can give rise to transmissible resistance factors that may compromise the therapeutic use of antibiotic in humans (Casewell et al., 2003). In this sense, natural plant products such as essential oils (EO) become an alternative to manipulate rumen fermentation (Iason, 2005). Chao et al., 2000 suggested that gram-negative bacteria's shows a trend to have higher resistance to essential oils than gram-positive bacteria. Decreasing gram + bacteria may improve animal performance. Therefore, seventy two Nellore bulls (375 ± 14 kg BW) were fed 15% of sugar-cane bagasse and 85% of concentrate for 81d in individual pens. The treatments compound different combinations of essential oil blend or monensin (M) or both (1*: 100mg EO; 2*: 20 mg of M + 100 mg of EO; 3*: 20 mg of M + 200 mg of EO; 4*: 200 mg of EO; 5*: 20 mg of M and 6*: 10 mg of M + 100 mg of EO). Treatment mixes were incorporated into the concentrate ration, which was composed by corn, soybean meal and citrus pulp. Diets were isoenergetic and isonitrogenous. Throughout the entire experimental period, the provided feed amounts were adjusted to allow approximately 100g/kg residue comparing with the total consumed on previous day. Average daily gain was calculated using the initial and final individual live weight divided by the number of experimental days. Data was subjected to analysis of variance compared by orthogonal contrast. Animals fed 20mg of M had the greatest liveweight gain (1.242 kg/d), treatments 20mg of M + 100mg of EO and 100mg of EO achieved 0.909 and 0.910kg/d, respectively. Animals supplemented with 10mg of M + 100 mg of EO and 20mg of M + 100mg of EO had lower average daily gain than 5* but higher than 2*. However, 6* and 3* were not statistically different, the ADG for this treatment were 1.174 kg/d and 1.008 kg/d, respectively. The data of feed conversion (kg DM/ADG) shown for treatment 1* feed intake of 9.278 kg DM/d to gain 1kg liveweight, and the treatments 2*, 3*, 4*, 6*; 9.196, 8.398, 8.244, 8.385, respectively. Animals the treatment 5* had the lower intake (7.137). Therefore, strategic use of essential oil did not improve the animal performance.

Key Words: essential oil, feedlot, monensin

1721 (T334) Effect of coconut oil and lauric acid on omasal nutrient flow and microbial protein synthesis in dairy cows.

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Ruminal protozoa (RP) contribute to ruminal bacterial turnover. Previously, feeding lauric acid (LA; C12:0), sharply decreased RP. However, despite reducing RP, LA reduced DMI and milk yield. In this trial, we tested coconut oil (CO), which contains about 50% LA, as a practical defaunating agent and assessed its effects on nutrient and microbial omasal flow. Six cows fitted with ruminal cannulae were blocked by DIM into 2 blocks of 3 cows and randomly assigned within blocks to 3 dietary treatments in a 3X3 replicated Latin square with 21 days of adaptation and 7 days of sampling. The basal diet contained (DM basis) 50% alfalfa silage, 10% corn silage, and 40% concentrate (corn, molasses, and soybean), 16% CP and 29% NDF. Diets A and C provided the same amount of fat: A) 3% Megalac and C) 3% CO. Diets B and C provided the same amount of LA (287g/d). Data were analyzed using the mixed procedure in SAS. Results are reported in Table 1721. DMI was similar among treatments; however, diet B increased NDF flow at the omasal canal and decreased ruminal NDF apparently digestibility. There were trends for reduced DM flow at the omasal canal, ruminal N digestibility and RDP supply, and increased RUP omasal flow, when diet B was fed.

Key Words: coconut oil, omasal flow, protozoa

Table 1721. Ruminal metabolism and omasal flows

Item	Control	LA	CO	SEM	*P*-value
DM intake, kg/d	22.8	22.4	23.0	1.0	0.14
DM flow, kg/d	14.1	13.6	14.2	0.7	0.06
DM apparently digested in the rumen, kg/d	8.68	8.77	8.76	0.82	0.21
NDF flow, kg/d	4.61[b]	4.82[a]	4.64[ab]	0.19	0.05
NDF apparently digested in the rumen, kg/d	1.87[a]	1.61[b]	1.89[a]	0.16	< 0.01
Total NAN[1] flow, g/d	523	522	525	25	0.19
N truly digested in the rumen, g/d	414	404	423	23	0.07
RDP supply, kg/d	2.52	2.46	2.58	0.15	0.09
RUP flow kg/d	1.15	1.17	1.13	0.06	0.08
NMNAN[1] flow, g/d	173	176	169	15	0.16
FAB-NAN[1] flow, g/d	152	149	155	10	0.13
PAB-NAN[1] flow, g/d	198	196	201	16	0.16
Total microbial NAN flow, g/d	350	345	356	19	0.12
Microbial efficiency, g of NAN/kg of OMTDR[1]	26.0	25.7	26.1	0.7	0.12

[a-b] Within the same row with different superscripts differ ($P < 0.05$).
[1] NAN = non-ammonia N; NMNAN = nonmicrobial NAN; FAB- and PAB-NAN = fluid- and particle-associated bacterial NAN; OMTDR = OM truly digested in the rumen.

1722 (T335) Supplementation of lemongrass oil and a mixture of garlic and ginger oil improved in vitro feed digestion. A. Nanon[1], W. Suksombat[1] and W. Yang*[2], [1]*Suranaree University of Technology, Muang, Thailand,* [2]*Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*

Lemongrass has shown antibacterial, antioxidant, and anti-hyper-NH_3–producing ruminal bacterial activities. However, the lemongrass, especially its essential oil (EO) has little been evaluated on its effect on ruminal fermentation. The objective of this study was to investigate the effect of lemongrass oil (LMO) and a mixture (1:1) of garlic and ginger oil (CEO) on gas production (GP) and feed digestion in batch culture. Four feeds: wheat distillers dried grains with solubles (DDGS), barley grain, grass hay, and a total mixed ration (TMR) were used as substrate with varying EO dosages from 0, 100, 200 to 300 mg/kg substrate DM. The TMR consisted of 35% grass hay, 15% alfalfa hay, 20% barley grain, 10% corn DDGS, 10% wheat DDGS, 5% canola meal, and 5% vitamin and mineral supplement. GP was measured at 3, 6, 12, 24, 36, and 48 h post incubation, and disappearance of DM (DMD) and neutral detergent fiber (NDFD) were determined at 24 and 48 h of incubation, respectively. There was no interaction on in vitro DMD and NDFD between the EO source and EO dose. DMD (% of input) were greater ($P < 0.05$) with CEO compared to LMO for wheat DDGS (48.6 vs. 47.9) and barley grain (61.5 vs. 60.3), but less ($P < 0.03$) for TMR (40.9 vs. 41.8) after 24 h of incubation. Increasing dosage of either CEO or LMO linearly ($P < 0.01$) increased DMD and NDFD of grass hay and TMR at 24 and 48 h of incubation, whereas increasing CEO or LMO dosages linearly ($P < 0.01$) increased only DMD of wheat DDGS and barley grain at 24 h of incubation. Cumulative GP was affected ($P < 0.03$) by both LMO and CEO in a quadratic manner after 24, 36 or 48 h of incubation with greatest GP at 200 mg/kg grass hay or TMR. These results suggested that the LMO and CEO appeared to be more effective to improve the DMD of fibrous feeds and modulated the digestive microorganisms in a dose-dependent manner. The EO used in the present study could be potentially developed as rumen modifier to improve feed digestion in ruminant.

Key Words: dry matter disappearance, in vitro, lemongrass oil

1723 (T336) Use of lemongrass oil for manipulation of ruminal fermentation using Rusitec technique. A. Nanon[1], W. Suksombat[1] and W. Yang*[2], [1]*Suranaree University of Technology, Muang, Thailand,* [2]*Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*

Supplementation of lemongrass powder or meal has revealed a positive impact on ruminal fermentation in beef cattle. However, lemongrass essential oil (LMO) has little been evaluated on its effect on ruminal fermentation. A study using Rusitec technique was conducted to investigate the effect of increasing dose of LMO supplementation on fermentation characteristics of a dairy cow diet. Experiment was a completely randomized design with 4 replications in each treatment and consisted of 10 d of adaptation and 6 d of data collection. The substrate consisted of 35% grass hay, 15% alfalfa hay, 25% barley grain, 20% wheat dried distillers grains with solubles, and 5% vitamin and mineral supplement. Four treatments were: 1) control (no additives), 2) low LMO (100 mg LMO/kg DM), 3) high LMO (200 mg LMO/kg DM), and 4) monensin (30 mg/kg diet DM). Increasing LMO supplementation affected neither volatile fatty acid (VFA) concentration (averaged 26.0 m*M*) nor molar proportion (mol/100 mol) of acetate (49.0), propionate (23.3) or butyrate (16.2). However, increasing LMO linearly ($P < 0.01$) increased large peptide N from 2.6, 3.1 to 3.3 mg/mL and small peptide N from 3.3, 4.1 to 4.5 mg/mL, and linearly ($P < 0.01$) reduced ammonia N concentration from 8.8, 8.3 to 7.9 mg/mL in fermentation media. Increasing LMO addition also linearly ($P < 0.02$) increased bacterial protein production from 66.3, 66.2 to 70.1 mg/d N, and tended ($P = 0.10$) to improve bacterial efficiency from 12.7, 12.9 to 13.3 g N/kg digested OM. However, digestibility (% of input) of DM (52.8), NDF (41.9), starch (76.5), and CP (59.0) was not affected by increasing LMO addition. Supplementation of monensin did not affect fermentation characteristics, feed digestion, and bacterial protein production. These results suggest that supplementation of a dairy cow diet with LMO inhibited deamination process by possibly altering microbial populations such as proteolytic bacteria.

Key Words: fermentation, lemongrass oil, Rusitec

1724 (T337) Effect of tea oil and sunflower oil on rumen fermentation, milk composition and rumen microbial population in water buffaloes fed elephant grass-based diets. C. Yang*, X. Liang, S. Wei, X. Liang, S. Li, C. Zou, B. Yang and L. Li, *Buffalo Research Institute, Chinese Academy of Agricultural Sciences, Nanning, China.*

The objective of this study was to investigate the effect of tea oil and sunflower oil on rumen fermentation, milk composition and rumen microbial population in water buffaloes fed elephant grass-based diets. Thirty two lactating water buffaloes were allocated at random to 1 of 4 treatments composed of elephant grass and concentrates containing no additional oil (Control group), or supplemented with 200g of sunflower oil(SF group), 200 g tea oil(TO group), 200 g sunflower oil and tea oil (SF:TO = 1:1, ST group). On d 7, 14, 21, 28, samples of milk were collected for milk composition analysis using GC and a MilkoScan FT120. On day 28, rumen fluids was collected by stomach tube and used for pH, VFA, NH_3–N determination and DNA extraction. Total bacteria, Methanogens, fungi, protozoa, *R. flavefaciens*, *F. succinogenes*, and

Butyrivibrio group were quantified by relative real-time PCR. Compared with the control, dietary supplements of 200 g tea oil or sunflower oil alone or in combination with each other decreased the concentration of NH_3–N and milk production significantly ($P < 0.05$). Concentrations of milk fat and total solids were greater than control group after oil supplementation ($P < 0.05$). Oils supplementations have no effect on concentrations of milk protein and lactose. Acetate: propionate ratios were significantly increased after oils supplementation ($P < 0.05$). Concentrations of acetate, propionate, butyrate and total VFAs were not affected by oils supplementation. C18:2 and c9t11-CLA were increased by sunflower oil or the combination of sunflower and tea oil ($P < 0.05$). Only Cis9 C18:1 was increased after tea oil supplement alone ($P < 0.05$). Inclusion tea oil resulted in greater concentration of milk fat, Cis9 C18:1 and total solids and less concentration of NH_3–N and milk production. Methanogens, fungi, protozoa, *R. flavefaciens*, *F. succinogenes*, and *Butyrivibrio* group populations were not influenced by oil supplementation. In conclusion, tea oil or sunflower oil manipulated ruminal fermentation and milk composition without effect on abundance of fibrolytic bacteria and *Butyrivibrio* group when water buffaloes were fed elephant-grass based diets.

Key Words: water buffalo, rumen, milk composition

1725 (T338) Effects of echium and flaxseed oil on ruminal fatty acid metabolism in vitro.

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Echium oil (EO) contains high level of γ-linolenic acid (*c*6, *c*9, *c*12) and stearidonic acid (*c*6, *c*9, *c*12, *c*15) and is considered to be a more desirable source of n-3 fatty acids (FA) than flaxseed oil (FO). However, there is little information on the metabolism of EO in the rumen. An in vitro study was designed as 2 × 2 (oil type × dose) + 1 (control) to assess the effect of EO and FO on ruminal FA profiles. A mixture of barley silage, barley grain and minerals and vitamin supplement (75:22:3, DM basis) was incubated with 0 (control), 3 or 6% of EO or FO in serum vials with rumen fluid. Each treatment was triplicated and incubated for 0, 3, 6, 24, and 48 h. The experiment was repeated (run) three times. The statistical model included run and treatments for the fixed effects and vial as unit. The whole content was freeze-dried and extracted for total FA which was used to determine the individual FA profile by GC. Percentage of C18:0 (g/100g total FA) was lower ($P < 0.001$) for 6% EO treatment than in other treatments at both 24 and 48 h of incubation. Both oil treatments had higher ($P < 0.001$) *cis* 15-C18:1 percentage than control. Inclusion of 3% and 6% FO resulted in higher ($P < 0.001$) *cis* 15-C18:1 than EO at 6, 24 and 48 h. However, incubation with 6% EO yielded FA with the highest ($P < 0.001$) *trans* 9-C18:1 and *trans* 11-C18:1 percentage at 24 and 48 h. *Cis*-9, *trans*-11-C18:2 was increased ($P < 0.001$) by both oil treatments. The total unsaturated FA and *trans* FA were higher ($P < 0.01$) with the addition of oil groups and 6% EO was the greatest ($P < 0.001$). The increased *trans* 11-C18:1 with EO but not FO suggests that EO is more desirable in that it produced more *trans* 11-C18:1, the precursor of *cis*-9, *trans*-11-C18:2 which has been reported to benefit human health.

Key Words: echium oil, fatty acids, in vitro

1726 (T339) Effects of linseed oil and propolis additives on protozoa population in dairy cows.

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Although the role of protozoa in the rumen fermentation is unquestionable, the truth is that its elimination may represent, in some cases, an additional benefit to the ruminant as increased microbial N outflow. The objective of this experiment was to examine the effect of linseed oil and additives on the population of ciliate protozoa in the rumen of dairy cow. Four lactating Holstein cows were used in a 4X4 Latin square design. Diets were composed of 600:400 forage:concentrate (dry matter basis-DM). The treatments were: basal diet (C); basal diet + linseed oil (25 $g.kg^{-1}$ DM) (LO); basal diet + linseed oil + propolis (10 mg $flavonoids.kg^{-1}$ DM) (LOP); basal diet + linseed oil + propolis + vitamin E (375 $UI.kg^{-1}$ DM) (LOPE). Samples of rumen contents were obtained (2 days in each period) manually through the fistula approximately 30 min before feeding and were fixed by diluting with an equal volume of formalin solution (18.5% formaldehyde final concentration). Total counts and generic distribution of protozoa were made in 100 microscopic fields at a magnification of 100x according to Dehority (1993). Statistical analyses were performed by analysis of variance ($P < 0.05$) and orthogonal contrasts to compare effects of 1) Linseed oil (C vs. LO, LOP and LOPE), 2) Propolis (LO vs. LOP and LOPE); 3) Vitamin E interaction (LOP vs. LOPE). There were no effects of linseed oil on the species of *Entodinium* ($P = 0.097$), *Isotricha* ($P = 0.143$) and total protozoa population ($P = 0.092$). In general, the *Endodinium* species was represented by the largest proportion (99.69%) and a lower *Isotricha* species (0.30%). However, the Diplodiniinae subfamily was not identified. It can be conclued that linseed oil and propolis additives do not change protozoa population.

Key Words: microbiology, omega-3, additives

Table 1726.

	Treatments					Orthogonal contrasts[1]		
Parameters	C	LO	LOP	LOPE	SEM	1	2	3
	—— Nx10^5 ciliates/mL ——							
Entodinium	4.894	3.731	4.097	3.026	0.403	0.097	0.813	0.226
Isotricha	0.024	0.008	0.011	0.008	0.004	0.143	0.879	0.792
Total	4.918	3.739	4.108	3.034	0.405	0.092	0.814	0.222
	———— % Total ————							
Entodinium	99.58	99.83	99.76	99.60	0.111	0.633	0.635	0.678
Isotricha	0.41	0.16	0.24	0.39	0.111	0.633	0.635	0.678

[1] *P*-value.

1727 (T340) Effect of linoleic and linolenic acid sources supplementation on in vitro rumen fermentation characteristics and microbial diversity.

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An in vitro experiment was conducted to estimate the effects of oil sources on rumen fermentation characteristics and microbial diversity. Oil sources were corn oil (CO), linseed oil (LSO) and Ca-salts of linoleic acid (CaSalt). Rumen fluid was collected from 2 canulated Hanwoo steers fed rice straw and concentrate mixture in 2:8 ratio. Incubation was performed in 50 ml glass serum bottles containing 150 mg of synthetic diet (411 g cellulose, 411 g starch, and 178 g casein/kg DM), 7 mg (µl) of either oil sources, and 15 ml of incubation medium (rumen fluid + Van Soest medium = 1:2) at 37 °C for 0, 3, 6, 12 and 24 h with 5 replications and 5 blanks for each time period. After 24 h of incubation, total gas volume and the concentrations of ammonia-N and total VFA were unaffected ($P > 0.05$). The pH was higher ($P = 0.024$) in CaSalt with a concomitant lower in lactate concentration ($P = 0.001$). Acetate concentration was significantly higher in CaSalt ($P = 0.013$), but propionate concentration was higher in CO than that in others ($P = 0.007$). Concomitantly, acetate to propionate ratio was higher in CaSalt than in CO ($P = 0.016$). The real time PCR analysis was conducted for relative quantification of microbial DNA. At 12 and 24 h of incubation, *F. succinogens*, *R. flavefaciens*, and *R. albus* were significantly higher ($P < 0.05$) in CaSalt than those in CO and LSO. However, *S. bovis*was observed higher in LSO at both of those time periods ($P < 0.05$). On the other hand, after 24 h, Methanogenic archaea and ciliate protozoa was highest in LSO and CO, respectively ($P < 0.005$). It is concluded that CaSalt showed lowered rumen methanogenic archaea and ciliate protozoa, while less toxic effects on fibrolytic bacteria compared to other oil sources, as also evidenced from higher acetate production in this treatment.

