

Ruminant Nutrition: General III

W394 Effect of heat-treated field beans (*Vicia faba*) on lactation performance of dairy cows. Mohammad Ramin*, Annika Höjer, Märten Hetta, and Pekka Huhtanen, *Department of Agricultural Research for Northern Sweden, Swedish University of Agricultural Sciences (SLU), Umeå, Västerbotten, Sweden.*

In Sweden, the availability of organic protein feeds is rather limited (e.g., lack of soybean) and it was therefore the objective of this study to evaluate if the feeding value of heat-treated field beans (FB) could be improved. Other objective was to compare different protein supplements that could be used in organic farming on the performance of lactating dairy cows fed grass silage based diet. Twenty-four lactating Swedish Red cows (95 DIM, milk yield 29.1 kg per day) were used in a cyclic change-over trial with 3 21-d experimental periods. The control diet consisted of grass silage and barley (60:40, DM basis). For experimental diets barley was replaced with rapeseed expeller (RSE; 104 g/kg diet DM), or isonitrogenous supplements of peas (232), untreated FB (UFB; 140), heat-treated FB (TFB; 140) or heat-treated FB that provided the same dietary MP concentrations of UFB (80; TFB-low). Methane (CH₄) and carbon dioxide emissions were measured with the Green-Feed system. On average, protein supplementation had no significant effect on DMI (18.8 vs. 18.2 kg/d), milk yield (23.8 vs. 23.5 kg/d) or ECM yield (25.6 vs. 24.8 kg/d). This was mainly because peas or FB supplemented diets did not increase milk or protein yield compared with the control diet. The RSE treatment increased milk (24.8 vs. 23.6 kg/d) and protein yield (913 vs. 863 g/d) compared with other protein supplements. Heat-treated FB had no effect on DMI, milk or protein yield compared with UFB. Milk nitrogen efficiency (Milk N / N intake) decreased and MUN increased with protein supplementation compared with the control diet (265 vs. 306 g/kg and 3.92 vs. 3.01 mmol/L, respectively). The RSE supplemented diet tended to decrease ($P = 0.09$) CH₄ production compared with other protein supplements (383 vs. 399 g/d). Overall, this study suggests that in organic farming no improvement on the lactation performance of dairy cows were achieved by the inclusion of heat-treated FB or peas as compared with the control diet without any protein supplement, provided that RDP requirements are met. Only RSE supplementation resulted in significant improvements in animal performance compared with the control diet.

Key Words: heat treatment, methane production, organic feed

W395 Pre- and post-weaning performance of dairy calves fed a milk-wheat-plasma protein milk replacer. Max Thornsberry¹, Steve Younker*¹, Dave Ziegler², Hugh Chester-Jones², and Jim Linn¹, ¹*Milk Specialties Global, Eden Prairie, MN*, ²*University of Minnesota, Southern Research and Outreach Center, Waseca, MN.*

Traditionally, replacing a portion of milk protein in calf milk replacer (CMR) with plant and animal proteins has lowered CMR cost, but reduced calf growth performance. Newer processing methods for wheat protein have improved digestibility and when combined with bovine plasma as a partial replacement for milk protein in a CMR resulted in similar performance of calves fed an all milk protein CMR. The objective of this study was to compare performance of calves fed either a CMR containing a blend (B-CMR) of milk proteins (9% units protein), hydrolyzed wheat gluten protein (5% units protein) and bovine plasma (8% units protein) or all milk protein CMR (AM-CMR). Fifty-two 2- to 5-d-old Holstein heifer calves were randomly assigned to one of 2 CMR treatments. The B-CMR and AM-CMR were similar (DM basis)

in CP (23%) and crude fat (21%) and fed at 0.54 kg DM/d (13% solids) from study d 1 to 35. Both B-CMR and AM-CMR contained Bio-Mos, ClariFly and 1600 g/ton each of Neomycin sulfate and Oxytetracycline the first 14 d of CMR feeding. BovaTec replaced oxy/neo from 15 d until weaning (d 42). From 35 to 42 d of study, CMR was fed at 0.27 kg DM/d. All calves were fed a common 22% CP (DM basis) texturized calf starter from study d 1 to 56. Data were analyzed as a randomized complete block design using PROC MIXED (SAS). Total intake of CMR DM from 1 to 42 d was similar at 20.8 kg DM with no differences in DM intake by weeks. Total calf starter DM intake from study d 1 to 42 was not different ($P > 0.05$) at 27.6 kg for AM-CMR fed calves and 25.4 kg for B-CMR fed calves. Total 56 d calf starter intake was not different between treatments at 64.6 vs. 61.1 kg DM for AM-CMR and B-CMR fed calves. Average daily gain from 1 to 42 d of study tended ($P = 0.08$) to be slightly lower for calves on B-CMR (0.69 kg/d) than calves on AM-CMR (0.75 kg/d). There was no difference ($P > 0.05$) in daily gain from 1 to 56 d between B-CMR treatment calves (0.83 kg/d) and AM-CMR treatment calves (0.87 kg/d). Fecal scores (1 normal, 4 watery) were numerically lower (1.4 vs. 1.6) from d 1 to 14 and scour days were numerically lower (1.27 vs 1.88) from d 1 to 42 for B-CMR calves than AM-CMR calves, respectively.

Key Words: calves, milk replacer, protein

W396 Effects of ruminal dosing of dairy cows with *Megasphaera elsdenii* on milk fat depression and strain persistence. Paul J. Weimer*¹, Luciano da Silva Cabral², and Felipe Cacite², ¹*USDA-ARS, Madison, WI*, ²*Federal University of Mato Grosso, Cuiabá, MT, Brazil.*