Key Words: corn oil, linseed oil, Ca-salts of linoleic acid, rumen fermentation, rumen microbes

1728 (T341) Intake and daily gain of grazing Nellore bulls receiving concentrated supplementation with additives.

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The objective of this study was to evaluate the effect of a commercial concentrate supplement with additives in the intake and daily gain of grazing bulls, during the dry/rainy transition season in Aquidauana-MS, Brazil. Twelve Nellore bulls (initial body weight of 370 ± 15 kg) were randomly assigned to twelve *Brachiaria decumbens* Stapf pastures (1.0 ha/pasture; one bull/pasture) on a completely randomized design. Treatments were: 1) concentrate supplement Lipomax with homeopathic additives (Convert H, Sodo 100, Figotonus) and Virginiamicina (Lipomax treatment), and 2) concentrate supplement with a similar protein content (18% CP), and without additives (Control treatment). Animals were feed daily at rate of 0.5% of the animal's body weight. The animals were weighed (shrunk body weight) at beginning of the experiment and 104 d after, to evaluate the weight gain. After 45 days, a trial for estimated intake was made using the enriched and purified lignin (LIPE) as marker for fecal excretion estimation, and the indigestible neutral detergent fiber as internal marker. Forage nutritive value was estimated by hand-plucked sampling, and supplement intake was measured directly for each animal. A significance level of 5% was adopted. The forage (DMfor), supplement (DMsuppl), total dry matter, crude protein and TDN intakes showed no difference ($P > 0.05$) between treatments (Table 1728). However, DMsuppl intake was 50% higher when using additives (Lipomax treatment) with similar quantity reduction on DMfor. The lack of significance, in this case, could be explained by the high coefficient of variation of DMsuppl. The average daily gain was higher ($P < 0.05$) when using concentrate supplement with additives. In conclusion, additives in concentrate supplement increased the efficiency of nutrient use for grazing animals.

Key Words: grazing bulls, intake, performance

Table 1728. Intake and daily gain of Nellore bulls grazing brachiaria grass receiving concentrated supplementation with or without additives

Item	Treatment		CV (%)	*P*-value
	Control	Lipomax		
	kg/d			
DMfor[1]	8.418	7.988	15.1	0.561
DMsuppl[2]	0.844	1.269	51.0	0.205
DMtot[3]	9.261	9.258	12.7	0.996
CPint[4]	0.848	0.835	22.0	0.797
TDN[5]	6.374	6.134	16.3	0.746
ADG	0.811	1.107	19.2	0.028

[1]DMfor is dry matter intake of pasture.
[2]DMsuppl is dry matter intake of supplement.
[3]DMtot is the total dry matter intake.
[4]CPint is crude protein intake. [5]TDN is total digestible nutrients intake.

1729 (T342) Effects of concentrate level and combined use of virginiamycin and salinomycin on nutrient intake and digestibility of Nellore steers.
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Eight ruminally cannulated Nellore steers (434 ± 35 kg initial BW) were allotted to a 4x4 replicated Latin square design (21-d periods) to evaluate the effects of concentrate and virginiamycin levels in diets containing salinomycin on nutrient intake and digestibility. Treatments were arranged as a 2x2 factorial, with 2 concentrate levels (70C and 90C diets had 70 and 90% concentrate, respectively) and 2 virginiamycin levels (0 and 15 ppm) in the diet DM. Steers were fed once daily at 0800 and salinomycin was included in all diets (13 ppm). The 70C diet contained 33% starch, 16% CP, and 31% NDF, whereas the 90C diet contained 47% starch, 16% CP, and 19% NDF on DM basis. Dry matter, CP, NDF, and starch intakes were calculated as the difference between the amount of nutrient offered and refused. Apparent digestibilities of nutrients were determined by total fecal collection for 3 d on each experimental period. Statistical analyses were performed using the MIXED procedure of SAS. No interactions between concentrate and virginiamycin levels were observed for any analyzed variable. Steers receiving the 90C diet showed greater ($P \leq 0.01$) DM (7.73 and 8.23 ± 0.19 kg/d for 70C and 90C, respectively), CP (1.24 and 1.32 ± 0.03 kg/d for 70C and 90C, respectively), and starch intakes (2.58 and 3.78 ± 0.13 kg/d for 70C and 90C, respectively), whereas NDF intake was greater ($P \leq 0.01$) for steers fed the 70C diet (2.28 and 1.57 ± 0.07 kg/d for 70C and 90C, respectively). Intake variables were not affected by virginiamycin inclusion. Animals receiving the 90C diet showed greater ($P < 0.01$) apparent digestibilities of DM (66.21 and 73.70 ± 0.94% for 70C and 90C, respectively) and CP (71.23 and 77.35 ± 0.83% for 70C and 90C, respectively), whereas NDF and starch digestibilities did not differ between concentrate levels. Steers fed only salinomycin showed greater ($P = 0.05$) starch digestibility in comparison with those receiving both additives (90.90 and 88.98 ± 0.78% for 0 and 15 ppm virginiamycin, respectively). There were no effects of virginiamycin inclusion on DM, CP, and NDF digestibilities. In conclusion, nutrient intake and apparent digestibility of Nellore steers are affected by dietary concentrate levels, whereas the effects of the combined use of virginiamycin and salinomycin on these variables are less pronounced.

Key Words: antibiotic, ionophore, Zebu cattle

1730 (T343) A meta-analysis of effects of feeding nitrate on toxicity, production, and enteric methane emissions in ruminants.
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Nitrate is usually considered an undesirable compound in ruminant feeds due to its potential toxicity (methemoglobinaemia). Despite this concern, nitrate has recently received attention as an electron acceptor in the rumen that could possibly reduce enteric methane emissions. It was also proposed that nitrate might be a useful non-protein nitrogen source as a substitute for urea. Therefore, a meta-analysis was conducted to investigate the effects of feeding nitrate on its toxicity and effects on animal production and enteric methane emissions. Data were collected from published literature (PubMed, ScienceDirect and CAB direct) and analyzed using the MIXED procedure of SAS with study as a random effect. When nitrate was fed without a gradual acclimation (stepwise increases in nitrate in diets) or infused into the rumen, blood methemoglobin levels (MetHg, % of total hemoglobin) linearly responded to nitrate levels [9 studies with 25 treatments; MetHg (%) = 41.3 × nitrate (g/kg BW/d) + 1.2; $R^2 = 0.76$, $P < 0.001$]. However, when nitrate was fed using a gradual acclimation, the potential toxicity of nitrate was considerably lowered [3 studies with 11 treatments; MetHg (%) = 4.2 × nitrate (g/kg BW/d) + 0.4, $R^2 = 0.76$, $P = 0.002$]. Animals fed nitrate reduced enteric methane emissions in a dose–response manner [8 studies and 25 treatments; CH_4 (g/kg DMI) = −8.3 × nitrate (g/kg BW/d) + 15.2, $R^2 = 0.80$, $P < 0.001$]. Three studies examined the persistent efficacy of nitrate on reducing enteric methane emissions (54, 90, and 92 d, respectively). Animals fed nitrate (2.1 to 2.7% of dietary DM) reduced methane emissions persistently by 16.5 to 35.4% (treatments × time, $P > 0.31$). However, dry matter intake (DMI) and live weight gain (LWG) of cattle were not affected by nitrate (DMI, 20 studies and 46 treatments; $R^2 = 0.007$, $P = 0.65$; LWG, 12 studies and 35 treatments; $R^2 = 0.03$, $P = 0.31$). In conclusion, the potential toxicity of nitrate can be reduced by acclimatizing the animals to nitrate gradually. Nitrate is a potential feed additive to re-

duce enteric methane emissions and its efficacy is persistent. However, lowering methane production using nitrate may not re-direct additional metabolizable energy towards animal production. This meta-analysis, however, needs to be interpreted with caution because of the small number of studies used.

Key Words: meta-analysis, nitrate, ruminants

1731 (T344) Methane production of Nellore young bulls on pasture in the rainy season supplemented with crude glycerin associated energy sources.

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The objective of this study was to evaluate the effect of adding 28% crude glycerin (CG) in the supplement (DM basis), replacing corn or soybean hulls, with or without a source of oil, on enteric methane emission, average daily gain (ADG) and daily carcass gain (GC) of young bulls in the pasture. A total of 36 young Nellore bulls with an average initial BW of 333.20 ± 41.60 kg were distributed in a completely randomized design (three animals per paddock and three paddocks per treatment) with nine replicates. Treatments were arranged as a 2x2 factorial (high or low starch, with or without a source of oil). Paddock was the experimental unit, and the model effects included treatment. These animals were grazed on *Brachiaria brizantha* cv. Xaraés in the rainy season (January 2013 to May 2013), with the same treatments and supplemented at the rate of 500 g/100 kg BW. The supplements were: T1- CG with high starch (corn), T2- CG with low starch (soybean hulls), T3- CG with high starch associated to a source of oil (corn and soybeans) and T4- CG with low starch associated to a source of oil (soybean hulls in soybean grain). The sulfur hexafluoride (SF_6) tracer method for measuring eructated CH_4 was used in this study (Johnson et al., 1994). To determine daily carcass gain, eight animals were slaughtered as a reference at the beginning of the experiment and after 133 days of the experiment, eight more animals were slaughtered. Data were analyzed using the SAS PROC GLM, considering the significance of $P < 0.05$. Daily carcass gain (GC, kg.day^{-1}) and average daily gain (ADG, kg.day^{-1}) of the animals was evaluated. The methane emission were expressed in kilogram of methane emitted per year (kg CH_4.yr^{-1}), gram per day (g CH_4.day^{-1}), kilogram per kilogram of carcass produced (kg CH_4.kg CAR^{-1}) and kilogram per kilogram of average daily gain (kg CH_4.kg ADG^{-1}). Differences were not detected ($P > 0.05$) between treatments, with average values of 0.54 kg.day^{-1}, 0.88 kg.day^{-1}, 44.03 kg.yr^{-1}, 120.64 g.day^{-1}, 0.22 kg.kg CAR^{-1} and 0.16 kg CH_4.kg ADG^{-1}, respectively. Crude glycerin associated with high or low levels of starch, with or without a source of oil, did not alter the methane production of Nellore bulls on pasture supplemented during the rainy season.

Key Words: energy, environment, ruminant

1732 (T345) Effects of encapsulated nitrate on toxicity, feed intake and feed consumption rates in beef cattle.

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Slow-release encapsulated nitrate [EN; 66.9% nitrate in DM; GRASP Ind. and Com. LTDA, Paraná, Brazil] was investigated for its effects on toxicity threshold, feed intake, and feed consumption rates in 2 experiments. In Exp. 1, 5 beef heifers were fed once daily a diet (55:45 forage:concentrate) at 75% of ad libitum intake. The proportion of EN in the diet was increased by 1% every 4 days to 1.0, 2.0, 2.9, 3.9, 4.8, and 5.8% of dietary DM (10.3 to 15.6% CP at 0 to 5.8% EN). In Exp. 2, 8 beef heifers were used in a replicated 4 × 4 Latin square design and fed ad libitum once daily diets (iso-nitrogenous, 12.7% CP; 55:45 forage:concentrate) containing 0, 1, 2, and 3% EN (DM basis) using a 21-d stepwise adaptation. In Exp. 1 with restrictive feeding, a heifer was removed due to rapid feed consumption causing nitrate-poisoning at 3% EN and another due to refusal to eat the 2% EN diet. Comparing 0% with 5.8% EN, feed consumption from 0 to 3 h after feeding was decreased (70.3 to 48.6% of total; $P = 0.03$), that from 12 to 24 h was increased (0.6 to 22.6%; $P = 0.01$), and feed consumed over 24 h was decreased (100 to 92.3%; $P = 0.01$). Animals showed negligible blood methemoglobin levels (< 1%; MetHb, % of hemoglobin) at 1% EN. However, MetHb levels were greater (avg. 8.6 vs. 3.3% and max. 23.6 vs. 13.6% at 3 h) at 2.0 and 2.9% EN than at 3.9% or more EN because of sorting of the concentrates containing higher levels of EN. The MetHb level peaked 3 h after feeding for all EN levels and the magnitude of the peak was dependent on the amount of feed consumed from 0 to 3 h. In Exp. 2 with ad libitum feeding, feed consumption rates were not different (41.8% of total from 0 to 3 h) among EN levels. Although MetHb levels increased ($P < 0.01$) with increasing EN level, the magnitude was lower for Exp. 2 compared with Exp. 1 (avg. 2.8 vs. 8.4%; max. 7.2 vs. 23.6% at 3% EN). Sorting of the EN diets was not observed in Exp. 2. In conclusion, MetHb responses to EN levels were dependent on feed consumption rates after feeding. Offering a diet containing EN for ad libitum intake minimized risks of nitrate toxicity.

Key Words: encapsulated nitrate, methemoglobin, beef cattle

1733 (T346) Effects of the combined use of virginiamycin and salinomycin on rumen fluid kinetics of Nellore steers. A. J. C. Nuñez[1], V. V. Almeida[2], F. Pinese[1], I. E. Borges[1], F. T. Mercado[1], S. L. Silva[*1], P. R. Leme[1] and J. C. M. Nogueira Filho[1], *[1]Department of Animal Science- FZEA/USP, Pirassununga/SP, Brazil, [2]Department of Animal Science- FCAV/UNESP, Jaboticabal/SP, Brazil*

Two experiments were conducted to evaluate the combination of dietary virginiamycin and salinomycin on rumen fluid kinetics of Nellore steers fed high concentrate diets. In experiment one, 8 Nellore steers (322 ± 26 kg initial BW) were allotted to a replicated 4x4 Latin square design (21-d periods), in a 2x2 factorial arrangement of treatments, with 2 salinomycin concentrations (0 and 13 ppm) and 2 virginiamycin concentrations (0 and 15 ppm) in the diet DM, which contained 80% concentrate. In experiment two, 8 Nellore steers (434 ± 35 kg initial BW) were allotted to the same experimental design, with 2 concentrate inclusions (70C and 90C diets had 70 and 90% concentrate, respectively) and 2 virginiamycin concentrations (0 and 15 ppm) in the diet DM. Salinomycin was included in all diets (13 ppm). In both experiments, on d 20 of each period, 300 g of polyethylene glycol 4000 (PEG) were diluted in 600 mL of deionized water and infused into the rumen of each steer at 0800. Rumen fluid samples were collected before infusion and at 1.5, 3, 6, 12, and 24h after infusion, and PEG concentrations were determined by colorimetry. Ruminal fluid rate of passage (RP; %/h) and volume (FV; L) were calculated from linear regression of the natural logarithm of PEG concentration on time. Fluid retention time (RT; h) was determined as the inverse of RP, whereas flow rate (FR; L/h) was calculated as RP multiplied by FV. Statistical analyses were performed using the MIXED procedure of SAS, and the model included the random effects of animal, period, and Latin square, and the fixed effects of salinomycin or concentrate, virginiamycin, and the two-way interaction. No interactions were observed for any variable. In experiment one, rumen fluid kinetics variables were not affected by treatments. In experiment two, steers receiving the 70C diet showed greater ($P \leq 0.02$) RP (9.90 and 7.92 ± 0.48%/h for 70C and 90C, respectively), FV (39.07 and 31.47 ± 1.89 L for 70C and 90C, respectively), and FR (3.69 and 2.55 ± 0.23 L/h for 70C and 90C, respectively), whereas RT was greater ($P < 0.01$) for steers fed the 90C diet (9.77 and 13.24 ± 1.15 h for 70C and 90C, respectively). No effects of virginiamycin were observed for any variable. In conclusion, rumen fluid kinetics of Nellore steers is affected by dietary concentrate inclusion, but not by the combined use of virginiamycin and salinomycin.

Key Words: antibiotic, ionophore, Zebu

1734 (T347) Monensin, virginiamycin and functional oils on rumen health of Nellore cattle fed high concentrate diets without adaptation. A. P. dos Santos Silva[1], R. Ferreira Carvalho[2], C. A. Zotti[2], M. Rezende Mazon[1], L. Silva Oliviera[2], S. Luz e Silva[*2] and P. R. Leme[1], *[1]University of Sao Paulo, Pirassununga, Brazil, [2]University of Sao Paulo/FZEA, Pirassununga, Brazil*

Feed additives and adaptation strategies are used to prevent metabolic disorders in feedlot cattle. The extent on how additives can contribute to rumen health of Zebu cattle that are not adapted to high grain diets is still unknown. To evaluate the different feed additives on rumen health, 48 Nellore bulls (322 ± 23 kg of BW, 20 months old) were submitted to a diet change, without adaptation, from grass pasture to a high concentrate diet (92% grains) fed ad libitum during 120 days. The treatments were different feed additives added to the basal diet: monensin at 30 mg/kg DM (M30), monensin at 40 mg/kg DM (M40) fed during the first 14 days, decreasing to 30 mg/kg after this period, monensin at 30 mg/kg DM + virginiamycin at 25 mg/kg DM (MV) and functional oils (a blend of castor oil and cashew oil) at 400 mg/kg DM (FO). After 120 days animals were slaughtered and the livers were examined for abscesses. Rumen pH was measured and the incidence of ruminites (IR) was classified according to a 0 to 10 scale. Fragments of 3 cm^2 were taken from the cranial sac of the rumen and kept in buffer solution for the measurements of papillae number (PN), papillary area (PA) and absorption surface (AS). PN was counted by 3 evaluators and PA and AS were measured on the UTHSCA Image Tool free software. Animals fed FO diet had higher ($P = 0.01$) daily DMI than M30 and MV. However, there was no difference ($P = 0.22$) between OF and M40.There was no difference among treatments for ADG ($P = 0.13$), final BW ($P = 0.16$) and G:F ($P = 0.10$). No difference ($P = 0.86$) was verified for rumen pH (6.37 ± 0.51). There was no incidence of liver abscesses and low IR ($P = 0.61$; 1,09 ± 1,42). No differences ($P = 0,90$) were found on PN (53.18 ± 14.25), on PA ($P = 0.60$; 0.7 ± 0.26) and also on AS ($P = 0.82$; 38.07 ± 17.89). No metabolic disorders occurred and there was no decrease in animal performance indicating a relative protection of the additives and the possibility of feeding high concentrate diets to Nellore cattle without adaptation. Also, FO, a natural product, may substitute ionophores and antibiotics as additives for rumen protection when high concentrate diets are fed.

Key Words: feed additives, Zebu, feedlot

1735 (T348) Effects of grain source and monensin level on site and extent of digestion in feedlot heifers.

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Many feedlot producers include wheat grain into the rations due to increasing supplies of feed wheat in North America, whereas few studies have documented the effects of wheat source on animal response. A study was conducted to examine feed intake and site and extent of digestion by substituting wheat grain (soft or hard) for barley and to determine whether increasing monensin level would improve feed digestion in feedlot heifers. Five ruminally and duodenally cannulated beef heifers were used in a 5 × 5 Latin square design with 2 × 2 + 1 factorial. Treatments were barley (10% barley silage, 90% barley-based concentrate, and 28 mg/kg monensin), and diets substituting soft or hard wheat for barley combining with 28 (low) or 44 (high) mg/kg monensin. The barley diet is a standard feedlot diet used in western Canadian feedlots. Contrasts were generated to compare barley vs. wheat diets in low monensin; soft vs. hard wheat; and low vs. high menensin in wheat diets. Intake of DM was affected neither by grain source (8.3 kg/d) nor by wheat source (7.7 kg/d), whereas increased monensin level reduced ($P < 0.02$) DMI from 8.1 to 7.3 kg/d. Inclusion of wheat in place of barley grain did not affect the flows of OM to the duodenum (3.8 kg/d) and digestibility (% of intake) of OM in the rumen (64.2%) and in the total tract (80.5%). However, digestibility of NDF (barley vs. wheat; 60.6 vs. 48.3%; $P < 0.01$) and that of starch (barley vs. wheat; 95.5 vs. 97.6%; $P < 0.03$) in the total digestive tract were different. Feeding soft vs. hard wheat delivered lower ($P < 0.03$) OM (soft vs. hard; 3.4 vs. 3.6 kg/d) and non-ammonia N (soft vs. hard; 164 vs. 178 g/d) to the duodenum with no differences in ruminal and intestinal digestibility of OM. Increased monensin supplementation decreased ($P < 0.05$) duodenal flows of OM from 3.7 to 3.3 kg/d, total N from 182 to 168 g/d, and microbial N from 99 to 87 g/d without affecting the site and extent of feed digestibility. These results indicated that wheat exhibited similar feed value to barley; high level monensin may potentially alleviate ruminal acidosis by reducing DMI of finishing cattle.

Key Words: feedlot heifers, grain source, digestibility

1736 (T349) Effects of different doses of sodium monensin on rumen tissue histology of feedlot cattle.

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This study, conducted at the São Paulo State University feedlot, Dracena Campus, Brazil, was designed to determine the effects of different doses of sodium monensin on rumen tissue histological variables of feedlot cattle. The experiment was designed as a completely randomized block, with 12 replications per treatment, in which 60 20-mo-old yearling Nellore bulls (402.52 ± 33.0 kg) were fed in individual pens for 84 days according to the different doses of monensin (DM basis): 1) 0 ppm (D0); 2) 9 ppm (D9); 3) 18 ppm (D18); 4) 27 ppm (D27), and 5) 36 ppm (D36). The adaptation program consisted of ad libitum feeding of two adaptation diets over period of 14-d with concentrate level increasing from 68% to 84% of diet DM. The finishing diet contained: 71.5% cracked corn grain, 16.0% sugarcane bagasse, 7.7% soybean meal, 3.0% supplement, 1.2% urea, and 0.6% limestone (DM basis). At harvest, a 1-cm^2 fragment of each rumen ($n = 60$) was collected from ventral sac for histological assessment. Histological sections were stained with hematoxylin and eosin, embedded in paraffin wax, and sectioned. Morphometric measurements, such as papillae surface area, papillae height, papillae width, keratinized layer thickness, and mitotic index, were determined in four papillae per animal using computer-aided light microscope image analysis. Orthogonal contrasts were used to evaluate linear, quadratic, cubic and quartic relationship between doses of monensin and the dependent variable. The use of different doses of sodium monensin did not affect ($P > 0.10$) keratinized layer thickness. However, as doses of sodium monensin increased, papillae width in mm (D0 = 0.46; D9 = 0.42; D18 = 0.44; D27 = 0.45; D36 = 0.38), papillae surface area in cm^2 (D0 = 2.43; D9 = 2.12; D18 = 2,25; D27 = 2.68; D36 = 1.72) and mitotic index, as % of basal cells (D0 = 2.57; D9 = 3.15; D18 = 2.92; D27 = 2.71; D36 = 3.11) were affected ($P < 0.05$) cubically. The papillae height in mm (D0 = 4.98; D9 = 5.42; D18 = 5.04; D27 = 6.21; D36 = 4.71) was affected ($P = 0.05$) quadratically as dose of sodium monensin increased. Thus, increasing doses of sodium monensin affected histological variables of rumen tissue. The feeding of either 9 ppm or 27 ppm of sodium monensin seemed to be the best options in this study.

Key Words: Nellore, mitosis, papillae

1737 (T350) Effects of different doses of sodium monensin on DMI variation and selective consumption by feedlot cattle. D. H. Watanabe*[1], M. C. Pereira[1], J. Silva[1], T. V. Carrara[2], A. L. Rigueiro[1], L. A. Tomaz[1], D. P. Silva[1], D. V. Vicari[1], A. C. J. Pinto[1], D. D. Estevam[2], M. D. Arrigoni[2] and D. D. Millen[1,3], *[1]São Paulo State University (UNESP), Dracena campus, Dracena, Brazil, [2]São Paulo State University (UNESP), Botucatu campus, Botucatu, Brazil, [3]São Paulo State Foundation (FAPESP), São Paulo, Brazil*

This study, conducted at the São Paulo State University feedlot, Dracena Campus, Brazil, was designed to determine the effects of different doses of sodium monensin on DMI variation and selective consumption (sorting) of diets by Nellore cattle. The experiment was designed as a completely randomized block, replicated 12 times, in which 60 20-mo-old yearling Nellore bulls (402.52 ± 33.0 kg) were fed in individual pens for 84 days according to the following treatments (DM basis): 1) 0 ppm (D0); 2) 9 ppm (D9); 3) 18 ppm (D18); 4) 27 ppm (D27), and 5) 36 ppm (D36). The adaptation program consisted of ad libitum feeding of two adaptation diets over period of 14-d with concentrate level increasing from 68% to 84% of diet DM. The finishing diet contained: 71.5% cracked corn grain, 16.0% sugarcane bagasse, 7.7% soybean meal, 3.0% supplement, 1.2% urea, and 0.6% limestone (DM basis). The DMI variation was calculated for each individual pen as the difference in intake, expressed as % of variation, between consecutive days throughout the study. Samples of orts and diets were collected on days 10 and 40 of the study for particle size distribution determination, which was performed by sieving using the Penn State Particle Size Separator and reported on as-fed basis. Values equal to 1.0 indicate no sorting, < 1.0 show selective refusals, and > 1.0 indicate preferential consumption. Orthogonal contrasts were used to assess linear, quadratic, cubic and quartic relationship between doses of monensin and the dependent variable. During the period of adaptation, DMI variation was affected (P = 0.02) quadratically as dose of sodium monensin increased (D0: 15.3%; D9: 14.6%; D18: 13.6%; D27: 13.5%; D36: 18.5%); however, the use of different doses of sodium monensin did not affect (P > 0.10) DMI variation during the finishing period. Increasing doses of sodium monensin only affected particle sorting during the adaptation period, in which as dose of sodium monensin increased, sorting for screens one (diagonal opening = 19.0 mm; D0 = 0.986; D9 = 0.962; D18 = 0.947; D27 = 0.928; D36 = 1.021), two (diagonal opening = 8.0 mm; D0 = 0.992; D9 = 1.013; D18 = 1.014; D27 = 0.936; D36 = 0.932), and three (diagonal opening = 1.18 mm; D0 = 1.001; D9 = 1.015; D18 = 1.065; D27 = 1.043; D36 = 0.993), and bottom pan (D0 = 0.938; D9 = 1.022; D18 = 1.020; D27 = 1.074; D36 = 1.016) were affected (P < 0.05) quadratically. Thus, the feeding of sodium monensin up to 27 ppm reduced DMI variation, but increased diet sorting during the adaptation period.

Key Words: fluctuation, Nellore, sorting

1738 (T351) Feeding monensin or essential oils in high corn or byproduct finishing diets for Nellore bulls. L. J. Chagas*[1], M. G. DOS Santos[1], A. H. De Melo[1], J. R. R. Dórea[2], D. F. A. Costa[2] and F. A. P. Santos[2], *[1]University of São Paulo- ESALQ, Piracicaba, Brazil, [2]University of São Paulo, Piracicaba, Brazil*

The objective of this study was to evaluate the effects of sodium monensin replacement for essential oils on behavior, DMI, ruminal pH and ammonium concentration in feedlot cattle. Sixteen Nellore bulls (339 ± 30 Kg initial BW) were allocated in individual pens to four 4 × 4 Latin square (LS) design, consisting of 21 d (including 14 d of adaptation). One of two basal diets used had 5% sugar cane bagasse, 50% wet corn gluten feed, 43.5% soybean hulls and 1.5% mineral and vitamin mix and the other had 80.6% ground corn, 12% sugar cane bagasse, 4% soybean meal, 0.9% urea, and 2.5% mineral and vitamin mix (DM basis). Each basal diet was used in two 4 × 4 LS. Feed additives were mixed within the mineral and vitamin mix according to treatments: 1) Control (CON), no additives;2) Monensin (MON), 25 mg/kg of DM (Rumensin); 3) Essential oil (EO), 0.5 g/kg of DM (commercial additive extracted from castor and cashew oils, Essential); and 4) Essential oil plus monensin (E+M), 0.3 g/kg of DM and 25 mg/kg of DM, respectively. There were no differences between the basal diets for DMI (8.2 kg/d), feeding and idle time (193 and 1104 min in 24 h), feeding frequency (9.5 feed/d) and meal size (22 min/feed). Supplementing essential oils at 0.5 g/kg of DM (EO) decreased (P < 0.05) rumination in 37% compared to control, 130 vs. 208, respectively. Essential oils only, or E+M increased (P < 0.01) ruminal pH and ammonia nitrogen, 6.06 and 6.01 vs. 5.79 and 5.89 mg/dL, respectively for EO, E+M, CON and MON. Feeding frequency was the only parameter affected (P < 0.05) when byproducts were used, with 12.9 and 8.1 meal/d, for CON and MON, EO and M+E, respectively. In conclusion, castor and cashew essential oils have some beneficial effects on cattle physiology in the short time, such as the 21 days adaptation period to high grain diets.

Key Words: feedlot, feed additives, ionophores

1739 (T352) The effect of a citrus extract rich in flavonoids (Bioflavex) and its main components on rumen fermentation and microbial population under in vitro system using steers fed high concentrate diet as rumen liquor donors.

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To evaluate the effect of flavonoids on rumen fermentation and microbial population an in vitro assay was designed. Four sets of incubation series (batches) were separately conducted using a complete randomized block design. Four steers fed high concentrate ration (90:10 comemercial concentrate:barley straw) were used as donors. Serum glass bottles (120 ml) were filled with 80 ml of an incubation solution under a CO_2 stream. A mixture of the same concentrate and barley straw (600:60 mg/bottle) was used as substrate. Bioflavex (BF) was tested against its main flavonoid components (Hesperidine [HS]; Isonaringine [IN]; Naringine [NG]; Neoeriocitrine [NE]; Neohesperidine [NH] and Poncirine [PC]) at 200µg/g DM, and the substrate without flavonoids was considered as a control (CTR). Bottles were incubated at 39 ± 1°C and two bottles per treatment opened after 12 h, and sampled for pH, NH_3–N, volatile fatty acids (VFAs) and microbiota analyses. The DNA was extracted using QIAamp DNA Stool Mini Kit. qPCR was used to quantify the protozoa and hydrogenotrophic methanogenic archaea (HMA) concentration, moreover specific primers were used to determine the relative abundance of *Streptococcus bovis*, *Selenomonas ruminantium* and *Megasphaera elsdenii* in relation to the total bacteria while HMA and the acetoclastic *Methanosarcina* spp. were refered to total archaea. The treatments did not alter pH and no differences were recorded in NH_3 nor in total VFA concentration. However, in relation to the CTR, the addition of flavonoids (except for HS), altered the VFA profile, reducing acetate and increasing propionate proportion. Ciliate protozoa concentration was reduced by BF, NG, NH and PC ($P < 0.05$). Flavonoids, did not alter the relative abundance of *S. bovis* as lactate producing bacteria, (except for NE) although they enhanced ($P < 0.05$) *M. elsdenii* propotion in relation to the CTR (except for HS, IN and NE). A clear inhibition of flavonoids on the relative abundance of HMA was observed although only PC, NH, NG and BF reduced the relative abundance of *Methanosarcina* spp. ($P < 0.05$). Flavonoids exert significant changes in the fermentation end products and also altered the concentration and composition of lactate-utilizing bacteria, methanogenic population and ciliate protozoa. However, the different tested flavonoids substances did not interact homogeneously against rumen population.

Key Words: absolute and relative microbiota quantifications, in vitro incubation and pure flavonoids

1740 (T353) Use of a citrus flavonoids extract (Bioflavex) to improve rumen fermentation efficiency and performance in steers consuming high concentrate diets.

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To study the effects of a citrus ñavonoids extract (Bioñavex; BF) on fermentation and performance in steers fed high concentrate diets (90:10 Concentrate:Barley straw), two experiments were performed. In the first one, eight Friesian bulls (398 ± 12.2 kg BW) fitted with rumen cannula and were housed in individual pens and assigned to one of two treatments, they received the basal concentrate (CTR) or the basal concentrate supplemented with Bioflavex (450 mg/kg DM) in 2×4 cross over design. The trial lasted for 24 days and was divided in 2 experimental periods of 12 days, 10 days for dietary change-over followed by two sampling days. In the second experiment, 32 Friesian steers (395 ± 10.1 kg BW) were weighed and blocked in 2 homogeneous groups (BW basis) receiving the same treatments as Exp. 1 (CTR and BF) and were weighed at day 7 and 24 of the experiment. Concentrate and barley straw were offered ad libitum, once a day (0800 h) for 24 days. At the sampling days of 1st trial, rumen was sampled (at 0, 4 and 8 h post feeding) for pH, NH_3–N, volatile fatty acids (VFAs) and microbiota analyses. BF in the concentrate improved pH values (6.1 vs. 5.8 for BF and CTR; SEM 0.05; $P < 0.01$) and molar proportion of propionate (24. 2 vs. 22.5 SEM 0.60; $P = 0.05$). Flavonoids did not alter absolute abundances of total bacteria nor relative abundance of *Streptococcus bovis* while relative abundances of *Selenomonas ruminantium* ($P < 0.01$) and *Megaesphera elsdenii* ($P = 0.05$) were enhanced by the presence of BF in the concentrate. In the second trial no differences were observed neither in the final BW (425 vs. 420 kg SEM 10.9) nor in average daily gain (1.1 vs. 1.2 Kg/d SEM 0.14, for CTR and BF respectively) but feed conversion ratio was lower in BF than CTR steers (6.1 vs.6.8 SEM 0.8; $P = 0.05$). Flavonoid supplementation might be effective in improving rumen fermentation and animal's performance which may be explained changes induced by BF in the microbial flora.

Key Words: animal's performance, flavonoids and ruminal fermentation

1741 (T354) Effect of blend *Enterococcus faecium* plus *Saccharomyces cerevisiae* in different doses on intake and digestibility of steers in feedlot.

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The goal of this study was to evaluate the effect of different probiotic doses on the intake and partial digestibility of dry matter.

Were evaluated six Nellore steers fitted with ruminal cannulas and allocated to a double 3 x 3 Latin square design with three treatments and tree periods on two simultaneous repetitions. The blend of *Enterococcus faecium* (5 x 10^9 ufc/g of product) and *Saccharomyces cerevisiae* (5 x 10^9 ufc/g of product) in different doses (0, 1 or 2 g/day) were provided on the rumen. Steers were fed a diet containing 200 g/kg of corn silage and 800 g/kg concentrate. Within each experimental period, 18 days were to adaptation, DMI and digestibility were recorded from d 19 to 21. The statistical analyzes were conducted using PROC MIXED from SAS and means were compared using Tukey test ($P < 0.05$). Different doses of probiotic did not affect ($P > 0.05$) DMI, whereas the digestibility of OM (746.4, 697.9, 689.2 g/kg), and carbohydrates (757.4, 715.8, 706.6 g/kg) showed a quadratic response to 0, 1 and 2 g/day, respectively.

Key Words: concentrate, digestibility, probiotic

1742 (T355) Effect of doses at *Enterococcus faecium* and *Saccharomyces cerevisiae* on ruminal parameters responses of feeder cattle.

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This study aimed to evaluate the effect of doses of *Enterococcus faecium* and *Saccharomyces cerevisiae* on the pH, ruminal ammonia nitrogen (RAN) and short-chain fatty acids (SCFA) in beef cattle in feedlot. Six Nellore steers fitted with ruminal cannulas, with initial average body weight of 460 kg were used in a double Latin square 3 x 3. Within each experimental period, 18 days were to adaptation and three days for sampling. Steers were fed a diet containing 200 g/kg of maize silage and 800 g/kg of concentrate. The following treatments: 0, 1 or 2 g/day of a blend with *Enterococcus faecium* (5 x 10^9 cfu/g of product) and *Saccharomyces cerevisiae* (5 x 10^9 cfu/g of product) provided in the rumen were evaluated. The statistical analyzes were conducted using PROC MIXED from SAS and means were compared using Tukey test ($P < 0.05$). Different doses of probiotic did not showed statistic difference ($P > 0.05$) for the variables evaluated, however, statistical difference were achieved to the time of sampling ($P > 0.05$). The pH was highest up to 6 hours after feeding the animals. Highest level of ammonia nitrogen (36.28 mg/dL) was observed 3 hours after feed supply. Concentrations of acetic acid was highest (72.59 mmol/L) 9 hours after feed supply ($P < 0.05$), however the highest level of propionic (22.94 mmol/L) occur after 12 hours ($P < 0.05$), and butiric acid had highest level 15 hours after feed supply ($P < 0.001$). The use of different doses of the blend with *Enterococcus faecium* and *Saccharomyces cerevisiae* did not affect the ruminal parameters.