Megasphaera elsdenii (*Me*) is a lactate-utilizing bacterium whose ruminal abundance has been shown to be greatly elevated during milk fat depression (MFD). To further examine this association, a total of 23 cannulated multiparous Holstein cows were examined in 3 studies in which strains of *Me* were directly dosed into the rumen ($\sim 2 \times 10^{12}$ cells/dose); control cows were dosed with sterile lactate-free culture medium. Cows were fed a TMR (30% starch, dry matter (DM) basis) that contained primarily corn silage, alfalfa silage, finely ground high-moisture corn, supplemental protein, and corn oil (3 g/kg DM). Studies differed in stage of lactation of the cows (middle or late), dosing events (single dose, or 4 doses over a 5 d period), timing of dose (pre-feed or 3 h postfeed), and *Me* strain (lab strain Y19 or 3 strains isolated from cows in the same herd). DM intake, milk yield and composition were measured from 5 d to 0 d before dosing and 1 to 7 d after first dosing, plus later time points that varied by experiment. None of these measures were affected by dosing ($P > 0.05$). *Me* was quantified in the liquid phase of ruminal contents by polymerase chain reaction (PCR) with relative quantification (*Me* 16S rRNA gene copy number as a percentage of total bacterial 16S rRNA gene copies). Neither the *Me*-dosed or control cows displayed MFD after dosing, and in almost all cases *Me* populations returned to low baseline levels ($< 0.02\%$ of 16S rRNA gene copy number) within 24 h of dosing. This rapid decline in *Me* also occurred in several cows that were dosed with a strain that had been isolated from that particular cow during a previous bout of MFD. Ruminal pH, total mM volatile fatty acids (VFA) and mM lactate did not differ between dosed and control cows ($P > 0.05$), although acetate:propionate ratio declined ($P < 0.01$) in both groups, and butyrate increased after dosing with *Me* ($P < 0.05$). The results confirm that establishing exogenously added bacterial strains in the rumen is difficult, even for strains previously isolated from the

recipient cow. The potential role of *Me* as an agent of MFD remains unclear in the absence of successful establishment of the dosed strains.

Key Words: dosing, *Megasphaera elsdenii*, milk fat depression

W397 Effects of Cerrado plant extracts on in vitro rumen microbial fermentation in high inclusion concentrate diets. Flavia Martins de Souza*, Barbara Juliana Martins Lemos, Fabiola Alves Lino, Kiria Karolline Gomes Moreira, José Realino de Paula, Victor Rezende Moreira Couto, and Juliano José de Resende Fernandes, *Universidade Federal de Goiás, Goiânia, Goiás, Brazil.*

The objective was to study the effect of the typical plant extracts of the Brazilian Cerrado on in vitro rumen microbial fermentation under a high concentrate diet. Two separate trials were conducted to evaluate 4 doses (0, 30, 300 and 3,000 mg/L) of stem bark extract from *Stryphnodendron adstringens* (Trial 1; 48.1% tannins) and *Lafoesnia pacari* (Trial 2; 21.1% tannins). The trials were analyzed as a randomized block design with 5 repetitions, treating incubation as the blocking factor. Treatments were evaluated using a TE-150 incubator ((Tecnal) in a batch culture of rumen fluid with a 10:90 forage:concentrate diet (15% crude protein, 20% neutral detergent fiber) incubated using filter bags of non-woven textile for 2, 4, 8, 12, 24, and 48 h (triplicates each time) to fit the disappearance of dry matter (DM). Volatile fatty acids (VFA), pH, and ammonia nitrogen (NH₃-N) were evaluated after 48 h of incubation. *S. adstringens* extract at 3,000 mg/L reduced ($P < 0.05$) in 34.5% the potential degradability (a + b) of DM. There was significant reduction in total VFA concentration from 66.3 mM (0 mg/L) to 40.2 and 24.3 mM by adding 300 and 3,000 mg/L of *S. adstringens* extract, respectively. This was also observed for NH₃-N concentration, representing a decrease of 36.9% (300 mg/L) and 57.8% (3,000 mg/L). The pH significantly increased (5.9 vs 6.1) with the addition of 3,000 mg/L. Regarding *L. pacari* extract, the addition of 3,000 mg/L promoted ($P < 0.05$) reduction of 20.3% in the potential degradability of DM but detrimental effects on the fermentation profile were not observed. The 30 mg/L dose increased ($P < 0.05$) the total VFA concentration (63.4 vs. 85.2 mM), decreased the acetate:propionate ratio (4.3 vs 3.6) and the proportion of isovalerate (1.9 vs 1.5 mM). Changes in the concentration of NH₃-N were only observed at a dose 3,000 mg/L, with a reduction of 43.0%. The results indicated that Cerrado plant extracts are potential modifiers of rumen fermentation under a high concentrate diet.

Key Words: antimicrobial additive, *Lafoesnia pacari*, *Stryphnodendron adstringens*

W398 Effect of fibrolytic and aminolytic enzymes in ruminal metabolism and methane production in cattle. Ricardo Galbiatti Sandoval Nogueira, Lizbeth Lourdes Collazos Paucar*, Flavio Perna Jr, Eduardo Cuellar Orlandi Cassiano, Diana Carolina Zapata Vasquez, Lerner Arevalo Pinedo, and Paulo Henrique Mazza Rodrigues, *University of São Paulo, Pirassununga, São Paulo, Brazil.*

Methane (CH₄), a greenhouse gas, can be held responsible for loss of 2–12% the gross energy of the diet. The objective of this study was to evaluate the effect of enzymes on ruminal metabolism and the production of enteric CH₄ in cattle. Five cows with average weight of 923.04 ± 86.76 kg were assigned to 5 treatments in 5 × 5 Latin square design: (1) diet without enzymes (control); (2) diet with 7.5 g/animal/day of amylase (Amaize, Alltech); (3) diet with 15 g/animal/day of xylanase (Fibrozyme, Alltech); (4) diet with 7.5 g/animal/day of cellulase + protease (Allzyme VegPro PO, Alltech); (5) Diet with 30g/ animal/day

of enzymes mixture (amylase, xylanase, cellulase + protease). Animals were fed twice daily at 0800 and 1600 h. Each experimental period consisted of 21 d, and collections were made in the last 6 d. On d 21, ruminal pH was measured every 10 min using a continuous measurement device and rumen contents were collected at 0, 3, 6, 9 and 12 h after feeding to determine the production of short chain fatty acids (SCFA) and CH₄ by ex situ technique. Data were analyzed using SAS, through the MIXED procedure. The model included the effect of treatment as fixed factors, animal and period effects as random factors. The addition of different enzymes in the cattle diet showed no significant difference ($P > 0.05$) in relation to dry matter intake. There were significant differences ($P < 0.05$) for SCFA production in relation to the control diet. The enzyme mixture improved the production of acetic acid, propionic acid and total SCFA, while protease + cellulase improved the production of propionic acid. The CH₄ production was not significantly difference among treatments ($P > 0.05$). Also no significant differences ($P > 0.05$) were observed for the pH variables, as minimum, average and maximum pH, as well as time and area where pH was below to 5.8, 6.0, 6.2 and 6.5. It is concluded that these additives did not affect the variables DMI, CH₄ production and pH. The association of the enzymes showed improvement in the production of rumen SCFA without increasing the emission of CH₄.