Key Words: feedlot, probiotic, ruminal parameter

1743 (T356) Influence of soybean meal supplementation with tannins extracted from pistachio hulls on performance and feed efficiency of Holstein bulls.

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The objective of this study was to examine the effects of soybean meal (SBM) supplementation with pistachio concentrated extract (PEC) on performance and feed efficiency of Holstein bulls. The sun dried pistachio hulls was grounded through a 0.5 mm screen and soaked with ratio of 1:10 in (pistachio: water). Filtered extract was concentrated by heating at 95 ℃. The SBM was treated with PCE containing 11.14% total phenol and 7.13% total tannin/DM of extract. The experiment duration was 14 weeks and involved 28 growing young bulls (256 ± 56 kg BW) in a completely randomized design. The study lasted 94 d (10 d adaption). Treatments included: (1); control (SBM without PEC) (2); SBM with 5% PEC (3); SBM with 10% PEC and (4); SBM treated with 15% (kg PEC/100kg DM SBM). Diets were formulated to meet nutrient requirements according to NRC (1996) and to be isocaloric and isonitrogenous, with forage concentration ratio of 30:70. The TMRs were supplied ad-libitum to bulls in two equal meals (08.00 and 17.00) and bulls had free access to fresh water. Body weight (BW) of each calf was recorded every 28 days before the morning feeding. Results indicate that, tannin supplementation did not affect ($P < 0.05$) final BW and dry matter intake but there were significant differences among treatment 15% and control in average daily gain (1.25 Vs. 1.06 consequently, $P < 0.01$) and feed efficiency (gain: feed) (6.62 Vs. 7.82 consequently, $P < 0.05$). So it seems that the high level of PCE can improve performance and feed efficiency of Holstein bulls.

Key Words: Holstein bulls, pistachios hulls, soybean meal, tannin

1744 (T357) Depression of rumen ammonia and protozoal population of Holstein bulls fed soybean meal treated with tannins extracted from pistachio hulls.

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An experiment was conducted to determine the effects of soybean meal (SBM) supplementation with tannins extracted from pistachio hulls (TEP) on some ruminal parameter such as: pH, rumen ammonia and protozoal population of Holstein growing bulls. Twenty-eight Holstein young bulls (average initial weigh 256 ± 63kg) were used in a completely randomized design with four treatments and seven replicates for 94 days. Tannin were extracted from pistachio hulls (TEP) and

contained 11.14% total phenol and 7.13% total tannin/DM of extract. Treatments included: (1); control (SBM without TEP) (2); SBM with 5% TEP (3); SBM with 10% TEP and (4); SBM treated with 15% (kg TEP/100kg DM SBM. Rumen fluid was collected via stomach tube 4h after morning feeding. The pH was determined in ruminal samples immediately after sampling and then Protozoa were counted using Burker counting chamber on days 83 and 85. Rumen fluid was transported to the laboratory and frozen for ammonia analysis. According to results, there was a significant decrease ($P < 0.05$) in the rumen ciliate protozoa population caused by feeding 15% levels of TEP. On the other hand, there was a significant decrease ($P < 0.05$) of tannin supplementation on ammonia concentrations and pH among treatment 15% TEP and control. This result indicates that tannin are able to reduce protein degradation in the rumen and increase bacterial flow to the duodenum by effecting defaunation in male bulls.

Key Words: Holstein young bulls, pistachios hulls, protozoal, rumen ammonia,tannin

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1745 (T358) Could soybean meal supplementation with crude extract of pistachio hulls change the blood metabolites of Holstein male bulls? M. Dehghan banadaky*[1], A. Jolazadeh[2], K. Rezayazdi[1] and N. Vahdani[2], [1]*Department of Animal Science, Faculty of Agriculture, University of Tehran, Karaj, Iran,* [2]*University of Tehran, Karaj, Iran.*

An experiment was carried out to determine the effect of soybean meal (SBM) supplementation with crude extract of pistachio hulls (CEP) on blood metabolites of Holstein bulls. CEP were extracted from hulls of pistachio containing 7.13% total tannin/DM of extract. Twenty-eight bulls 256 ± 63kg (mean ± SEM) were assigned randomly to one of the four treatment groups with seven replicates in a completely randomized design for 94 days. The bulls were housed in individual tie stalls and had free access to water. They were fed twice daily at 08:00 and 17:00 h. Four iso-energetic and iso-nitrogenous diets were offered to the experimental animals. Treatments included: (1); control (SBM without CEP) (2); SBM with 5% CEP (3); SBM with 10% CEP and (4); SBM treated with 15% (kg CEP/100kg DM SBM). Blood samples were taken from each bull at end of each month prior to morning feeding via coccygeal venipuncture and immediately chilled. According to results, Plasma total protein and albumin concentration was greater ($P = 0.001$) for bulls fed SBM with 15% CEP compared with other levels and Control. Plasma Glucose, BUN and Triglycerides concentrations were not affected by treatments ($P > 0.05$). Probably, in this experiment tannin able to reduce protein degradation in the rumen by formation tannin-protein complex and bypass them to the small intestine and increase digestive utilization of dietary protein is the reason for increase Plasma albumin and total protein concentration ($P < 0.001$) in bulls. It was therefore concluded that CEP could be used as chemical additives for improving the digestive utilization of protein-rich feeds in Holstein bulls.

Key Words: blood metabolites, pistachios hulls, tannin

1746 (T359) Effect of Saikosaponin on rumen gas production, volatile fatty acid concentrations and microbial populations in vitro. L. Pan*, D. P. Bu, J. Q. Wang, J. B. Cheng and X. Z. Sun, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China*

There has been increasing interest to exploit bioactive saponins for improving rumen metabolism. This experiment was conducted to investigate effects of Saikosaponin (SSA) on rumen gas production, volatile fatty acid concentrations and microbial populations using batch cultures in vitro. It was anaerobically incubated in triplicates together with 0.5 g TMR, 50 mL basal media and 25 mL rumen fluid obtained from rumen-cannulated lactating Holstein dairy cows. Four treatments consisted of supplemental SSA at 0 (control), 0.25, 0.5 and 1.0 mg/g of dry matter,which were assigned randomly to 5 of 20 incubation bottles. Cumulative gas production (GP) was continuously measured in an automated trace gas recording system (AGRS-III, Beijing) at 39 °C during 48 h of incubation, after which the pH values were measured immediately and 10.0 mL of culture fluid sample were kept for analysis of volatile fatty acids (VFAs) by a gas chromatographic and the copy number of rumen bacteria populations by quantitative RT-PCR with species-specific PCR primers amplifying partial 16S rDNA regions. Data were analyzed using GLM procedure of SAS 9.2. Results revealed that SSA did not affect GP kinetics and fermentation gas pattern, while the increase of SSA addition improved the total gas production (131.78^{a}, 112.56^{ab} and 123.50^{ab} vs. 107.50^{b} ml/g DM, $P < 0.05$) and dry matter degradability (53.49^{a}, 50.36^{ab} and 51.83^{ab} vs. 48.67^{b} %, $P = 0.07$) compared with the control. The concentrations of acetate (54.88^{a}, 53.82^{a} and 54.00^{a} vs. 52.13^{b} mmol/L, $P < 0.05$), propionate (20.83^{a}, 20.32^{ab} and 20.25^{ab} vs. 19.74^{b} mmol/L, $P < 0.05$) and total VFA (91.58^{a}, 89.19^{a} and 89.34^{a} vs. 86.53^{b} mmol/L, $P < 0.05$) were increased, whereas molar proportions of acetate to propionate ratio were not influenced by supplementing SSA. There was no treatment effect on Ruminococcus flavefaciens and Butyrivibrio fibrisolvens, while the relative copy number of the following bacterial species: Ruminococcus albus, Prevotella ruminicola, Anaerovibrio lipolytica, Streptococcus bovis and Fibrobacter succinogene were increased ($P < 0.05$) compared to the control. Overall, SSA supplementation improved gas production, VFA concentrations and major microbial species in the culture fluid in vitro, therefore Saikosaponin may be beneficial to manipulate rumen microbial fermentation in vitro.

Key Words: microbial populations; Saikosaponin; volatile fatty acid

1747 (T360) Methane production from dairy cows fed red clover- or corn silage-based diets supplemented with linseed oil. C. Benchaar*[1], F. Hassanat[1], R. Gervais[2] and R. Martineau[1], [1]*Agriculture and Agri-Food Canada, Dairy and Swine Research and Development Centre, Sherbrooke, QC, Canada,* [2]*Université Laval, Québec, QC, Canada*

The objective of this study was to examine the effect of linseed oil (LO) supplementation on enteric CH_4 emissions from dairy cow fed red clover-(RC) or corn silage (CS)-based diets. Twelve lactating, multiparous Holstein cows (DIM = 91 ± 25; milk yield = 45.2 ± 4.7 kg) were used in a replicated 4 × 4 Latin square (35-d period; 14-d adaptation) with a 2 × 2 factorial arrangement of treatments. Cows were fed (ad libitum; 5% orts on an as-fed basis) a TMR (60:40, forage:concentrate ratio) not supplemented or supplemented with 4% LO (DM basis) and with the forage portion of the TMR consisting of either RC or CS. Production of CH_4 was determined (3 consecutive days) using respiration chambers, while milk performance was determined over 6 consecutive days. Main effects of forage source, LO supplementation and interactions (LO × forage source) were determined using the MIXED Procedure of SAS and significance was declared at $P \leq 0.05$. Significant interactions between LO and forage source were observed for DM intake, and yield of fat-corrected milk, which were not changed by adding LO to RC-based diets but decreased when LO was added in CS-based diets. Similarly, CH_4 production (g/d or as a proportion of gross energy intake) was unaffected by supplementing LO to RC-based diets, but declined by 25% when LO was included in CS-based diets (LO × forage source interaction; $P < 0.01$). When expressed on FCM yield basis, CH_4 production decreased with LO addition regardless the source of forage used (12.7 vs. 14.4 g CH_4/kg FCM). Results of this study show that 4% LO had no effect on CH_4 production when supplemented to RC-based diets, but decreased daily CH_4 emissions and CH_4 energy losses if supplemented to CS-based diets.

Key Words: dairy cow, methane, corn silage, red clover silage, linseed oil

1748 (T361) Replacing alfalfa with panicled-tick clover or sericea lespedeza in a dairy diet decreases ruminal methane but not total gas production. H. D. Naumann*[1], S. A. Armstrong[2,3], M. A. Fonseca[4], B. D. Lambert[5,6] and L. O. Tedeschi[4], [1]*University of Missouri, Columbia,* [2]*Prince Agri Products, Inc, Quincy, IL,* [3]*Oregon State University, Corvallis,* [4]*Texas A&M University, College Station,* [5]*Texas A&M AgriLife Research, Stephenville,* [6]*Tarleton State University, Stephenville, TX*

Enteric methane (CH_4) emissions by ruminants represent a decrease in gross-energy intake by the animal. Biologically active forage plant polyphenols, condensed tannins (CT), are known to suppress enteric CH_4 production in ruminants that consume them. However, consumption of these forages alone, or in too great of quantities could result in antinutritional effects, negatively impacting ruminant efficiency and growth. The objective of this study was to determine the effects of replacing the forage component of a traditional dairy diet (50% corn grain, 50% alfalfa; CRN:ALF) with that of forages containing CT on enteric methane and total gas production. *Desmodium paniculatum* (panicled-tick clover; PTC) and *Lespedeza cuneata* (sericea lespedeza; SL) were evaluated as an alfalfa replacement at levels of 15%, 30% and 45%. Methane production was determined using an in vitro gas production technique. In a randomized complete block design, replications consisted of two fermentation events, 06/25/2012 and 09/16/2012, where each diet was fermented in each of two fermentation chambers. Fermentation chamber was considered a random variable, whereas fermentation flasks within each fermentation chamber were considered random factors. Two ruminally-cannulated steers not adapted to forage containing CT were used for rumen fluid collection. Forages were individually fermented anaerobically in rumen fluid for 48h. Methane concentrations were determined by gas chromatography following fermentation. LS-means were determined and a value of $P < 0.05$ was considered significant. There was no difference in CH_4 production among PTC 15%, SL 15% and CRN:ALF (130.5, 132.2 and110.8 g/kg fermentable-organic matter; FOM, respectively). Fermentation of PTC 30% and SL 30% produced 85.5 and 89.7 g CH_4/kg FOM, respectively, which did not differ from CRN:ALF. However, fermentation of PTC 45% resulted in the least amount of CH_4 produced (38.1 g/kg FOM), which was 54% less than that of SL 45% (84.0 g/kg FOM; $P = 0.0022$) and 65% less than that of CRN:ALF ($P < 0.0001$). Total gas production did not differ among treatments compared to the CRN:ALF control. Results from this study suggest that 45% replacement of alfalfa with PTC or SL will suppress ruminal CH_4 with no compromise in total gas production (i.e. FOM).

Key Words: condensed tannin, legume, ruminal fermentation

1749 (T362) Effects of forage source and NDF concentration on methane emissions and milk production of dairy cows. K. J. Hammond*, A. K. Jones, D. J. Humphries, L. A. Crompton and C. K. Reynolds, *University of Reading, Reading, United Kingdom*

Strategies to mitigate greenhouse gas emissions from dairy cows are unlikely to be adopted if production or profitability is reduced. Dietary manipulation to reduce methane emissions can be readily used and may benefit productivity. The objectives of this study were to examine the effects of silage type and diet NDF concentration on methane emissions and milk production of dairy cows. A 12-week randomized block con-

tinuous design was used with 40 mid-lactation Holstein cows (74 DIM ± SEM 2.57) assigned to one of 4 treatments (10 cows each) according to calving date, parity and milk yield. Milk production and DMI were measured daily and milk composition measured weekly (weeks 3 to 12), and methane emissions estimated using a GreenFeed automated head chamber (weeks 10 to 12). Four isonitrogenous diets were fed as total mixed rations (TMR) containing 50% silage (DM basis) offered ad libitum. Silage was comprised of either 25:75 (MS) or 75:25 (GS) grass silage:maize silage on a DM basis, without or with additional NDF from chopped straw and soy hulls (+ 47 g NDF/kg TMR DM). A commercial calf pellet was included in the TMR (weeks 1 to 8) or provided via the GreenFeed (weeks 9 to 12). Data (weeks 10 to 12) were analyzed using mixed models for effects of silage, NDF, and their interaction. Cows fed MS had a greater milk yield ($P < 0.01$; 34.5 vs. 29.0 kg/d), milk protein yield ($P < 0.001$; 1076 vs. 926 g/d), DMI ($P < 0.001$; 24.6 vs. 19.3 kg/d), lower milk fat concentration ($P < 0.001$; 3.59 vs. 4.19%) and lactose yield ($P < 0.01$; 1540 vs. 1286 g/d), and lower methane yield ($P < 0.001$; 17.7 vs. 24.1 g/kg DMI), compared to GS. Added NDF increased methane production (410 vs. 461 g/d) and yield (16.5 vs. 18.9 g/kg DMI) when MS was fed, but not GS (460 g/d and 24.0 g/kg DMI, respectively), as indicated through a silage by NDF interaction ($P < 0.10$). Effects of silage type and NDF on methane emissions may be attributable to changes in rumen digesta dynamics, including rumen outflow and retention time, and warrants further investigation.

Key Words: methane, dairy cows, forage NDF

1750 (T363) Changes of rumen methanogen diversity associated with different types of forage and protein in diets. X. W. Wang, J. Q. Wang*, D. P. Bu and S. G. Zhao, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China*

The objective of this study was to compare the methanogenic community and number in the rumen of dairy cows fed with different types of forage and protein in diet. Forty-eight healthy Chinese Holstein dairy cows were randomly assigned into three groups according to milk yield and day in milking. The diets in three treatments were as follows: MF (alfalfa and corn silage, soybean meal), CSA (corn stover, soybean meal), CSB (corn stover, cottonseed and rapeseed meal). The cows were fed with different diets (MF, CSA, CSB) for 91 days. Rumen fluid samples were collected before and after feeding using stomach-tube on d 91. Mothur software was used to assign clones to operational taxonomic units (OTUs) based on a 94% sequence identity cutoff. The results showed that the copy number of total methanogen of CSA was greater than that of CSB ($P = 0.049$). However, there was no difference between CSA and MF ($P = 0.67$). A total of 739 clones isolated from six methanogen mcrA gene clone libraries (samples from MF, CSA and CSB groups before or after feeding) were assigned to 25 species-level OTUs. The average OTU coverage of clone libraries was 96% (from 95% to 97.6%). Libshuff analysis showed methanogenic community of CSA and CSB, MF and CSA were different ($P = 0.03$ and $P = 0.04$, respectively). MF (2.08) and CSB (2.24) had lower diversity of methanogen based on Shannon index, compared with CSA (2.31). Additionally, Rumen cluster C (RCC, 73.2%) and *Methanobacteriales* (26.3%) were the predominant methanogenic archaea in the rumen. However, OTU10 were only found in CSA and CSB, and OTU20 only in MF. Meanwhile, OTU11 was only found in CSA and MF, while OTU21 only in CSB. Taxonomy analysis showed that OTU10, OTU20, OTU11 and OTU21 were closely related to *Candidatus methanomethylophilus alvus Mx1201* (83%), *Thermoplasmatales archaeon BRNA* (100%), *Methanobrevibacter ruminantium M1* (94%) and *Methanomassiliicoccus luminyensis B10* (78%), respectively. In conclusion, soybean diet could promote the number of total methanogen and increase the diversity of methanogen compared with rapeseed diet in rumen, and the diet with corn straw had higher diversity than the alfalfa and corn silage diet.