Key Words: enzyme, methane, SCFA

W399 Effects of diets containing glycerin, derived from biodiesel production, on instrumental meat quality characteristics of lambs. Rebeca D. X. Ribeiro*, Ronaldo L. Oliveira¹, Gleidson G. P. Carvalho¹, Thadeu M. Silva¹, André G. Leão², Jonival B. Costa¹, Sara M. Ribeiro¹, Elisiane S. Santos¹, and Abraão S. Nunes¹, ¹University of Bahia, Salvador City, Bahia State, Brazil, ²Federal University of Mato Grosso, Rondonópolis City, Mato Grosso State, Brazil.

Glycerin is a low-cost byproduct from biodiesel production, and is also a potential source of carbohydrates. This study was conducted to determine the optimal amount of glycerin in the diets of lambs. Forty-four crossbreed male lambs (23.9 ± 3.4 kg) were distributed in a completely randomized design, and fed with a TMR that contained 50% of *Cynodon sp.* chopped hay and 50% of concentrate composed of corn bran, soybean meal, mineral premix, and the amounts of glycerin: 0; 7; 14 and 21% of total DM. Those amounts were the treatments. The feed trial lasted 78 d. The last day the animals were submitted to feed fasting, and slaughtered. The carcasses were stored in a cold chamber for 24h, and then the *Longissimus lumborum* was collected, stored in a freezer, and all measurements were made on this muscle, after thawing. The pH was measured by a digital potentiometer (skewer type extremity) directly in the muscle. The color measurement was made using a colorimeter to determine the parameters: L* - luminosity, a* red content and b* yellow content. Cooking losses were calculated by the weight difference from the samples before and after cooked, and results expressed in percentages. Tenderness was measured through the shear strength, using a texturometer equipped with a Warner Bratzler blade. The data were subjected to ANOVA and regression testing. Significance was declared as $P < 0.05$. There are no effects of glycerin inclusion on instrumental characteristics (Table 1). The similar values of pH, which is correlated with the glycogen source in muscle, can be related to the similarity among the other parameters. Glycerin, derived from biodiesel production, can be added up to 21.0% (DM) in the diets of lambs without compromising meat quality.

Contd.

Table 1 (Abstr. W399). Cooking losses (CL), shear force (SF), pH, and color of L. lumborum of lambs fed diets containing glycerin from biodiesel production

Item	Glycerin (%DM)				SEM	P-value	
	0.0	7.0	14.0	21.0		Linear	Quad
CL (%)	28.25	25.01	25.74	30.71	1.64	0.27	
SF (Kgf)	3.41	2.41	2.43	3.45	0.30	0.92	
pH	5.60	5.82	5.65	5.67	0.06	0.87	
Color							
L	36.21	35.87	35.82	36.36	0.62	0.89	
a	19.48	19.08	19.36	19.65	0.36	0.63	
b	6.05	5.33	5.74	5.90	0.38	0.98	

Key Words: nutrition, ruminant

W400 Effects of salinomycin and virginiamycin supplementation on ruminal microbial population in Nellore steers fed a high concentrate diet. Amoracyr J. C. Nuñez^{*1,2}, Vivian V. Almeida¹, Italo E. Borges², Fabio Pinese², Fernando T. Mercado², Ligia G. Mesquita², Juliane Diniz-Magalhães², Luis Felipe P. Silva², Paulo R. Leme², and José Carlos M. Nogueira Filho², ¹Purdue University, West Lafayette, IN, ²University of São Paulo, Pirassununga, SP, Brazil.

This experiment was conducted to evaluate the effects of adding salinomycin (SL), virginiamycin (VM), or their combination to finishing diets of Nellore steers on the ruminal population of *Streptococcus bovis*, *Megasphaera elsdenii*, *Selenomonas ruminantium*, and methanogenic archaea. Eight ruminally cannulated Nellore steers (322 ± 26 kg initial BW) were allotted to a 4 × 4 replicated Latin square design with four 16-d periods. Experimental diets had 80% concentrate (DM basis), and treatments were arranged in a 2 × 2 factorial, with 2 SL levels (0 and 13 ppm) and 2 VM levels (0 and 15 ppm) in the diet DM. Animals were housed in individual pens and fed once daily at 0800 h. Ruminal fluid samples were collected at 0 and 4 h post-feeding on d 13 of each period, and DNA was extracted from samples using the Qiagen DNA stool mini kit. Ruminal bacteria and methanogenic archaea populations were assessed by real-time PCR. Statistical analyses were performed using the MIXED procedure of SAS. No interactions between SL or VM levels, nor between time of collection and SL or VM levels were observed. The relative population of *S. bovis* tended to decrease ($P = 0.09$) for animals fed diets containing 15 ppm VM in comparison with those not receiving the additive, but no effects of dietary treatment were observed for any other microbial species (Table 1). There was an effect of time of collection in the relative populations of *M. elsdenii*, *S. ruminantium*, and methanogenic archaea, which were greater ($P \leq 0.01$) in samples collected at 0 h post-feeding. In conclusion, adding SL, VM, or both to the diets of Nellore steers had little effect on the populations of ruminal bacteria and methanogenic archaea.

Table 1 (Abstr. W400). Relative populations of ruminal bacteria and methanogenic archaea in Nellore steers fed diets with 2 levels of salinomycin (SL) or virginiamycin (VM)

Item	0 ppm SL		13 ppm SL		SEM	P-value		
	0 ppm	15 ppm	0 ppm	15 ppm		SL	VM	SL × VM
	VZM	VM	VM	VM				
<i>S. bovis</i>	1.00	0.58	0.86	0.49	0.03	0.61	0.09	0.97
<i>M. elsdenii</i>	1.00	1.09	1.09	0.69	0.02	0.43	0.44	0.26
<i>S. ruminantium</i>	1.00	0.79	1.22	0.97	0.04	0.33	0.26	0.99
Methanogenic	1.00	0.64	0.71	1.24	0.08	0.61	0.84	0.11

Key Words: antibiotic, bacteria, ionophore

W401 Productive performance of lambs fed diets containing glycerin from biodiesel production. Ronaldo L. Oliveira^{*1}, Rebeca D. X. Ribeiro¹, Gleidson G. P. Carvalho¹, Thadeu M. Silva¹, André G. Leão², Jonival B. Costa¹, Sara M. Ribeiro¹, Elisiane S. Santos¹, and Abraão S. Nunes¹, ¹University of Bahia, Salvador City, Bahia State, Brazil, ²Federal University of Mato Grosso, Rondonópolis City, Mato Grosso State, Brazil.

Glycerin is a by-product from biodiesel production, an important alternative fuel. It is also a low-cost source of carbohydrates. This study was conducted to determine the optimal amount of glycerin to include in the diets of lambs. Forty-four crossbred male lambs (23.9 ± 3.4Kg) were distributed in a completely randomized design, and fed with a TMR that contained 50% *Cynodon* sp. chopped hay and 50% concentrate composed of corn bran, soybean meal, mineral premix, and the amounts of glycerin: 0; 7; 14 and 21% of total DM. Treatments varied in the amount of glycerin included. During the performance trial the animals were fed ad libitum (diet was offered to allow 10% of orts). The feed and orts were weighed daily. The feedlot trial lasted 78 d, and on the last day the animals were weighed, submitted to feed fasting, and slaughtered. A general linear model was used to perform linear and quadratic regression. Significance was declared as $P < 0.05$. The glycerin inclusion promoted increase in final BW, BW gain, and gain:feed ratio up to 5.8, 3.8, and 2.75% of inclusion respectively (Table 1). After that, glycerin inclusion reduced those parameters. The initial increase can be related to the increment on energy intake, because the glycerin used in this study contained 30% of lipids. However, the increase in lipid intake can also reduce fiber digestibility, and then cause decrease in the DM intake, which is related to reduction in productive performance parameters. Glycerin, from biodiesel production, can be added between amounts of 2.75% and 5.8% without compromising the productive performance of lambs.

Table 1 (Abstr. W401). Productive performance of lambs fed diets containing glycerin from biodiesel production

Item	Glycerin amount (% of DM)				SEM	P-value	
	0	7	14	21		Lin	Quad
Final BW, kg	37.87	40.45	35.98	32.26	1.21	<0.001	0.0007 ¹
BW Gain, kg	14.91	15.58	12.34	8.00	0.65	<0.001	0.0007 ²
ADG, g/d	191.24	199.83	158.28	102.62	0.85	<0.001	0.0007 ³
Gain:Feed	0.155	0.149	0.141	0.102	0.01	<0.0001	0.025 ⁴

$$^1Y = -0.0321X^2 + 0.3707X + 38.26.$$

$$^2Y = -0.0256X^2 + 0.1944X + 15.051.$$

$$^3Y = -0.3278X^2 + 2.4924X + 193.04.$$

$$^4Y = -0.0002X^2 + 0.0011X + 0.1541.$$

Key Words: by-product, nutrition, ruminant

W402 Ruminal hydrogen sulfide concentrations on low-quality grass hay by lambs drinking saline water. Agustín López^{*1,3}, José I. Arroquy^{1,2}, Ana V. Juárez Sequeira^{2,3}, Nicolás DiLorenzo⁴, Héctor Fissolo¹, and María C. Barrionuevo³, ¹INTA EEA Santiago del Estero, Santiago del Estero, Argentina, ²CONICET, Santiago del Estero, Argentina, ³FAyA - Univ. Nac. Santiago del Estero, Santiago del Estero, Argentina, ⁴University of Florida, NFREC, Marianna, FL.

The objective of this study was to determine the impact of protein supplementation on dry matter intake and ruminal hydrogen sulfide concentration ([H₂S]) in lambs consuming low-quality tropical grass hay and drinking low salt water (LS) or high salt water (HS). Twenty

lambs in individual cages were used in a 10 treatments by 2 period (10 × 2) trial. First factor was water quality (WQ): LS (466 mg/kg TDS) vs. HS (8927 mg/kg TDS of which 6680 mg/kg as sulfates). Second factor was 5 levels of soybean meal (SBM; %BW/d). Water quality × SBM interactions were significant for forage (FOMI; $P < 0.05$) and total OM intake (TOMI; $P < 0.05$), but not for water (WI; $P = 0.60$) and sulfur water intake (SWI; $P = 0.14$). At the higher levels of SBM (>0.5%) there was no statistical difference for FOMI and TOMI. Water intake was not affected by WQ ($P = 0.39$) but increased linearly ($P < 0.01$) in response to SBM. Ruminal H₂S concentration was affected by WQ × SBM interaction ($P < 0.01$). Our results suggest further research is needed on the water quality × protein interaction to understand the mechanisms involved in H₂S production, to generate efficient supplementation strategies on low-quality forages.

Table 1 (Abstr. W402). Effects of SBM supplementation and WQ on sulfur water intake (SWI) and ruminal H₂S concentration in lambs fed low-quality grass hay

Water quality	SBM	SWI, mg/kgBW ^{0.75}	H ₂ S (ppm) ¹
Low salt	0	5.10	1.23 (16.98)
	0.25	4.90	1.19 (15.49)
	0.50	5.26	1.24 (17.38)
	0.75	5.79	1.20 (15.85)
	1	6.48	1.70 (50.12)
High salt	0	328.67	1.59 (38.90)
	0.25	278.49	2.69 (489.78)
	0.50	359.00	3.32 (2089.30)
	0.75	383.06	2.99 (977.24)
	1	454.38	2.98 (954.99)
SEM		33.74	0.20
Effects			<i>P</i> -value
WQ		<0.01	<0.01
SBM		0.20	<0.01
WQ × SBM		0.14	0.01

¹Means were back transformed.

Key Words: sulfate, hydrogen sulfide, protein supplementation.

W403 Effects of Cerrado plant oils on in vitro rumen microbial fermentation in high inclusion concentrate diets.