Key Words: methanogen, forage, protein

1751 (T364) Effect of cashew nut shell liquid on lactation performance and rumen methane production in dairy cows. A. F. Branco[1], F. Giallongo*[2], T. Frederick[2], H. Weeks[2], J. Oh[2] and A. N. Hristov[2], *[1]Universidade Estadual de Maringá, Paraná, Brazil, [2]Department of Animal Science, The Pennsylvania State University, University Park*

Technical cashew nut shell liquid (CNSL) is a by-product of the cashew nut industry in tropical countries, and is known to exhibit a wide range of biological activities, including inhibitory effect against gram-positive bacteria. This study was conducted to investigate the effects of CNSL (73.3% cardanol, 16.4% cardol, and 3.0% metilcardol) on DMI, milk yield and composition, rumen fermentation and CH_4 and CO_2 production, and nutrient digestibility in dairy cows. Eight multiparous Holstein cows (DIM, 140 ± 14 d; BW, 669 ± 47.8 kg) were used in a crossover design trial with two, 21-d periods. The TMR was based on corn silage and alfalfa haylage, and was formulated to meet or exceed the NE_L and metabolizable protein requirements of the cows (NRC, 2001). The diet contained (DM basis): 15.5% CP, 32.0% NDF, and 1.53 Mcal/kg NE_L. Treatments were: control (no CNSL supplementation), or 30 g/cow/d CNSL. The daily dose of CNSL was mixed with about 2 kg of TMR and top-dressed. Dry matter intake (average 26.6 ± 1.0 kg/d), 3.5% FCM (38.8 ± 1.6 kg/d), and milk composition (fat 3.32 ± 0.28% and true protein 3.09 ± 0.05%) were not affected by CNSL. Milk yield was numerically increased ($P = 0.13$) by CNSL (40.9 kg/d) compared with the control (39.0 kg/d). Rumen CO_2 production, measured using GreenFeed (C-Lock Inc., Rapid City, SD), was

not affected by CNSL. Compared with the control, CNSL numerically decreased (P = 0.12) rumen CH_4 production (534 vs. 505 ± 39.6 g/cow/d, respectively) and CH_4 emission intensity (P = 0.16; 13.3 vs. 12.3 ± 1.05 g/kg milk) and tended to decrease (P = 0.08) CH_4 production per kg of DMI (20.3 vs. 19.1 ± 0.83 g/kg). CNSL did not affect total tract apparent digestibility of nutrients, except NDF digestibility tended to be increased compared with the control (P = 0.09; 36.8 vs. 34.2 ± 1.47%, respectively). Total urinary N, urea N, and urinary purine derivatives excretions were not affected by treatment. MUN concentration was numerically increased (P < 0.13) in cows receiving CNSL (8.57 vs. 7.50 ± 0.62 mg/dL, respectively). Plasma urea and glucose concentrations were not affected by CNSL. In this study, CNSL tended to decrease rumen CH_4production per kg DMI and numerically increased milk yield without affecting DMI in dairy cows.

Key Words: cashew nut shell liquid, methane, dairy cow

1752 (T365) Metabolism of dairy cows as affected by dietary starch level and supplementation with monensin during early lactation. M. M. McCarthy*[1], T. Yasui[1], C. M. Ryan[1], S. H. Pelton[1], G. D. Mechor[2] and T. R. Overton[1], *[1]Cornell University, Department of Animal Science, Ithaca, NY, [2]Elanco Animal Health, Greenfield, IN*

The objective of this study was to evaluate the impact of dietary starch level and monensin (M) on metabolism of dairy cows during early lactation. Primiparous (n = 21) and multiparous (n = 49) Holstein cows were fed high starch (HS; 26.2% starch, 34.3% NDF, 22.7% ADF, 15.5% CP) or low starch (LS; 21.5% starch, 36.9% NDF, 25.2% ADF, 15.4% CP) TMR beginning at parturition until 21 DIM with a topdress pellet containing 0 or 450 mg/d M in a completely randomized design with a 2 × 2 factorial arrangement of treatments. Prior to parturition all cows were fed a common controlled energy diet with daily topdress of either 0 or 400 mg/d M consistent with postpartum treatment. Postpartum blood samples were collected 3× per wk and liver biopsies were taken on d 7 ± 4. Cows fed HS had higher plasma glucose (57.5 vs. 53.9 mg/dL; P = 0.003) and insulin (0.26 vs. 0.19 ng/mL; P = 0.008), and lower NEFA (533.1 vs. 696.6 μEq/L; P = 0.002) than cows fed LS. Cows fed LS had elevated BHBA during 11 to 21 DIM compared to cows fed HS (starch × d; P = 0.04). There was no effect of M on postpartum plasma NEFA. Cows fed M had higher plasma glucose compared to controls (58.1 vs. 53.3 mg/dL; P < 0.001) which was driven by a M × parity interaction in which heifers fed M had greater plasma glucose concentrations than controls (62.0 vs. 54.2 mg/dL; P = 0.008). Cows fed M had lower plasma BHBA compared to controls (10.08 vs. 12.66 mg/dL) which was contributed to by a M × parity interaction in which heifers fed M had lower BHBA concentrations than controls (10.11 vs. 13.99 mg/dL; P = 0.03). There was no effect of starch treatment on overall liver triglyceride content. Heifers fed M had increased liver triglyceride content compared to control heifers and cows fed M had decreased liver triglyceride content compared to control cows (M × parity; P = 0.05). Cows fed LS with M had higher liver glycogen content than cows fed the LS without M, with no effect of M treatment for cows fed HS (starch × M; P = 0.008). Overall, animals fed HS postpartum and M throughout the transition period exhibited improvements in energy metabolism during early lactation.

Key Words: starch, monensin, metabolism

1753 (T366) Effect of dietary monensin supplementation and amino acid balancing on lactation performance by dairy cows. A. L. Hagen*[1,2], L. F. Ferraretto[1], R. D. Shaver[1] and R. Martin[2], *[1]University of Wisconsin, Madison, [2]Vita Plus Corporation, Madison, WI*

A continuous-lactation experiment was conducted to evaluate the effect of dietary monensin supplementation and amino acid balancing (Lysine and Methionine) on milk yield, composition, component yields, and feed conversions (kg actual or component-corrected milk/kg DMI). Multiparous (n = 96) and primiparous (n = 32) Holstein (n = 112) and Holstein × Jersey cross-bred (n = 16) cows were stratified by breed, parity, and DIM (104 ± 39 at trial initiation) and randomly assigned to 16 pens of 8 cows each. Pens were randomly assigned to 1 of 4 treatments in a 2 × 2 factorial arrangement of treatments: control (CN; no monensin or amino acid balancing), amino acid balanced (AA), CN plus monensin (CNMN), or AA plus monensin (AAMN) for a 2-wk covariate period with cows fed a common non-experimental diet followed by a 10-wk treatment period with cows fed their assigned treatment diet. The TMR contained on average (DM basis) corn silage (37.5%), alfalfa silage (23%), and concentrate mixture (39.5%). The AA and AAMN treatments were supplemented with blood meal and a ruminally-protected Methionine source (Ultramet, Vita Plus Corp.; contains MetaSmart, Adisseo) to achieve a 3:1 Lysine:Methionine ratio in the metabolizable protein. The MN and AAMN treatments were formulated using Rumensin 90 (Elanco Animal Health) to provide a monensin intake of 540 mg/cow/d. Data were analyzed using Proc Mixed in SAS with covariate, monensin, amino acids, monensin x amino acids, week, and treatment x week interactions as Fixed effects and pen within treatment as a Random effect. DMI was reduced by monensin (26.6 vs 28.1 kg/d; P < 0.01). Milk yield was unaffected (P > 0.10) by treatment. Actual milk feed conversion was greater for cows fed monensin (1.82 vs. 1.73 kg milk/kg DMI; P = 0.03). Milk protein percentage and yield were increased by amino acids (3.16% vs. 3.09% [P < 0.01] and 1.53 vs. 1.50 kg/d [P = 0.03]), respectively. Component-corrected feed conversions were greater (P < 0.05) for cows fed diets containing monensin. Monensin × amino

acid interactions were not ($P > 0.10$) detected for any of the parameters measured. Dietary monensin supplementation increased feed conversions, while milk protein percentage and yield were greater for cows fed the amino acid balanced diets.

Key Words: monensin, amino acids, dairy cows

1754 (T367) Effects of beta-extract of *Humulus lupulus* (hops) on fermentation by rumen microbes in continuous culture. S. W. Fessenden*, I. J. Salfer and M. D. Stern, *University of Minnesota, Saint Paul*

Beta-acids in hops (*Humulus lupulus*) have been shown to exhibit selective bacteriostatic properties toward Gram-positive and hyper-ammonia producing bacteria in pure and co-culture. Previous work with whole or ground hops in batch culture fermentations with rumen microbes demonstrated promising results toward altering microbial output, however confounding factors such as additional fermentable substrate and presence of condensed tannins in hops can be difficult to control. Use of hop beta-acid extract can eliminate major confounding factors and improve consistency of administration. The objective of this experiment was to evaluate effects of beta-acid extract from hops on microbial fermentation in continuous culture. Eight dual-flow continuous culture fermenters were used in two consecutive 10-d periods consisting of 7 d of adaptation followed by 3 d of sampling. A basal diet containing 44% corn silage, 14% alfalfa hay, 13% ground corn, 11% protein mix, 10% corn gluten feed, 5% cottonseed, and 3% liquid vitamin and mineral supplement on a DM basis was provided to the fermenters at a rate of 75 g of DM/L of fermenter volume/d. Hop beta-extract (BE) was added daily to the artificial saliva to supply 0, 600, 1200, or 1800 mg of β-acids/kg of diet DM/day. Effluents from sampling days were composited by fermenter within period, resulting in 4 reps/treatment. Beta extract inclusion had no effects on DM, OM or fiber digestion ($P > 0.05$). Volatile fatty acid production and N metabolism were not affected by BE inclusion ($P > 0.05$). Mean and maximum fermentation pH tended ($P = 0.09$) to increase linearly with increasing levels of BE inclusion. Time spent above pH 6.2 tended to increase linearly with greater BE inclusion ($P = 0.08$), while time spent between pH 5.8 and 6.2 tended to decrease linearly ($P = 0.07$). Changes in pH were less than biologically relevant levels. Increasing concentration of BE had very limited effects on fermentation measurements by rumen microbes using continuous culture fermenters.

Key Words: continuous culture, hops, beta-acids, rumen

1755 (T368) Evaluation of Celmanax SCP on lactational performance and ruminal fermentation of Holstein dairy cows fed corn silage based diets with a moderate starch content. H. M. Dann*[1], P. Ji[1], K. W. Cotanch[1], C. S. Ballard[1], R. J. Grant[1] and C. C. Elrod[2], *[1]William H. Miner Agricultural Research Institute, Chazy, NY, [2]Vi-COR, Inc., Mason City, IA*

Primiparous ($n = 21$) and multiparous ($n = 39$) Holstein cows averaging 123 ± 28 (SD) days in milk were used in a randomized complete block design (RCBD) study to evaluate the effect of supplemental yeast culture plus enzymatically hydrolyzed yeast cell wall (Celmanax SCP; Vi-COR, Mason, City, IA) on lactational performance and ruminal fermentation. Following a 2-wk covariate period with a yeast-free diet, cows (20/treatment) were fed a diet supplemented with 0, 3, or 5 g of Celmanax SCP per day for a 4-wk treatment period. The diet contained 30.8% bmr corn silage, 16.2% corn silage, 9.7% haycrop silage, and 43.3% concentrates with a nutrient content of 16.5% crude protein, 36.3% neutral detergent fiber, and 24.3% starch. Cows were fed individually, housed in freestalls, and milked 3× daily. Dry matter intake (DMI) and milk yield were measured daily and milk composition was measured weekly. Fifteen ruminally cannulated cows (5/treatment) were sampled during the last week of the covariate and treatment periods for ruminal pH (72-h period) and volatile fatty acids (VFA; 24-h period). Data from wk 3 and 4 of the treatment period were analyzed as a RCBD by ANOVA using the MIXED procedure of SAS. Least squares means were adjusted using data from the covariate period. On average, cows ate 27.3 kg DMI/d and produced 45.5 kg milk/d containing 3.88% fat and 3.21% true protein. There was a quadratic effect of supplementing Celmanax SCP on feed efficiency with feed efficiency highest at 3 g/d. Ruminal pH averaged 6.05 over a 24-h period with 308 min/d below 5.8. Celmanax SCP supplementation linearly increased the concentration of total VFA and acetate with no effect on propionate. Supplementation of Celmanax SCP improved feed efficiency potentially through changes in ruminal fermentation.

Key Words: yeast culture, dairy cow, lactational performance

Table 1755.

Item	0 g/d	3 g/d	5 g/d	SE	Linear *P*	Quadratic *P*
DMI, kg/d	27.4	27.1	27.4	0.2	0.87	0.20
Milk, kg/d	45.3	45.9	45.4	0.4	0.82	0.36
Solids-corrected milk, kg/d	44.8	45.4	44.6	0.6	0.80	0.33
Fat, %	3.88	3.90	3.86	0.05	0.78	0.54
True protein, %	3.23	3.20	3.20	0.02	0.35	0.69
Milk/DMI	1.66	1.70	1.66	0.01	0.82	0.01
SCM/DMI	1.64	1.69	1.63	0.02	0.87	< 0.01
Ruminal pH	6.11	6.02	6.03	0.08	0.38	0.70
Total VFA, m*M*	128.6	138.2	141.9	3.7	0.01	0.72
Acetate, m*M*	71.0	76.2	79.9	2.0	< 0.01	0.94
Propionate, m*M*	27.0	29.9	29.4	1.3	0.17	0.37

1756 (T369) Effects of *Bacillus subtilis* and yeast cell wall on diarrhea incidence and immune function of dairy calves. J. Freitas*, *University of Parana, Palotina, Brazil*

The effects of *Bacillus subtilis* spores and spray-dried yeast cell wall (YCW) on health of dairy calves in the first 60 d of age were evaluated using 30 animals in three treatments. In control treatment, dairy calves received 8 liter of milk/day, after the 2nd day of live and a 20% pellet ration fed "ad libtum", in treatment 2 the calves received the same ration of treatment 1 plus $3x10^9$ viable spores/calf/d of *Bacillus subtilis* (Calpis Co. Ltda, Tokyo, Japan), in treatment 3 it was offered treatment 2 + 4 g/calves/d of YCW (Alltech of Brazil, Brazil). The *Bacillus subtilis* spores and YCW were mixed with milk and fed directly to the calves. The animals were housed in individual pens, with free access to water, starter feed and milk (give three times a day) until weaning that occurs on 9th week of life. Fecal consistency (FC) was scored as 1 when firm, 2 when soft or of moderate consistency, 3 when runny or mild diarrhea, and 4 when watery and profuse diarrhea. The FC 1 and 2 were considered no diarrhea. The supplementation with *Bacillus subtilis* tended ($P = 0.08$) to increased number of calves without diarrhea (Table 1756). Dairy calves feeding with probiotic and YCW showed higher rectal temperature. However, there is no difference ($P > 0.05$) in the levels of serum *immunoglobulin* G (IgG). The use of *Bacillus subtilis* reduced diarrhea incidence of pre-weaning calves without effects on serum immunoglobulin levels.

Key Words: dairy calves, probiotic, immune function

Table 1756.

	Control	*B. subtilis*	*B. subtilis* +EPL	SEM	*P* Treat
RT mean[1]	38.71	38.75	38.87	0.039	0.02
RT % > = 39°C	26.58	28.44	36.81	3.7	0.14
FC < 3 (no diarrhea)[1]	25.3	33.20	27.80	-	0.08
FC < 3 (%)	61.76	75.22	68.61	-	0.34
IgG 20 d (mg mL^{-1})	25.50	21.00	24.38	-	0.51
Average IgG 20- 60 d (mg mL^{-1})	17.48	15.61	17.06	1.274	0.55
Weight weaning (kg)	77.55	81.60	78.20	3.102	0.61

[1] Rectal temperature, number of observation.

[2] Fecal consistency

1757 (T370) Effects of *Bacillus subtilis* and yeast cell wall on diarrhea incidence and immune function of dairy calves. J. A. Freitas*[1], V. Souza[2], J. C. De Souza[3], C. Nozawa[4] and P. Pinto[5], *[1]University of Parana, Palotina, Brazil, [2]University of Sao Paulo, Piracicaba, Brazil, [3]University of South of Mato Grosso, Aquidauana, Brazil, [4]University of Londrina, Londrina, Brazil, [5]University Federal of Parana, Palotina, Brazil*

The effects of *Bacillus subtilis* spores and spray-dried yeast cell wall (YCW) on heath of dairy calves in the first 60 d of age were evaluated using 30 animals in three treatments. In control treatment, dairy calves received 8 liter of milk/day and a 20% pellet ration, in treatment 2 calves received the same ration of treatment 1 plus $3x10^9$ viable spores/calf/d of *Bacillus subtilis* (Calpis Co. Ltda, Tokyo, Japan), in treatment 3 it was offered treatment 2 + 4 g/calves/d of YCW). *Bacillus subtilis* spores and YCW were mixed with milk and fed to calves. The animals were housed in individual pens, with free access to water, starter feed and milk (8 L, three times a day) until weaning. Fecal consistency (FC) was scored as 1 when firm, 2 when soft or moderate consistency, 3 when runny or mild diarrhea, and 4 when watery and profuse diarrhea. The FC 1 and 2 were considered no diarrhea. The supplementation with *Bacillus subtilis* tended ($P = 0.08$) to increased number of calves without diarrhea (Table 1757). Dairy calves feeding with probiotic and YCW showed higher rectal temperature. However, there is no difference ($P > 0.05$) in the levels of serum immunoglobulin G (IgG). The use of *Bacillus subtilis* reduced diarrhea incidence of pre-weaning calves without effects on serum immunoglobulin levels.

Key words: dairy calves, immune function, probiotic.