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The objective was to study the effect of the typical plant extracts of the Brazilian Cerrado on in vitro rumen microbial fermentation under a high concentrate diet. Two separate trials were conducted to evaluate 4 doses (0, 30, 300 and 3,000 mg/L) of trunk oil from *Copaifera langsdorffii* (Trial 1; 21.3% β-caryophyllene – essential oil) and fruit oil from *Pterodon emarginatus* (Trial 2; 5.3% β-caryophyllene – essential oil). The trials were analyzed as a randomized block design with 5 repetitions, treating incubation as the blocking factor. Treatments were evaluated using a TE-150 incubator ((Tecnal) in a batch culture of rumen fluid with a 10:90 forage:concentrate diet (15% crude protein, 20% neutral detergent fiber) incubated using filter bags of non-woven textile for 2, 4, 8, 12, 24, and 48 h (triplicates each time) to fit the disappearance of dry matter (DM), volatile fatty acids (VFA), pH, and ammonia nitrogen (NH₃-N) were evaluated after 48 h of incubation. The inclusion of 3,000 mg/L of oil *C. langsdorffii* reduced (84.7 vs 63.8%) the potential

degradability (a + b) of DM and tended to decrease ($P < 0.10$) the VFA (76.6 vs 60.6 mM), acetate (52.27 vs 42.11 mM) and NH₃-N (119.12 vs. 101.47 mg/dL) concentration. Acetate:propionate ratio (C₂:C₃) was significantly reduced (3.55 vs 2.81) at a dose 300 mg/L of *C. langsdorffii*. The proportion of isovalerate was affected ($P < 0.05$) at a dose 300 (1.93 vs 1.88 mM) and 3,000 mg/L (1.9 vs 1.6mM). No effect ($P > 0.10$) of *P. emarginatus* on the kinetics of disappearance of rumen DM was detected. However, the addition of 30 and 300 mg/L of *P. emarginatus* oil increased ($P < 0.05$) the total VFA concentration by an average of 28.3%. The 3,000 mg/L dose significantly decreased C₂:C₃ ratio (3.77 vs 2.76 mM) due to a 27.9% reduction in the proportion of acetate. The results indicated that Cerrado plant oil are potential modifiers of rumen fermentation under a high concentrate diet.

Key Words: *Copaifera langsdorffii*, essential oils, *Pterodon emarginatus*

W404 Effects of the combined use of virginiamycin and salinomycin on ruminal microbial population in Nelore steers fed diets with two concentrate levels.

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Eight ruminally cannulated Nelore 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 (VM) levels in diets containing salinomycin (SL) on the ruminal population of *Streptococcus bovis*, *Megasphaera elsdenii*, *Selenomonas ruminantium*, and methanogenic archaea. Treatments were arranged in a 2 × 2 factorial, with 2 concentrate levels (70 and 90%) and 2 VM levels (0 and 15 ppm) in the diet DM. Animals were fed once daily at 0800 h and SL was included in all diets at 13 ppm (DM basis). Ruminal fluid samples were collected at 0 and 4 h post-feeding on d 18 of each period, and DNA was extracted from samples using the Qiagen DNA stool mini kit. Ruminal bacteria and methanogenic archaea populations were assessed by real-time PCR. Statistical analyses were performed using the MIXED procedure of SAS. No effects of time of collection nor treatment x time of collection interactions were observed for any variable. The relative populations of *S. bovis*, *M. elsdenii*, and *S. ruminantium* were greater ($P < 0.01$) for steers fed the 90% concentrate diet than for animals fed less concentrate, but no effects of VM were observed for those bacteria populations (Table 1). There was a concentrate x VM interaction ($P = 0.04$) for the relative populations of methanogenic archaea, but within each concentrate level, no differences between VM inclusions were observed. In conclusion, the ruminal microbial populations evaluated in this study were more affected by variations in concentrate levels than by VM inclusion in the diets.

Table 1 (Abstr. W404). Relative populations of ruminal bacteria and methanogenic archaea in Nelore steers fed diets containing 2 concentrate (C) levels and 2 virginiamycin (VM) levels (0 and 15 ppm)

Item	70% C		90% C		SEM	<i>P</i> -value		
	0 ppm	15 ppm	0 ppm	15 ppm		C	VM	C × VM
<i>S. bovis</i>	1.00	0.92	5.62	8.82	0.27	<0.01	0.61	0.46
<i>M. elsdenii</i>	1.00	0.72	5.70	6.02	0.15	<0.01	0.76	0.67
<i>S. ruminantium</i>	1.00	1.22	5.13	3.07	0.11	<0.01	0.48	0.11
Methanogenic	1.00	2.06	0.44	0.23	0.08	<0.01	0.91	0.04

Key Words: antibiotic, bacteria, ionophore

Table 1 (Abstract W405).

Item	Inclusion of glycerin, % of DM				SEM	<i>P</i> -value				
	0	7	14	21		Diet	Time	Diet × Time	Lin	Quad
pH	6.31	6.38	6.38	6.32	0.03	0.65	<0.01	<0.01	0.89	0.22
NH ₃ , mg/dL	23.74	21.52	18.05	17.54	0.49	<0.01	<0.01	0.19	<0.01	0.39
Total VFA, mM	119.11	111.40	108.16	113.87	2.26	0.41	<0.01	0.85	0.37	0.16
Acetate, mM	74.37	58.82	55.37	53.12	1.42	<0.01	0.04	0.44	<0.01	0.05
Propionate, mM	24.76	25.11	27.06	33.68	0.74	<0.01	<0.01	0.06	<0.01	0.05
Butyrate, mM	14.27	21.16	20.21	19.46	0.44	<0.01	<0.01	<0.01	<0.01	<0.01
C2:C3 ¹	3.05	2.39	2.21	1.73	0.05	<0.01	<0.01	<0.01	<0.01	0.20

¹Acetate:propionate ratio.

W405 Ruminal fermentation of dairy cows supplemented with crude glycerin. Pablo G. Paiva^{*1}, Carlos E. C. Consentini², Fernanda C. R. Santos², Arthur G. B. V. B. Costa², Victor C. Galvao², Guilherme F. Cabral³, Elmeson F. Jesus¹, Tiago A. Del Valle², Thiago H. Silva², Caio S. Takiya², and Francisco P. Renno², ¹*Animal Science Department, Universidade Estadual Paulista, UNESP/Jaboticabal-SP*, ²*School of Veterinary Medicine and Animal Science, Universidade de São Paulo, USP*, ³*School of Animal Science and Food Engineering, Universidade São Paulo, USP/Pirassununga-SP*.

The objective of this study was to evaluate the effects of glycerin in replacing corn grain on ruminal fermentation of lactating dairy cows. Eight rumen cannulated Holstein cows (184 ± 50 DIM; 29.38 ± 0.89 kg/d milk yield; 594 ± 39 kg BW) were assigned in a replicated 4 × 4 Latin square design, with 21 d of experimental periods. Cows were assigned within each square to receive one following diets: Control or 0% glycerin; 7% of glycerin; 14% of glycerin; and 21% glycerin added to diets in replacing corn ground. On 20 d of experimental period, ruminal fluid samples were collected before (0), 2, 4, 6, 8, 10 e 12 h after morning feeding for analysis of the ruminal pH, NH₃ and volatile fatty acids (VFA). Data were analyzed as repeated measures in PROC MIXED (SAS for Windows 9.0), in the statistical model the effects of animal, period, square, treatment, beyond the effects of time with their interactions with treatment were considered. There was no effect of glycerin on total VFA (*P* > 0.05); but glycerin inclusion in the diet increased propionate and butyrate, and decreased acetate concentrations, resulting in lower acetate: propionate ratio (*P* < 0.05). Cows fed glycerin had lower ruminal pH in the first time of collect (*P* < 0.05). Ruminal NH₃ was linearly decreased as glycerin levels increased (*P* < 0.05). Glycerin inclusion in the diets of lactating dairy cows changed ruminal fermentation, with increase in propionate concentration, that indicate better efficiency the use of the energy diet.

Key Words: by-product, glycerol, performance.

W406 Dry matter intake and nutrient digestibility of dairy cows supplemented with crude glycerin. Pablo G. Paiva^{*1}, Fernanda C. R. Santos², Arthur G. B. V. B. Costa², Victor C. Galvao², Guilherme F. Cabral³, Carlos E. C. Consentini², Elmeson F. Jesus¹, Tiago A. Del Valle², Thiago H. Silva², Caio S. Takiya², and Francisco P. Renno², ¹*Animal Science Department, Universidade Estadual Paulista, UNESP/Jaboticabal-SP*, ²*School of Veterinary Medicine and Animal Science, Universidade de São Paulo, USP*, ³*School of Animal Science and Food Engineering, Universidade São Paulo, USP/Pirassununga-SP*.

The aim of this study was to evaluate the effects of glycerin in replacing corn grain on dry matter intake (DMI) and nutrient digestibility of lactating dairy cows. Twenty-four Holstein cows (184 ± 50 DIM;

29.38 ± 0.89 kg/d milk yield; 594 ± 39 kg BW) were assigned in 4 × 4 Latin square design, with 21 d of experimental periods. Cows were assigned within each square to receive one following diets: Control or 0% glycerin; 7% of glycerin; 14% of glycerin; and 21% glycerin added to diets on replacing corn ground. On d 16 to 18 of each period, fecal samples were taken from each cow, twice daily after milking, comprising a composite sample. The indigestible acid detergent fiber was used as internal marker to estimate fecal excretion and total-tract apparent digestibility of the nutrients. Data were analyzed with PROC MIXED (Statistical Analysis System for Windows 9.0), diet, period, and square were considered as fixed effect, animal within square and residual error as random effect. The inclusion of glycerin in the diets decreased DMI (*P* < 0.05). However, total-tract digestibility of dry matter, crude protein, and ether extract was linearly increased, and neutral detergent fiber (NDF) linearly decreased with glycerin inclusion in the diet (*P* < 0.05). High glycerin levels in corn silage based diets affected NDF digestibility and decreased DMI of lactating dairy cows.

Table 1 (Abstr. W406).

Item	Inclusion of glycerin, % of DM				SEM	<i>P</i> -value	
	0	7	14	21		Lin	Quad
DMI, kg/d	21.97	21.97	21.42	21.06	0.32	0.04	0.73
DMI, % of BW	3.54	3.63	3.49	3.37	0.05	0.01	0.07
Digestibility, %							
DM	69.63	70.39	71.72	72.40	0.30	<0.01	0.85
CP	73.38	73.60	75.57	77.24	0.37	<0.01	0.16
EE	72.93	76.15	84.17	86.93	0.82	<0.01	0.82
NDF	59.99	58.00	57.13	54.30	0.50	<0.01	0.71

Key Words: biodiesel, by-product, energy

W407 Nitrogen utilization of Nelore bulls supplemented with energy sources associated crude glycerin on finishing phase. Antônio José Neto^{*1}, Joanis Tilemahos Zervoudakis², Pedro Veiga Rodrigues Paulino², Luciana Keiko Hatamoto-Zervoudakis², Luciano da Silva Cabral², Juliane Quenoizoré Soares², Rosemary Lais Galati², Renata Pereira da Silva-Marques², and Lilian Chambó Rondena Pesqueira Silva², ¹*Department of Animal Science; São Paulo State University-UNESP, Jaboticabal, SP, Brazil*, ²*Department of Basic Sciences and Animal Production; Federal University of Mato Grosso-UFMT, Cuiabá, MT, Brazil*.

Glycerin has the potential to partially replace starch-based ingredients in the diet, such as corn, because glycerol is converted to propionate in the rumen and acts as a precursor for hepatic glucose synthesis. The objective of this study was to evaluate the effects of crude glycerin (Gly) combined with protein sources on balance of nitrogen compounds of

Nellore bulls fed tropical pasture during the rainy season. Five Nellore bulls (448.2 ± 14 kg; 25 ± 3 mo) were evaluated in a 5 × 5 Latin square design with 5 treatments and 5 periods. The animals were allocated into 5 paddocks of 0.25 ha, consisting of *Brachiaria brizantha* 'Marandu' in the rainy season. Crude glycerin (83.9% of glycerol) was used in all supplements to replace (15% of DM) corn. The supplements were: T1 - Gly with urea, T2 - Gly with soybean meal, T3 - Gly with cottonseed meal, and T4 - Gly with gluten, and the control supplement received mineral mixture *ad libitum*. Animals were individually supplemented at the rate of 300 g · 100 kg⁻¹ of BW, daily, at 1000 h. The experimental period was the 17 d, divided in adaptation (14 d) and 3 d for collections the feces in different times. Urine samples were collected 4 h after the supplementation to determine the concentration of nitrogen, on the last day of period. Data were analyzed using the PROC MIXED of the SAS with $\alpha = 0.05$ and F-test. Nitrogen intake (g · d⁻¹) was greater ($P < 0.01$) for Gly-urea compared with control and protein sources. There were differences in total grams of N excreted across treatments ($P < 0.01$). The increase in urinary and fecal N output by animals fed gly-urea contributed to greater total N output compared with other supplements. Nitrogen retained (g · d⁻¹ or % of N intake) was not affected by protein sources, but there were greater than control supplement ($P < 0.01$). Independently of protein source utilized, there was an increase of 59.5% ($P < 0.01$) in the N utilization (N retained, g · d⁻¹) for animals supplemented when compared with control group. Crude glycerin associated with protein sources can be efficient for improve the N utilization.