Table 1757. Rectal temperature (RT), feces consistence (FC), serum imunoglobulin at 20 day (mg mL^{-1}), average of serum IgG (20-60 day) and weaning weight (kg) for Holstein calves receiving B.subtilis and yeast

	Control	*B. subtilis*	*B. subtilis* +EPL	SEM	*P* Treat
RT mean[1]	38.71	38.75	38.87	0.039	0.02
RT % > = 39°C	26.58	28.44	36.81	3.7	0.14
FC < 3 (no diarrhea)[1]	25.3	33.2	27.8	-	0.08
FC < 3 (%)	61.76	75.22	68.61	-	0.34
IgG 20 d (mg mL^{-1})	25.5	21	24.38	-	0.51
Average IgG 20- 60 d (mg mL^{-1})	17.48	15.61	17.06	1.274	0.55
Weaning weight (kg)	77.55	81.6	78.2	3.102	0.61

1758 (T371) Effects of different doses of *Bacillus subtilis* Natto on in vitro rumen fermentation parameters.

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This experiment was conducted to investigate the effects of different doses (0 (contrl), 0.2×10^{11}cfu/ml (BSL),1×10^{11}cfu/ml (BSM), 5×10^{11}cfu/ml (BSH)) of *Bacillus subtilis Natto* culture (BSN) on rumen fermentation in vitro. Ruminal fluid was collected from three lactating Holstein dairy cows (BW = 558 ± 10 kg, DIM = 153 ± 16 d) fed diets contained (DM basis) Chinese wildrye (3.7%), Alfalfa hay (28.4%), Corn silage (26.7%), Corn (22.6%), Soybean meal (11.8%), Cottonseed fuzzy (5.1%), $CaHPO_4$ (0.6%), NaCl (0.5%), Premix (0.6%). Diets were mixed with phosphate buffer (1:2), incubated (90ml) anaerobically at 39°C for 0h, 12h, 24h, 36h and shaken at 50rpm. Each substrate (500mg DM basis) which had same concentrate mixture with donors was added to. Four sets of bottles were sealed anaerobically under CO_2 atmosphere with butyl rubber stoppers and capped with aluminum. One set (0h) were sampling immediately after mixed, other sets were incubated 12h, 24h, 36h respectively. Each set contained four levels of supplements, and for each level, three bottles were incubated. Statistical analysis was carried out by ANOVA (GLM) using SAS (SAS9.2). Medium pH was unaffected (P = 0.61) by BSN in all treatments, ammonia-N tended to increase linearly with increasing BSN dose ($P < 0.01$). Compared with the control, the molar proportion of acetate(46.66 vs 57.32, 60.96 and 68.17, $P < 0.01$), propionate (19.23 vs 22.88, 24.48 and 29.98 linear, $P < 0.01$), iso-butyrate (0.83 vs 2.18, 2.50 and 3.70, $P < 0.01$), iso-valerate (1.55 vs 4.50, 5.02 and 7.70, $P < 0.01$), valerate (1.52 vs 4.38, 5.04 and 6.89, $P < 0.01$) and total VFA (79.93 vs 102.77, 110.12 and 131.03, $P < 0.01$) was enhanced significantly with increasing concentrations of BSN. The molar proportion of butyrate of BSL treatment was increased ($P < 0.05$) and BSM and BSH treatment were increased significantly ($P < 0.01$). The molar proportion of acetate:propionate was increased ($P < 0.05$) in BSL and BSM treatment compared with control, however, decreased significantly in BSH treatment ($P < 0.01$). The results indicated that the *Bacillus subtilis Natto* culture can stimulated in vitro fermentation by increase the molar proportion of VFA and change the rumen fermentation type by change the molar proportion of acetate:propionate, and the diets should consist of a minimum of 10^{10}cfu/g (DM) of BSN to make sure it's effect.

Key Words: *Bacillus subtilis Natto*, in vitro, rumen fermentation

1759 (T372) An on-farm application of feed probiotics to increase total tract starch digestibility (TTSD) in high producing, lactating dairy cows.

W. L. Braman*, K. A. Bryan and J. E. Kurtz, *Chr. Hansen Animal Health and Nutrition, Milwaukee, WI*

With the increased cost of grains and forages in the USA, dairy producers have turned their attention to the feed efficiency of milk production. Two reviews of starch digestibility in lactating dairy cows have suggested that over 50% of TTSD takes place in the lower digestive tract. Low on-farm starch digestibility contributes to reduced feed efficiency. Several researchers have demonstrated that measuring fecal starch is highly correlated to TTSD in lactating dairy cows. Our previous studies using a dairy feed probiotic (Probios Complete, Chr. Hansen, Inc., Milwaukee, Wisconsin USA) demonstrated increases in TTSD, production performance, and feed efficiency in lactating dairy cows fed high starch + sugar diets (32% and 35%, respectively). To further validate this probiotic research, field trials were conducted to test a similar probiotic, Probios Precise containing 3 strains of *Enterococcus faecium* and live yeast, on fecal starch on farm. Total mixed ration and fecal samples were collected from the same pen at 30-d day intervals for 90 d on 10 commercial dairy farms averaging 2041 cows located in Wisconsin, Texas, New Mexico and Minnesota. Fresh floor fecal samples were collected from at least 20 cows per pen from cows less than 120 d-in-milk. Total mixed rations and fecal samples were analysed by Rock River Laboratories (Watertown, WI). Fecal components including starch (FS), protein, NDF, 120 h-indigestible NDF, fat, and ash (DM basis) were measured. Samples on d 0 were taken prior to adding Probios Precise to each herd's diet which averaged 23.7% starch (DM basis). Subsequent samples taken at 30, 60, and 90 d were analysed to measure the response from the probiotic treatment. The REG procedure of SAS was used to analyse the relationship between days fed Probios Precise and FS. As days fed the probiotic increased, there was a reduction in FS ($R^2 = 0.31$; $P < 0.001$; 5.41, 3.95, 3.09, and 3.04%, respectively for d 0, 30, 60, and 90 sampling times). These results suggest that feeding the probiotic decreased FS confirming earlier trials that indicated certain feed probiotics decreased FS and increased TTSD in early lactation dairy cows. Thus,

supplementing the dairy feed probiotics, Probios Complete and Probios Precise, can be a management tool to decrease FS, increase TTSD, with potential increase in feed efficiency.

Key Words: dairy, probiotics, starch

1760 (T373) Effect of feeding yeast culture (YC) on lactation performance of dairy cows fed diets differing in rumen fermentability. A. L. Dias*, R. A. Azevedo, J. A. Freitas, B. Micai, T. V. Silva, G. C. Gomes, E. S. Ribeiro, L. F. Greco, P. M. Leopoldo Junior and J. E. P. Santos, *Department of Animal Sciences, University of Florida, Gainesville*

Objectives were to evaluate the effect of feeding YC (*Saccharomyces cerevisiae*, Rumen Yeast, ICC, Brazil) on lactation performance of dairy cows fed diets with two concentrations of starch. Fifty-six Holstein cows at 42 d postpartum were blocked by parity and milk production and randomly assigned to 1 of 4 treatments, low starch no YC (22% starch and control; LSC), low starch and YC (22% starch and 15 g/d of YC; LSYC), high starch no YC (28% starch and control; HSC), and high starch with YC (28% starch and 15 g/d of YC; HSYC). The study lasted 13 weeks and milk yield, body weight, and dry matter intake were measured daily. Milk samples were collected weekly to determine concentrations of milk components and somatic cells. Data was analyzed by ANOVA for repeated measures using the MIXED procedure of SAS. Results are presented in Table 1760. Feeding high starch improved yields of milk and milk protein, whereas inclusion of YC improved yields of milk and all milk components regardless of starch in the diet.

Key Words: dairy cow, lactation, yeast culture.

Table 1760. Effect of YC and level of starch on lactation performance of dairy cows

	Treatment					*P*		
Variable	LSC	LSYC	HSC	HSYC	SEM	Starch	YC	Starch x YC
Milk yield, Kg/d	38.7	40.4	40.4	41.7	1.2	0.09	0.09	0.81
3.5% FCM, Kg/d	40.2	41.9	40.3	43.3	1.3	0.57	0.05	0.62
Milk fat, %	3.90	3.84	3.64	3.82	0.09	0.10	0.49	0.17
Fat yield, Kg/d	1.47	1.53	1.43	1.57	0.05	0.96	0.05	0.41
Milk protein, %	2.90	2.84	2.97	3.04	0.05	0.01	0.95	0.12
Protein yield, Kg/d	1.09	1.12	1.16	1.24	0.03	0.01	0.04	0.40
Milk NE_L, Mcal/d	27.2	28.2	27.5	29.4	0.9	0.28	0.04	0.51
Body condition	2.85	3.00	2.89	2.92	0.05	0.70	0.06	0.21

LSC: low starch and no YC; LSYC: low starch and YC; HSC: high starch and no YC; HSYC: high starch and YC.

1761 (T374) Milk fatty acid profile in cows fed red clover or alfalfa based diets differing in rumen-degradable protein supply. M. Leduc*[1], P. Y. Chouinard[1], R. Gervais[1], E. Baumann[1], Y. Lebeuf[1] and G. Tremblay[2], *[1]Université Laval, Québec, QC, Canada, [2]Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Quebec, QC, Canada*

Polyphenol oxidase in red clover silage (RCS) has been shown to reduce lipolysis and consequently protect its constituent fatty acid (FA) against biohydrogenation by ruminal microorganisms. Fatty acid biohydrogenation could be further inhibited by reducing the supply of nitrogen to ruminal bacteria. To compare the effects of RCS and alfalfa silage (AS) fed in diets differing in rumen-degraded protein (RDP) supply on milk FA profile, 8 multiparous Holstein dairy cows (72 ± 17 DIM) were used in a replicated 4×4 Latin square design (21-d periods, 14-d adaptation). Four treatments were compared in a 2×2 factorial arrangement with AS or RCS fed in diets formulated to provide 85% (RDP85) or 100% (RDP100) of calculated RDP requirements. Untreated and heat-treated (AminoPlus) soybean meals were used to adjust dietary RDP. No significant interaction of silage by RDP was observed on milk FA profile ($P > 0.05$). As compared with AS, feeding RCS increased ($P < 0.01$) c9c12c15-18:3 (6.89 vs. 4.26 mg/g fat) and c9c12-18:2 (18.64 vs. 16.50mg/g), but decreased ($P < 0.01$) t11-18:1 (5.87 vs. 6.75 mg/g; $P < 0.01$) and t11c15-18:2 (0.63 vs. 0.82 mg/g) concentrations in milk fat. As compared with AS, feeding RCS increased ($P < 0.03$) milk fat content of iso 13:0 (0.23 vs. 0.21 mg/g), iso 14:0 (1.23 vs. 0.89 mg/g), iso 15:0 (1.46 vs. 1.22 mg/g), iso 16:0 (2.25 vs. 1.84 mg/g), iso 17:0 (1.90 vs. 1.77 mg/g), anteiso 15:0 (4.01 vs. 3.57 mg/g), and anteiso 17:0 (3.58 vs. 3.10 mg/g), but decreased ($P < 0.01$) milk fat content of 11:0 (0.60 vs. 1.32 mg/g), 13:0 (0.98 vs. 1.83 mg/g), 15:0 (10.64 vs. 15.77 mg/g), 17:0 (4.99 vs. 5.87 mg/g), and c9-17:1 (1.65 vs. 2.05 mg/g). The supply of RDP had only minor effects on milk FA with higher concentrations ($P < 0.01$) of iso 13:0, iso 15:0, and iso 17:0 observed with RDP100 (0.23, 1.41, 1.91 mg/g, respectively) as compared with RDP85 (0.21, 1.28, 1.76 mg/g, respectively). In conclusion, cows fed RCS as compared with those fed AS produced milk with greater concentrations of major forage FA (i.e. c9c12c15-18:3 and c9c12-18:2) and lower proportions of intermediates (i.e. t11-18:1 and t11c15-18:2) that are produced during the ruminal biohydrogenation of these FA. Variations in milk fat concentrations of odd and branched chain FA, which are known to be synthesized in the rumen by various microbial populations, may reflect the effect of forage legume species on ruminal fermentation.

Key Words: biohydrogenation, odd and branched chain fatty acids, polyphenol oxidase

1762 (T375) Use of virginiamycin and monensin sodium in diets of confined beef steers. F. R. Camilo[1], A. M. Mobiglia[1], R. K. Grizotto[2], J. A. Alves Neto[3], M. Q. Manella[4], F. D. D. Resende[2], G. R. Siqueira[2] and J. J. R. Fernandes[*5], *[1]Escola de Veterinária e Zootecnia da UFG, Goiânia, Brazil, [2]APTA-Agência Paulista de Tecnologia dos Agronegócios, Colina, Brazil, [3]Universidade Estadual Paulista, Jaboticabal, Brazil, [4]Phibro Animal Health Corporation, Guarulhos, Brazil, [5]Universidade Federal de Goiás, Goiânia, Brazil*

Feed additives are used as tool of nutrition management to enable the supply of high concentrate diets. The association of antibiotics may improve the response of ruminal fermentation manipulation and increase performance. The objective of this study was to evaluate the isolated and combined effects of the virginiamycin (VM) and monensin sodium (MON) in diets of crossbreed steers in feedlot. The animals were kept in feedlot in group pens for 105-d with a 28-d adaptation period. Three hundred and thirty nine 1/2Nellore x 1/2 Guzera beef steers (402.7 ± 1.3 kg of initial BW) were used in a randomized complete block design with 5 treatments and 7 replicates. The blocks were defined by initial BW. Treatments were defined by levels of VM and MON (mg/kg of dry matter) as follows: 30MON; 15VM+30MON; 25VM+30MON; 34VM+ 30MON e 34VM. Animals were fed < *i* > ad libitum < /*i* > twice daily with isonitrogenous and isoenergetic diets, with a 88:12 concentrate:forage (sugarcane bagasse) ratio. Steers were weighed at the beginning, after the adaptation period and at the end of the trial. Data are shown in Table 1762. Dry matter intake (DMI), final BW and average daily gain (ADG) were not affected ($P > 0.05$) by treatments. However, effects ($P < 0.05$) were observed on DMI for percentage of body weight (BW) between 34VM and 25VM + 30 MON, with lower DMI/BW (%) for the intermediate association. The treatment 30 MON showed higher feed efficiency (FE) than 34VM. In conclusion, the MON showed higher FE in relation to VM, however, no effects were observed on treatments with different association levels of feed additives. Supported by Phibro/Minerva/FAPEG.

Key Words: feed additives, feedlot, performance

Table 1762. Performance of beef steers fed with different levels of feed additives

	Treatments					
Variables	30MON	15VM+ 30MON	25VM+ 30MON	34VM+ 30MON	34VM	SEM
Initial BW (kg)	402.7	401.2	402.7	402.4	404.6	1.3
Final BW (kg)	569.2	560.2	563.0	565.3	564.1	3.3
DMI (kg/day)	10.6	10.4	10.4	10.6	10.7	0.1
DMI/BW (%)	2.19^{ab}	2.17^{ab}	2.15^{b}	2.20^{ab}	2.22^{a}	0.02
ADG (kg/day)	1.602	1.527	1.541	1.564	1.531	0.031
FE	0.150^{a}	0.146^{ab}	0.148^{ab}	0.147^{ab}	0.143^{b}	0.002

Different superscripts indicate differences among treatments by t test at 5% of probability

1763 (T376) GLOBAL NETWORK for the development of nutrition-related strategies for mitigation of methane and nitrous oxide emissions from ruminant livestock. A. N. Hristov[*1], E. Kebreab[2], Z. T. Yu[3], C. Martin[4], M. Eugène[4], D. R. Yáñez–Ruiz[5], K. J. Shingfield[6], S. Ahvenjärvi[6], P. O'Kiely[7], C. K. Reynolds[8], K. J. Hammond[8], J. Dijkstra[9], A. Bannink[10], A. Schwarm[11] and M. Kreuzer[12], *[1]Department of Animal Science, The Pennsylvania State University, University Park, [2]University of California, Davis, Davis, [3]The Ohio State University, Columbus, [4]INRA, Clermont-Ferrand, France, [5]Estacion Experimental del Zaidin, CSIC, Granada, Spain, [6]MTT Agrifood Research, Animal Production Research, Jokioinen, Finland, [7]7Animal and Grassland Research and Innovation Centre, Teagasc, Dunsany, Ireland, [8]University of Reading, Reading, United Kingdom, [9]Animal Nutrition Group, Wageningen University, Wageningen, Netherlands, [10]Animal Nutrition, Wageningen UR Livestock Research, Lelystad, Netherlands, [11]ETH Zurich, Institute of Agricultural Sciences, Zurich, Switzerland, [12]ETH Zurich, Zurich, Switzerland*

Ruminant husbandry is a major source of anthropogenic greenhouse gases (GHG). There is a large body of existing nutrition-related GHG and ammonia (NH_3) mitigation data that are not well organized. The main objective of the GLOBAL NETWORK consortium, a 4-yr project funded through The Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI), is to accumulate and analyze ruminant GHG mitigation data. The specific goals of this collaborative project are to: (1) Create, update, and expand animal and feed databases for the mitigation of enteric methane (CH_4); (2) Gain understanding of the contribution of genetic and microbial factors to the variation in enteric CH_4 production, digestion, and nutrient utilization; (3) Validate markers of enteric methanogenesis for the development and monitoring of CH_4 mitigation strategies in ruminants; (4) Create, update, and expand a database of mitigation strategies aimed at improving dietary N utilization and lowering N excretion and decreasing NH_3 and nitrous oxide (N_2O) emissions from manure; (5) Develop Standard Operating Procedures (SOP) and guidelines for conducting and assessing data from in vitro and in vivo studies designed to evaluate nutritional strategies for mitigation of CH_4, NH_3, and N_2O emissions; (6) Develop new and evaluate existing models for predicting CH_4 emission and N excretions under various nutritional, animal, and farm management scenarios; and (7) Identify and recommend CH_4, NH_3, and N_2O mitigation technologies that are both practical and feasible for implementation in various ruminant livestock production systems. These activities will be integrated with those of the "Network and Database on Feed and Nutrition in Relation to GHG Emissions" (FNN; http://animalscience.

psu.edu/fnn), which is an activity of the Livestock Research Group (LRG) of the Global Research Alliance (GRA) on Agricultural GHG. The newly created GLOBAL NETWORK consortium intends to fill important knowledge gaps and provide the much needed expert recommendations for future research priorities, methodologies, and science-based GHG mitigation solutions to governments and non-governmental organizations, advisory/extension networks, and the ruminant livestock sector. Animal scientists with an interest in GHG mitigation research are encouraged to contact members of the consortium to identify areas and opportunities for future collaboration and contribution of data.