Key Words: beef cattle, glycerol, nitrogen

W408 In vitro production of gas in diets containing different levels of ethanolic extract of propolis. Sandra M. Yamamoto*, Cintia M. Araujo, Fernanda G. da Silva, Marcela A. Formiga, Layse A. Gordiano, and Daniel R. Menezes, *Federal University of Vale do São Francisco, Petrolina, Pernambuco, Brazil.*

In this study, we evaluated propolis as a safe alternative for ruminants feeding free of antibiotic additives and growth promoters. Phenolic compounds with antibiotic activity mainly against gram-positive bacteria, in the same manner as ionophores, are present in propolis. We evaluated the effects of different levels of ethanolic extract of propolis (EEP) at 30% on the in vitro production of gases by bacteria. Feed was formulated to contain 50% ground elephant grass (*Pennisetum purpureum*) and 50% concentrate, consisting of corn, soybean meal and core minerals and vitamins. EEP was added to the concentrate at 0, 6, 12, 24, and 36 mL/kg. A sample of 1000mg was weighed in nylon bags, with a weight of 20 mg/cm², sealed and added to the fermentation vials (160mL) previously injected with CO₂, with 4 replicates per treatment. To each vial was added 90mL of buffer solution and 10 mL of ruminal fluid spray kept under CO₂. The vials were sealed, placed in a room at 39°C and stirred every 2 h. Gas pressure readings were made at 2, 4, 6, 8, 9, 11, 12, 14, 17, 20, 24, 28, 34, 48, 72, 96, and 120 h after incubation. Statistical analyzes were performed using SAS 9.1 (SAS Institute Inc., Cary, NC). Data were previously checked for normality of residuals by Shapiro-Wilk test (PROC UNIVARIATE) and the variances compared by orthogonal contrasts (PROC GLM) with significance level of 5%. When significant, the regression equations were determined (PROC MIXED). As EEP levels were not equidistant, it was generated vectors of each contrast using PROC IML. There were no effects ($P > 0.05$) of EEP levels to the fibrous (0.0715 ± 0.02 mL/hour), non-fibrous (0.013 ± 0.01 mL/hour), and total (0.083 ± 0.02 mL/hour) carbohydrate fermentation rates. For the potential production of total carbohydrate gases (Vt) there was a quadratic effect ($P < 0.05$). The lowest value of gas output (77.69 mL/g of DM) was obtained for the inclusion of 23

mL of EEP/kg of concentrate. For the gas production from non-fibrous carbohydrates, the lowest value (63.12 mL/g of DM) was obtained for the inclusion of 24.78 mL of EEP/kg of concentrate. The results suggests that EEP was efficient at inhibiting total gas production by ruminal microorganism in vitro.

Key Words: fermentation, growth promoters, propolis

W409 Influences of SmartCare in milk replacer and XPC in calf starter on the performance and health of pre-weaning Holstein calves challenged orally with an opportunistic infection with *Citrobacter freundii*. Tyler L. Harris*¹, Yu Liang¹, Matt D. Sellers¹, Cameron R. Nightingale¹, Kate P. Sharon^{1,2}, Jeff A. Carroll², Ilkyu Yoon³, Mark F. Scott³, and Michael A. Ballou¹, ¹*Department of Animal and Food Sciences, Texas Tech University, Lubbock, TX,* ²*USDA-ARS, Lubbock, TX,* ³*Diamond V, Cedar Rapids, IA.*

This study investigated how supplementing milk replacer with SmartCare (SC) and calf starter with original XPC (XPC) would affect performance and health following an oral challenge with *Citrobacter freundii*. The study was performed over a 54 d period with 30 Holstein bull calves. Calves were randomly assigned to treatments that included: CON: milk replacer and calf starter with no added products, SC: milk replacer with 1 g SC/calf/d and base calf starter, and SC+XPC: milk replacer with 1 g SC/calf/d and calf starter with 0.5% of DM as XPC. Calves were fed 350 g of milk replacer at 0700 and 1700 from d 0 to 42. Calf starter and water were offered *ad libitum* and recorded daily. Calves were challenged with 10⁸ cfu of *Citrobacter freundii* orally on d 16 of the study. Blood samples were collected on d 0, 7, 14, 16, 18, 21, 24, 28, and 35 and analyzed for hematology. All data were reported as CON, SC, and SC+XPC, respectively. LSMeans with various superscripts differ ($P \leq 0.05$). Calf starter intake and ADG did not differ overall ($P \geq 0.127$); however, the SC+XPC calves consumed more calf starter from d 36 to 54 (0.865^a, 0.840^a, 0.981^b ± 0.053 kg/d; $P = 0.054$) and had increased ADG from d 15 to 21 (0.677^a, 0.696^a, 0.840^b ± 0.046 kg/d; $P = 0.006$). There was treatment x time interaction in neutrophil to lymphocyte ratio (N:L; $P = 0.043$), whereas CON calves had greater ($P \leq 0.019$) N:L than SC and SC+XPC on d 7 (1.21^a, 0.83^b, 0.72^b ± 0.15) and d 16 (1.43^a, 0.93^b, 0.99^b ± 0.15). Additionally, the SC+XPC calves had lower hemoglobin throughout the study (10.9^a, 11.2^a, 10.3^b ± 0.19 mg/dL; $P = 0.006$). Average fecal scores by period were greatest among CON calves after the challenge on d 17 to 21 (2.7^a, 2.1^b, 1.9^b ± 0.003; $P \leq 0.010$) and CON was also greater than SC+XPC calves on d 22 to 28 (2.8^a, 2.4^{ab}, 2.1^b ± 0.15; $P \leq 0.002$). The *Citrobacter* challenge increased scours, but did not result in systemic disease. Feeding SC in milk replacer and XPC in calf starter improved calf performance, health, and reduced the risk of scours during neonatal life.