Key Words: livestock, greenhouse gas, mitigation, database

1764 (T377) Effect of oat grain variety on methane emissions from mature sheep.

J. M. Moorby*, H. R. Fleming and S. A. Cowan, *Aberystwyth University, Aberystwyth, United Kingdom*

Methane emissions from ruminants are driven by DM intake and feeds characteristics such as oil concentration and OM fermentability; an oat breeding program at Aberystwyth aims to breed new varieties for livestock feeding that help reduce pollutant emissions by manipulating nutritional characteristics. To study the effect of feeding different varieties of oat grains on enteric methane emissions from sheep, eight mature barren ewes, four each of two breeds (Welsh Mountain and Welsh Mule; mean LW 41.5 ± 1.93 and 64.9 ± 1.46 kg respectively) were fed diets comprising ryegrass silage and oats in a 1:1 ratio (on a DM basis) in a Latin square changeover design experiment. Feed was offered at rates (i.e. restricted) designed to supply ME requirements for maintenance (according to AFRC 1992 guidelines). The same grass silage was used throughout, fed with 1 of 4 oat grain treatments: A) a husked oat, cv Balado, B) a naked oat, cv Racoon, C) a new breeding line husked oat, NewLine, and D) a 1:1 (fresh) mix of B and C, Mix. Each of the 4 periods of the experiment consisted of 14 days for diet adaptation and 6 days for measurements of feed intake, whole tract apparent diet DM digestibility, and methane emission. Methane emissions were measured for each animal for 3 days in open-circuit respirations chambers. There were no significant sheep breed effects on measurements except for LW and therefore DMI (grand mean 637 g/d). There were significant effects of oat variety on methane emissions, both in g/d and when expressed in relation to intake and metabolic LW. Differences in methane emissions from the sheep are likely to be related to differences in fiber and oil concentrations of the oat grains. In conclusion, the Mix treatment composition is a good breeding target for new varieties of oats.

Key Words: sheep, oats, methane

Table 1764.

	Oat treatment					
	Balado	Racoon	New-Line	Mix	SED	*P*
Oat CP, % DM	10.5	10.5	10.9	10.7	-	
Oat NDF, % DM	23.1	6.1	9.5	6.0	-	
Oat total oil, % DM	5.6	10.2	4.9	7.5	-	
CH_4, g/d	15.2[a]	14.7[a]	17.2[b]	14.7[a]	0.60	0.002
CH_4/DMI, g/kg	24.1[ab]	23.0[a]	26.9[b]	23.9[a]	0.96	0.003
CH_4/dig. DMI, g/kg	3.11[ab]	2.88[a]	3.45[b]	2.85[a]	0.227	0.001
$CH_4/LW^{0.75}$, g/kg	0.78[a]	0.74[a]	0.88[b]	0.75[a]	0.031	0.002
CH_4E/GE intake, %	7.3[ab]	6.9[a]	8.1[b]	6.9[a]	0.29	0.003

Values in rows with different superscripts differed significantly, $P < 0.05$.

1765 (T378) Effect of acetate, propionate and pH on aqueous concentration and gaseous methane and hydrogen production in continuous culture.

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Four continuous culture fermenters were used to determine the effect of varying volatile fatty acid concentrations and pH on hydrogen and methane production. The experiment constituted 4 treatments applied in 4 periods. Treatments were: control, 20 mmol/d acetate infusion (INFAC), 7 mmol/d propionate infusion (INFPR), and low pH (LOWPH). In LOWPH buffer flow was adjusted to lower pH by 0.5 units compared to control. The fermenters were fed 40 g of a pelleted 50:50 alfalfa: concentrate diet once daily. One week of adjustment occurred each period before sampling. Filtered liquid effluent (20 ml) from the fermenters was sampled at 0, 2, 4, 6, 8, 12, 16, and 22 h after feeding for measurement of aqueous hydrogen and methane concentrations. Daily cumulative gas production and hourly production rate were analyzed for headspace methane and hydrogen. The effects of treatments are shown in Table 1765. Headspace methane production was lower ($P < 0.05$) in LOWPH compared to other treatments. Methane production rate in LOWPH was lower ($P < 0.05$) than other treatments from 2 to 9 h, and was lower ($P < 0.05$) compared to INFAC and INFPR at 10 h. Aqueous methane concentrations were higher ($P < 0.05$) in LOWPH compared to control and INFAC, whereas in INFPR it was higher than control ($P < 0.05$). The differences were significant ($P < 0.05$) at 16 h. Headspace hydrogen production was higher in INFAC, followed by INFPR and control, and LOWPH ($P < 0.05$). Production rate of headspace hydrogen from INFAC was higher ($P < 0.05$) than others from 2 to 7 h. The effect of treatment on aqueous hydrogen concentration was not significant ($P > 0.05$). These results reveal that headspace methane and hydrogen was lowered by low pH, and acetate infusion increased the headspace hydrogen in a continuous culture. Aqueous hydrogen was unaffected

by the treatments, whereas aqueous methane was increased by low pH and propionate infusion.

Key Words: fermenter, hydrogen, methane

Table 1765. Effect of low pH, acetate infusion, and propionate infusion on gaseous production and aqueous concentration of methane and hydrogen in continuous culture

Gas production and concentration	Control	INFAC[1]	INFPR[2]	LOWPH[3]	SE	*P*-value
Aqueous methane (uM)	120[a]	130[a,b]	176[b,c]	187[c]	18	0.02
Headspace methane (umol/d)	9775[a]	11266[a]	9998[a]	5823[b]	2220	< 0.001
Aqueous hydrogen (uM)	2.25	1.74	2.01	1.47	0.31	0.35
Headspace hydrogen (umol/d)	65.6[a]	142.6[b]	76.9[a,c]	18.8[d]	29.7	< 0.001

[1] INFAC: Acetate infusion (20mmol/d).

[2] INFPR: Propionate infusion (7mmol/d).

[3] LOWPH: buffer adjusted to lower pH by 0.5 units.

1766 (T379) Ruminal parameters of confined steers fed with diets containing virginiamycin and monensin sodium. F. R. Camilo[1], A. M. Mobiglia[1], G. F. Berti[2], N. M. Jerônimo[2], R. K. Grizotto[3], M. Q. Manella[4], F. D. D. Resende[3], G. R. Siqueira[3] and J. J. R. Fernandes[*5], *[1]Escola de Veterinária e Zootecnia da UFG, Goiânia, Brazil, [2]Centro Universitário da Fundação Educacional de Barretos-Unifeb, Barretos, Brazil, [3]APTA- Agência Paulista de Tecnologia dos Agronegócios, Colina, Brazil, [4]Phibro Animal Health Corporation, Guarulhos, Brazil, [5]Universidade Federal de Goiás, Goiânia, Brazil*

Ionophore and non-ionophore antibiotics are known for their abilility to manipulate rumen fermentation and increase efficiency of high concentrate diets. The aim of this trial was to evaluate the effects on ruminal parameters of confined Nellore steers fed with diets using isolated and combined levels of virginiamycin (VM) and monensin sodium (MON). Fifteen Nellore steers (536 kg of BW) with ruminal cannula were used in a randomized complete block design with five treatments and three replicates. The blocks were defined by initial BW. The animals were kept in feedlot in individual pens for 28-d. Ruminal ammoniacal nitrogen (NH_3–N), short-chain fatty acids (SCFA) and ruminal fluid pH were measured before feeding (T0) and 6 and 12 hours after feeding (T6 and T12, respectively). Treatments were defined by levels of VM and MON (mg/kg of dry matter) as follows: 30MON; 15VM+30MON; 25VM+30MON; 34VM+ 30MON and 34VM. Animals were fed ad libitum twice daily with isonitrogenous and isoenergetic diets, with a 88:12 concentrate:forage (sugarcane bagasse) ratio. Data are shown in Table 1767. There were not effects ($P > 0.05$) on NH_3–N concentration between treatments. However, pH and SCFA presented differences in T0 for the treatments, with lower SCFA concentration in 34VM+30MON than in 34VM. Acetate:propionate ratio (A:P) did not show differences ($P > 0.05$) between treatments. In conclusion, the different levels of isolated and combined associations of VM and MON did not affect pH, NH_3–N, SCFA and A:P ratio, except for pH and SCFA measured at T0, when we observed differences between treatments. *Supported by Phibro/Minerva/FAPEG.*

Key Words: feed additives, feedlot, ruminal fermentation

1767 (T380) Ruminal parameters of young Nellore bulls in a feedlot fed Yea-Sacc8417 live yeast, monensin and their combination. J. M. B. Benatti[1], N. M. Geronimo[2], J. A. Alves Neto[1], I. M. de Oliveira[*3], A. D. Moreira[1], C. L. Francisco[4], G. R. Siqueira[3] and F. D. D. Resende[3], *[1]Universidade Estadual Paulista, Jaboticabal, Brazil, [2]UNIFEB, Barretos, Brazil, [3]APTA- Agência Paulista de Tecnologia dos Agronegócios, Colina, Brazil, [4]Universidade Estadual Paulista- FMVZ, Botucatu, Brazil*

The objective of this study was to analyze the ruminal parameters of young Nellore bulls in a feedlot for 109 days. The treatments consisted of a control diet with monensin sodium (27.0 mg kg DM^{-1}), a diet with Yea-Sacc^{8417} live yeast (2.0 g $animal^{-1}$) and a diet with the two additives combined. Diets (10.00% sugarcane bagasse, 73.60% ground corn, 6.40% cottonseed, 6.40% soybean meal, 0.26% corn gluten, 0.79% urea and 2.55% mineral mix) varied only in the inclusion of additives. We used 16 non-castrated Nellore bulls (422.00 ± 80.26 kg) cannulated in the rumen. The experiment was arranged in a completely randomized blocks design (four replicates) as a function of the initial body weight. Data were analyzed by the MIXED procedure of SAS software and means were compared by Fisher's test at 10% significance. The animals were kept in individual pens and were considered the experimental unit. Dry matter intake (DMI) did not differ among the studied diets (9.6 kg DM day^{-1}), and neither did ($P > 0.10$) the digestibility of DM (65.8%). The rate of intake was also not affected ($P > 0.10$) by inclusion of additives, and 90.4% was consumed in the first 12 hours after the 1st feed. Monensin sodium increased ($P = 0.0150$) the selectivity for concentrate (0.8% more concentrate) as compared with the other diets (0.3% more concentrate). Live yeast, alone or combined with monensin, elevated ($P = 0.0420$) the acetate content in the rumen (58.15%) in relation to control diet and the treatment of monensin alone (56.97%). Monensin not combined with yeast reduced ($P = 0.0373$) the acetate-to-propionate ratio in the rumen (1.79) over the other diets (2.05). When supplied separately, the additives monensin sodium and live yeast showed lower values ($P = 0.0345$) for the rumen pH (5.74 and 5.93 for monensin and yeast, respectively) compared with the other

diet (6.07). The combination of the additives live yeast and monensin sodium controlled ($P = 0.0376$) the decrease in the rumen pH 12 hours after the feed (6.08) as compared with the diet with these additives supplied alone. Sodium monensin not combined with live yeast increased ($P = 0.0367$) the daily fluctuations of rumen pH (0.19) in relation to the other treatments (0.10). The monensin reduces the acetate-to-propionate ration and yeast increase the acetate proportion. The use additives live yeast and monensin sodium combined has an additive effect on the rumen pH. *Supported by FAPESP and Alltech.*

Key Words: digestibility, intake, ruminal pH

Table 1767. Ruminal parameters of steers fed with diet containing different levels of feed additives

Treatments	30MON	15VM+-30MON	25VM+-30MON	34VM+-30MON	34VM	SEM
NH_3–N (mg/dL)						
T 0	16.16	16.71	14.96	14.97	17.11	1.1
T 6	16.51	18.23	16.27	19.13	20.80	2.8
T 12	18.46	21.32	19.45	19.03	21.72	3.1
SCFA (mM)						
T 0	105.27ac	113.08ab	97.72bc	93.45c	116.03a	5.6
T 12	148.98	138.60	135.03	139.37	140.74	7.1
A:P ratio						
T 0	3.34	3.48	3.10	3.46	4.03	0.3
T 12	3.30	3.27	3.22	3.58	4.04	0.3
Ruminal pH						
T 0	6.68ab	6.67ab	6.78a	6.85a	6.54b	0.1
T 6	5.94	6.24	6.24	6.23	6.08	0.1
T 12	5.67	5.80	5.88	5.91	5.81	0.1

Different superscripts indicate differences among treatments by t test at 5% of probability

1768 (T381) Optimal ration of combined origanum essential oils to reduce methane emissions under in vitro ruminal fermentation.

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Origanum (*Origanum vulgare*) essential oils (EO; thymol T and carvacol C) have been reported as potential anti-methanogenic additives for dairy cattle rations. An in vitro fermentation trial was conducted to determine the optimal T:C ratio (100:0, 80:20, 60:40, 40:60, 80:20 and 0:100) in an EO combined dose of 100 mg/L added to a total mixed ration (TMR; 65:35 concentrate:forage). The incubation was carried out in 60 mL flasks in triplicate for each T:C ratio and the control. The in vitro buffered solution was prepared anaerobically. Inside of anaerobic chamber 20 mL of buffered medium and 10 mL of rumen fluid were dispensed in each flask containing 200 mg of the ground substrate. The flasks were sealed with butyl rubbers and aluminum seals and incubated at 39 °C for 24 h with a constant shaking at 150 rpm. After 24h of incubation, gas production was recorded and sampled to determine its composition and 5mL of liquid content were taken from each flask and preserve with metaphosphoric acid to determine VFA. Gas composition and VFA concentration were determined by chromatography. Dry matter digestibility (IVDMD) was determined by the DAISY procedure. Data were analyzed by PROC GLM of SAS (SAS, 1992) by a complete randomized design considering the EO ratio as sole effect. Adding EO to the ration did reduce total gas production ($P < 0.0001$) in all C:T ratios (Table 1768). Also, methane production was decreased ($P < 0.05$) by the EO in all treatments. However, the 80:20 T:C ratio showed the greatest reduction ($P < 0.0001$). Total VFA concentration and IVDMA was not affected ($P > 0.70$ and 0.93, respectively) by EO addition. The molar proportion of acetate was decreased by the 60:40 T:C ratio. These results suggest that 80:20 T:C ratio has the best potential to decrease methane emissions of dairy cattle without DM digestibility decreases.

Key Words: thymol, carvacrol, methane

Table 1768.

Treatment (T:C ratio)	GAS (ml/200 mg DM)	Reduction (%)	Methane (ml/200 mg DM)	Reduction (%)
Control	36	–	7.55	–
100:0	32	11	6.48	14
80:20	28	22	5.84	23
60:40	32	11	6.73	11
40:60	35	3	7.29	3
20:80	30	17	6.40	15
0:100	32	11	6.51	14

1769 (T382) Effect of phytogenic feed additives on performance parameters and health of bull calves under commercial conditions.

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The increased emphasis on achieving a good health status for adequate growth rates in calves and the ban on sub-therapeutic antibiotics in the European Union in 2006 have resulted in growing interest in alternative feeding strategies. Phytogenic feed additives (PFA) exert strong anti-inflammatory, anti-oxidative and anti-microbial activities, and all of which offer potential benefits for improving performance and preventing intestinal disorders. The aim of the study was to evaluate the efficacy of PFA on growth performance, feed-to-gain ratio and number of medical treatments in commercial calves. During the trial period of 56 days, 53 calves with an average initial body weight of 93.2 kg were assigned to either the control ($n = 26$) or treatment group ($n = 27$) based on their initial body weight and breed (Simmental and Belgian Blue). Calves were housed in groups (1 pen/group) and were fed

twice a day receiving calf milk replacer (CMR), calf starter (CS), corn silage, hay and a concentrate mixture consisting of corn, cereals, soybean and rapeseed meal. Control calves received a standard non-medicated CMR and CS. Experimental calves received CMR and CS supplemented with two different mixtures of PFA including herbs, spices and plant extracts [Digestarom Milk in CMR (500 g/t) and Digestarom Calf in CS (300 g/t), BIOMIN Phytogenics GmbH, Stadtoldendorf, Germany]. Feeding CMR was restricted during the first 3 wk, whereas CS was offered ad libitum. Calves were weighed individually on d 1, 21, 42 and 56. Feed intake was determined per group on a weekly basis. Medical treatments were recorded throughout the trial. Data for body weight and weight gain was statistically analyzed with the independent *t* test using SPSS. Calves offered CMR and CS containing PFA were superior in average daily gain (1.33 vs. 1.23 kg; $P = 0.06$) and exhibited a higher average final body weight (168.1 vs. 161.2 kg; $P = 0.02$). Adding PFA resulted in a slightly increased average dry matter intake (2.46 vs. 2.41 kg) and improved feed efficiency (feed-to-gain ratio 1.86 vs. 1.97). Moreover, PFA supplementation positively influenced the health status of calves, as indicated by a reduced number of animals treated for health problems (fever and diarrhea). This led to reduced medication costs and higher farm profits. In conclusion, PFA supplementation in the CMR and CS is a suitable tool to improve growth rates and reduce medication costs in commercial beef calves.

Key Words: phytogenic feed additive, calves, performance

1770 (T383) Efficacy of *Propionibacterium* strains in mitigating methane emissions from beef heifers fed a high forage diet.

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The objective of this study was to test the efficacy of *Propionibacterium* strains to mitigate methane (CH_4) emissions in beef heifers fed a high forage diet. Sixteen ruminally cannulated beef heifers were used in a randomized complete block design with 21-d periods. Treatments included: 1) Control, 2) *Propionibacterium freudenreichii* T114, 3) *P. thoenii* T159, and 4) *P. freudenreichii* T54. Strains (10×10^{11} CFU) were administered daily directly into the rumen prior to feeding. All heifers were fed a basal diet consisting of 60:40 barley silage:barley grain. Environmental chambers were used for CH_4 measurements. No treatment effects were observed for overall DMI ($P = 0.76$) or DMI in chambers ($P = 0.67$). Mean ruminal pH averaged 6.17 and was not affected by treatments ($P = 0.62$). Likewise, both minimum and maximum ruminal pH were similar for all treatments ($P > 0.10$). No treatment differences were observed for total VFA ($P = 0.44$) or ammonia-N concentration ($P = 0.79$). However, proportions of individual VFA changed with acetate being reduced with *Propionibacterium* T159 (61.1 vs 63.8; $P = 0.02$), whereas ruminal isobutyrate (1.18 vs 1.00; $P < 0.01$) and acetate:propionate ratio (3.95 vs 3.40; $P = 0.04$) were greater with *Propionibacterium* T114, relative to the Control. Total daily enteric CH_4 production averaged 188 g/d and was not affected by *Propionibacterium* strains ($P = 0.57$). Enteric CH_4 emission intensity averaged 22 g/kg of DMI and was numerically greater with *Propionibacterium* T114; however, treatment effects were not significant ($P = 0.19$). In conclusion, *Propionibacterium* strains, T159 and T54, did not affect total enteric CH_4 production possibly due to their inability to increase ruminal propionate concentrations. On the contrary, *Propionibacterium* T114 numerically increased CH_4 emission intensity and the effects could be attributed to greater acetate:propionate ratio observed with the inoculated strain.

Key Words: beef, methane, *Propionibacterium*

1771 (T384) Effect of a commercially probiotic on in vitro gas production of alfalfa hay and barley grain.

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Effect of addition of a commercial multi-strain probiotic (PrimaLac, Star Labs, St. Joseph, MO) was studied on Kinetics of fermentation of alfalfa hay and barley grain using in vitro gas production technique. Thirty six ml of buffered rumen fluid (30% rumen fluid + 70% buffer solution) was added to 300 mg of either ground alfalfa hay or barley grain with or without 20 mg PrimaLac. Each sample was incubated in three replicates. The pressure of gas produced in each tube was recorded using a pressure transducer (Manometer Digital testo 512) in barley grain and alfalfa hay at 2, 4, 6, 8, 12, 18, 24 and 48h after the start of the incubation and at 2, 4, 6, 8, 12, 18, 24, 48, 72 and 96h after the start of the incubation, respectively. The data were subjected to analysis of variance using General Linear Model procedure of SAS (2003). Mean separation was performed by the T-tests. Potential gas production (ml/300 mg DM) significantly ($P < 0.05$) increased in alfalfa hay and barley grain (75.85 vs 73.66 and 131.30 vs 113.55 respectively) due to the addition of the probiotic. Rate of gas production in half life (ml/h), lag time (h) and half-life (h, at which half of the total gas production is produced) was affected by PrimaLac both in alfalfa and barley grain ($P < 0.05$) Also, total rate of gas production (b) was increased significantly ($P < 0.05$) in Alfalfa hay (0.0162 vs 0.0082), but was not significant in barley grain. From the result of this experiment it appears that addition of PrimaLac at the level used has a pronounce effect on the fermentation of hay and grains.

Key Words: probiotic, Primalac, alfalfa hay, barley, in vitro gas production

1772 (T385) *Lactobacillus brevis* YM 3-30, a γ-aminobutyric acid producing bacteria, decreases blood endotoxin level of Hanwoo cattle.

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This study was conducted to determine the effects and significance of *Lactobacillus brevis* YM 3-30, a γ-amino butyric acid (GABA) producing bacteria (GPB) on growth performance, meat quality and blood endotoxin level of Hanwoo cattle. Twenty seven Hanwoo steers (602.06 ± 10.13 kg) were subjected to a 129-day feeding trial and were fed daily with commercially available total mixed ration (TMR) supplemented with different inclusion rates of GABA produced by GPB: 3 g/kg (T1), 5 g/kg (T2) or non addition (Con) of GABA. The data gathered were gain in weight, feed conversion ratio (FCR), average daily gain (ADG), marbling score, and blood endotoxin. Hanwoo steers fed with GPB-produced GABA had superior weight performance than the control animals. Additionally, mean weight gains in T1 and T2 were 6.50 kg and 18.34 kg higher than those of the control, respectively, which resulted in higher ADG values in T1 (0.76 kg) and T2 (0.85 kg) than the control (0.71 kg). However, these differences were not statistically significant. The marbling score of meat from animals upon slaughter also did not differ significantly among treatments. However, animals in T1 and T2 had lower ($P < 0.05$) blood endotoxin levels of 17.23 and 16.42 EU/ml, respectively, than the control group at 29.23 EU/ml. Hanwoo cattle fed with GPB-produced GABA diet decreased the plasma endotoxin level and comparable ADG, FCR, and beef marbling scores upon slaughter.

Key Words: blood endotoxin, γ-amino butyric acid, Hanwoo cattle

1773 (T386) Probiotic levels, chemical composition and fermentative characteristics in the solid state fermentation of paper sludge for ruminant feeding.

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Sludge from the paper industry could be used for animal feeding when treated with probiotics upon solid state fermentation process. This study assessed the effects of four probiotic levels (PT) on chemical and fermentative characteristics in SSF of the paper sludge (PS) at controlled temperature (30°C) in laboratory scale. The probiotic used in this experiment is a mexican commercial trademark (Prozoot15) rich in yeasts and lactobacilli, organic acids and vitamins. The tested treatments (T) were: T1 (0% PS), T2 (50 g/kg PS), T3 (100 g/kg PS) and T4 (150 g/kg PS), which were fermented at 0, 24, 48 and 72 h, according to a completely randomized design, in a 4 × 4 factorial arrangement with six repetitions per sampling. All treatments included (g/kg DM) 300 molasses, 15 urea, 20 ammonium sulfate, 9 calcium carbonate and 5 of vitamin and mineral premix, plus the PS which was substituted by the PT at 0, 50, 100 and 150 g/kg DM. The results showed a decrease in pH in all treatments at 24 h; however the lowest pH was at 72 h of fermentation. At 72 h of fermentation, the PT addition in T4 increased crude protein, true protein and yeast counts ($P < 0.05$), and decreased pH ($P < 0.05$). In all fermentation time, the PT addition increased ether extract, lactic acid and ammonia nitrogen ($P < 0.05$) and decreased dry matter, ash, NDF and ADF ($P < 0.05$). It was concluded that the addition of 150 g/kg of PT in SSF of paper sludge improves crude and true protein, ether extract, lactic acid, and ammonia. This treated byproduct may have a potential use in animal feeding.

Key Words: fermentation; paper sludge; yeast

1774 (T387) *Lactobacillus brevis* YM 3-30, a γ-aminobutyric acid producing bacteria, increases antioxidant concentration and reduces biogenic amines.

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This study was conducted to determine the effects of *Lactobacillus brevis* YM 3-30, a γ-amino butyric acid (GABA) producing bacteria (GPB), on in vitro rumen fermentation. Also, evaluation of biogenic amines and antioxidant concentration were analyzed. Ruminal samples were collected from ruminally cannulated Hanwoo cattle and soybean meal was used as substrate at 1g dry matter (DM) per 100ml buffered rumen fluid. Different inclusion rates of GABA produced by GPB, *L. brevis* YM 3-30, were investigated using in vitro rumen fermentation. The following treatments were: 2 g/kg and 5 g/kg fresh GABA, 2 g/kg and 5 g/kg autoclaved GABA, and non addition of GABA and, hereafter referred to as treatments 2, 3, 4, 5, and 1, respectively. Fresh culture of GPB was added in treatments 2 and 3 while autoclaved GPB for treatments 4 and 5. The GPB was autoclaved at 121°C for 15 min prior to inclusion into the fermentation bottles. Addition of GABA produced by GPB had no significant effect on pH and total gas production, but did increase ($P < 0.05$) the ammonia nitrogen (NH_3–N) and reduce ($P < 0.05$) the total biogenic amines (TBA). Treatment groups containing GPB-produced GABA

(T2 and T3) having the lowest ($P < 0.05$) volumes of TBA with 10.62 mM to 11.21 mM. Additionally, histamine was produced in the highest levels in T1 at 15.99 mM. Acetate, propionate, and butyrate concentrations and acetate:propionate (A:P) ratio did not differ significantly among treatments. The volume of production of SOD and GSH-Px were significantly highest in treatments added with 5 g/kg GABA (T3) after 24 h of incubation with 76.60 U/ml and 38.51 U/ml, respectively. The addition of GABA produced by GPB improves in vitro fermentation by reducing biogenic amines production while increasing antioxidant activity and NH_3–N production.

Key Words: antioxidant, biogenic amines, γ-amino butyric acid

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1775 (T388) Effects of lactobacilli and fibrolytic enzymes on chemical composition, ferementation traits, conservation characteristics and in situ digestibility of mixed cereal silage. L. Jin[*1], L. Duniere[1], Y. Wang[2] and T. A. McAllister[2], *[1]Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada, [2]Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*

Growing mixed cereal crops for silage offers benefits in terms of increased yields and enhanced disease resistance. Little information is available regarding the effects of silage additives on the conservation characteristics and nutritional value of mixed cereal crops. This study was to determine the effect of lactic acid-producing bacteria (LAB) and fibrolytic enzymes on chemical composition, conservation characteristics and in situ digestibility of a mixed cereal crop consisting of barley, oats and spring triticale seeded 1:1:1. Forage was harvested at the mid-dough stage, wilted to 33% DM, chopped to 1 cm and either not treated (Control) or inoculated with a mixture of esterase-producing *Lactobacillus buchneri*, *L plantarum* and *L casei* (T1), a mixture of non-esterase-producing *L. buchneri*, *L. plantarum* and *E. faecium* (T2) or T2 plus exogenous enzymes (Rovabio Excel LC, T3). The MIXED procedure of SAS was used for this study with completely randomized design. The fixed factors were bacteria treatment, run and cow for in ensiling, in vitro and in situ trials respectively. After treatment, forage was packed and stored in mini-silos for 90 d, prior to measurement of ensiling characteristics and in vitro and in situ digestibility. Both T1 and T2 silage had higher NDF ($P < 0.001$) than Control or T3. All inoculants increased populations of LAB ($P < 0.01$) but, reduced concentrations of water soluble carbohydrate ($P < 0.01$), ammonia ($P < 0.001$) and pH ($P < 0.001$) in mixed crop silage. Compared with Control, T1 silage had lower ($P < 0.001$) whereas T2 and T3 silage had higher ($P < 0.001$) concentrations of acetic acid and total VFA. Concentration of lactic acid was similar among all silages. All silages had similar DM disappearance and VFA production during 48-h of in vitro ruminal incubation. However, in situ NDF disappearance of T1 silage was higher ($P < 0.001$) than that of Control and T3 silage. Applying esterase-producing *Lactobacillus* at ensiling to a mixture of barley, oats and spring triticale has potential to improve fermentation traits and enhance the fibre digestibility of silage.

Key Words: *Lactobacillus,* mixed cereal silage, rumen digestion

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1776 (T389) Use of Yea-Sacc8417 live yeast, monensin and their combination in diets for young Nellore bulls in a feedlot. J. M. B. Benatti[1], N. M. Geronimo[2], J. A. Alves Neto[1], R. C. Silva[1], I. M. de Oliveira[*3], C. L. Francisco[4], G. R. Siqueira[3] and F. D. D. Resende[3], *[1]Universidade Estadual Paulista, Jaboticabal, Brazil, [2]UNIFEB, Barretos, Brazil, [3]APTA- Agência Paulista de Tecnologia dos Agronegócios, Colina, Brazil, [4]Universidade Estadual Paulista- FMVZ, Botucatu, Brazil*

The objective of this study was to analyze the effects of different food additives administered solely or combined in diets for young Nellore bulls in a feedlot for 109 days. The treatments consisted of a control diet with monensin sodium (27.0 mg kg DM^{-1}), a diet with Yea-Sacc^{8417} live yeast (2.0 g $animal^{-1}$) and a diet with the two additives combined. Diets (10.00% sugarcane bagasse, 73.60% ground corn, 6.40% cottonseed, 6.40% soybean meal, 0.26% corn gluten, 0.79% urea and 2.55% mineral mix) varied only in the inclusion of additives. We used 66 non-castrated Nellore bulls (387.24 ± 21.17 kg), 22 of which were slaughtered in the course of the experiment (6 at the beginning and 16 right after the adaptation period [25 days]) to measure the empty body weight (EBW) and served as reference animals. The experiment was arranged in a completely randomized blocks design (11 replicates) as a function of the initial body weight. Data were analyzed by the MIXED procedure of SAS software and means were compared by Fisher's test at 10% significance. The animals were kept in individual pens and were considered the experimental unit. The dry matter intake (DMI) was lower ($P = 0.0798$) (8.47 kg DM day^{-1}) in the treatments containing monensin in relation to control diet (10.20 kg DM day^{-1}). The yeast supplied alone did not interfere ($P > 0.10$) on DMI. The supply of net energy (NE) by the diet was greater ($P = 0.0055$) in the two treatments containing monensin (1.98 and 1.33 Mcal kg DM^{-1} for maintenance and gain, respectively) as compared with the control diet and with yeast alone (1.90 and 1.17 Mcal kg DM^{-1} for maintenance and gain, respectively). The average daily gain evaluated as body weight (BW) (1.47 kg day^{-1}) and as EBW (1.58 kg day^{-1}) did not differ ($P > 0.10$) among diets, but when evaluated as carcass, the diets with monensin reduced ($P < 0.10$) the values (0.89 kg day^{-1}) as compared with the others (1.04 kg day^{-1}). There was no difference ($P > 0.10$) among treatments regarding the final BW (521.01 ± 37.59 kg); however, the diets with monensin reduced ($P < 0.10$) the final carcass weight (293.37 kg) in relation to control

diet and the diet with yeast alone (304.96 kg). Live yeast does not change the DMI or performance of young Nellore bulls in a feedlot. Monensin reduces DMI and reduces the carcass weight. Supported by FAPESP and Alltech.

Key Words: carcass, empty body weight, performance

1777 (T390) Effects of lactobacilli and fibrolytic enzymes on ensiling as well as in vitro and in situ digestibility of of barley silage.

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Lactobacilli-based inoculants have been shown to improve the ensiling and aerobic stability of barley silage and there is evidence that those with esterase activity may improve fibre digestion. This study aimed to compare the effects of esterase-producing lactobacilli-inoculant to non-esterase or exogenous fibrolytic enzymes inoculants on ensiling characteristic and in situ digestibility. Whole barley crop was cut at the mid-dough stage, wilted to 33% DM and chopped to 1 cm. Chopped barley was subject to the following treatments: 1) control (C; sprayed with water) 2), T1 (inoculated with a mixture of esterase-producing *L. buchneri*, *L. plantarum* and *L. casei*), 3) T2 (inoculated with a mixture of non-esterase-producing *L. buchneri*, *L. plantarum*, and *E. faecium*) and T3 (inoculated with T2 plus exogenous enzymes (Rovabio Excel LC)). Forage was ensiled in PVC laboratory silos for 90 d at which point fermentation characteristics as well as in vitro and in situ digestibility were measured. Silages in T1 and T2 treatment had higher NDF concentration ($P < 0.01$), but lower water soluble carbohydrate content ($P < 0.01$) than C or T3 silage. Control silage had lower pH and concentrations of acetic acid, total VFA, total bacteria and lactic acid producing bacteria ($P < 0.01$), but higher levels of lactic acid and lactic acid: acetic acid ($P < 0.01$) than other silages. Gas production was lower in T3 silage than other treatments ($P < 0.01$) whereas C silage had a greater ($P < 0.01$) in vitro total gas production and rate of gas production. In situ NDF digestibility of T1 silage was greater ($P < 0.01$) than C silage whereas T3 silage had the lowest ($P < 0.01$) NDF digestibility. Esterase-producing *Lactobacillus buchneri* improved the ruminal NDF digestibility of barley silage, a response that was not observed if the inoculant lacked esterase activity or if fibrolytic enzymes were applied exogenously to the forage at the time of ensiling.

Key Words: *Lactobacillus,* barley silage, rumen digestion

1778 (T391) Effect of direct-fed microbials and monensin on in vitro fermentation of a high-froage substrate.

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An in vitro experiment was conducted to determine effects of direct-fed microbials (DFM) on rumen fermentation of a forage-based diet in the presence and absence of monensin (MON). In vitro treatments were arranged in a 2 x 2 factorial and included 2 levels of DFM (0 and 50,000 cfu; consisting of primarily *Lactobacillus acidophilus* and *Enterococcus faecium*) and 2 levels of monensin (0 and 5 ppm). In vitro runs were conducted on 3 separate days, with each run consisting of 4 vessels/treatment ($n = 12$/treatment). Inoculum for in vitro experiments consisted of buffer plus a composite of strained rumen fluid obtained from 4 steers fed an 80:20 forage:concentrate (alfalfa/corn/SBM/urea) diet. Fermentation vessels were supplied with common substrate (400 mg of donor steer diet) and incubated in a water bath (39 C) for 30 h. Gas pressure was measured at 5-min intervals and samples were collected at termination for determination of methane production, pH, and concentrations of VFA and ammonia. Data were analyzed as a randomized complete block design with run as the blocking factor. An exponential model without lag was determined to be the best fit model for gas production data and was used to calculate rate and total production of gas. Interactions between DFM and MON were absent ($P > 0.10$) for gas production and fermentative end products, with the exception of a DFM x MON tendency ($P = 0.07$) for total VFA concentration. In the case of the latter, DFM increased total VFA concentration in the absence but not in the presence of MON. Addition of DFM did not affect ($P > 0.10$) gas production or fermentative end products except for a tendency ($P = 0.08$) for a slight increase in proportion of isovalerate. In contrast, MON decreased ($P < 0.001$) CH_4 production and rate and production of total gases. Similarly, MON decreased ($P < 0.001$) total VFA and NH_3 concentrations and molar proportions of acetate and butyrate and increased ($P < 0.001$) proportions of propionate, valerate, and isobutyrate and isovalerate. Independently, DFM and MON increased ($P < 0.001$) end point pH, resulting in an additive effect when the two treatments were combined. Addition of MON altered fermentation and was not influenced by DFM. In contrast, fermentation characteristics were largely unaffected by DFM with two exceptions: a slight increase in total VFA in the absence of MON and a small increase in pH that appeared to occur through a different mechanism than that for MON.

Key Words: direct-fed microbials, monensin, fermentation