Key Words: calf, health, yeast culture

W410 Effect of adding *Enterococcus faecalis* on in vitro ruminal fermentation profiles. Lovelia L. Mamud, Ashraf A. Biswas, and Sang Suk Lee*, *Sunchon National University, Suncheon, Jeonnam, South Korea.*

Enterococcus faecalis is one of the beneficial microorganisms which produces enterolysin and converts fumarate to succinate. Hence, this study was conducted to determine the effect of adding *E. faecalis* on in vitro ruminal fermentation, methane concentration, microbial diversity and population. Ruminal samples were collected from ruminally cannulated Holstein Friesian cattle, and a substrate consisting of rice straw and concentrate mixture at 40:60 DM was offered at 1g DM/100mL

buffered ruminal fluid. Fresh culture of *E. faecalis* (7.5×10^8 cfu/mL) at different inclusion rates were investigated using in vitro ruminal fermentation. The treatments tested were: non addition (control), 0.1% (T1), 0.5% (T2), and 1.0% (T3) of *E. faecalis*. All treatments were conducted in triplicates and analyzed by ANOVA for randomized complete block design. Duncan's Multiple Range Test (DMRT) and Orthogonal Polynomial Contrast were used to identify differences among treatments and control. All analyses were carried out using SAS version 9.1 (SAS, 2002). Total gas production and ammonia nitrogen concentration of cultures were directly proportional to incubation times, while culture pH was inversely proportional to incubation times. Addition of *E. faecalis* lowered ($P < 0.05$) the total gas production after 24 h but the opposite was observed after 48 h of incubation having the highest ($P < 0.05$) in T3 followed by T4, T2 and control with 93.80, 91.00, 88.33 and 82.20 ml, respectively. Higher concentrations of acetate were detected in *E. faecalis* treatments than control at 12 and 48 h but the opposite was observed at 24 h, while propionate was highest ($P < 0.05$) in T3 after 48 h with 12.59 mM. Butyrate concentration was higher ($P < 0.05$) in *E. faecalis* treatments than control after 12 and 24 h of incubations and the highest ($P < 0.05$) concentrations were detected in T2 at 24 h and T3 at 48 h with 14.61 and 14.88 mM, respectively. Higher ($P < 0.05$) concentrations in *E. faecalis* treatments than control were also observed in total volatile fatty acid (VFA) concentration after 12 and 48 h. Addition of *E. faecalis* enhanced in vitro ruminal fermentation by increasing the butyrate and total VFA concentrations in dose dependent manner.

Key Words: *Enterococcus faecalis*, in vitro, pyrosequencing

W411 Acetohydroxamic acid did not influenced ruminal microbiota but altered urea metabolism. P. P. Wang¹, J. Q. Wang¹, D. P. Bu^{*1,2}, D. Jin¹, J. Zhang¹, and X. M. Nan^{1,3}, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²World Agroforestry Centre, East and Central Asia, Beijing, China, ³Synergetic Innovation Center Of Food Safety and Nutrition, Harbin, China.

The objective of this experiment was to investigate the effects of urea and acetohydroxamic acid (AHA) on in vitro ruminal urea-nitrogen (urea-N) metabolism and microbial community using total mixed ration as a substrate. Treatments were arranged in a 2×2 factorial design with urea supplemented at 0 or 2% dry matter (DM), and AHA equivalent to 0 or 450 mg/kg DM. Ruminal fluids were collected from 3 Chinese Holstein dairy cows through permanent ruminal fistula, diluted with artificial saliva (1:2, v/v), and incubated anaerobically at 39°C for 0, 1, 2, 4, 6, and 12 h. Each treatment was performed in 3 serum bottles and experiment was run 3 times. Supplementation of urea increased ($P < 0.01$) ruminal pH, ammonia-nitrogen (NH₃-N) concentration and urease activity, while addition of AHA inhibited ($P < 0.01$) their increments. Acetohydroxamic acid was still stable within 6 h of incubation. When AHA was added, urea-N concentration of fermentation fluid in the treatment with urea supplied was gradual decline ($P < 0.05$). The peak of NH₃-N concentration was not delayed by AHA addition, comparing with treatment with urea supplementation only. The bacterial PCR-DGGE profiles of 4 treatments were similar to each other before and after incubation. Urea stimulated ($P < 0.01$) the decrements of *Ruminococcus albus*, *R. flavefaciens*, *Fibrobacter succinogene*, and *Butyrivibrio fibrisolvens* populations, but had no effect on *Prevotella* population ($P = 0.18$). However, all those functional bacterial populations were not influenced by AHA addition. It was concluded that AHA could slow down the degradation of urea by the inhibition of urease activity, and the dose of 450 mg/kg DM could not alter ammonia formation pattern in

this fermentation condition. In addition, AHA had no effect on ruminal microbiota, which could be altered by urea supplementation.

Key Words: acetohydroxamic acid, in vitro fermentation, urea metabolism

W412 Effect of interaction of cereal and forage on rumen fermentation characteristics in the diet of cattle. S. Y. Cao¹, C. W. Yang², Z. B. Yang^{*1}, and Y. Wang³, ¹College of Animal Science, Shandong Agricultural University, Tai-an, Shandong, China, ²College of Life Science, Shandong Agricultural University, Tai-an, Shandong, China, ³Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB, Canada.

Four ruminally cannulated Limousin \times Luxi beef cattle were used in a 4×4 Latin square design to monitor the changes in rumen fermentation during the feeding cycle and compare the differences caused by the type of cereal (C) and forage (F) in the diet. The 4 experimental diets contained 60% of either *Leymus chinensis* (LC) or sweet potato vine (SP) as forage and 40% of concentrate with either wheat (W) or maize (M). Cattle were fed twice daily and samples from rumen fluid were taken before morning feeding on the first 10 d after changing the diet and then at 0, 3, 6, 9 and 12 h after the morning feeding for 3 d. Significant variability in ruminal pH with the WSP diet was more pronounced on which pH dropped from 6.81 on d 1 (before the dietary changes) to 6.57 by d 10 ($P = 0.03$). The NH₃-N and total VFA concentrations of the cattle fed the *Leymus chinensis* were decreased ($P < 0.05$) after diet changes and then increased to values similar to that before changing. Whereas the total VFA concentrations of the cattle fed the sweet potato vine have the opposite trend. Mean rumen pH, acetate and propionate proportion and the ratio of acetate to propionate were not affected by the treatments ($P > 0.05$). The cattle fed WSP diet had greater ($P < 0.05$) NH₃-N and total VFA concentrations and greater ($P < 0.05$) proportion of butyrate. The average pH values and the ratio of acetate to propionate were affected by cereal ($P = 0.004$, $P = 0.046$ respectively) and the concentrations of total VFA, the proportion of propionate and butyrate were affected by forage ($P = 0.006$, $P = 0.045$, $P < 0.001$, respectively). No cereal \times forage interactions were detected among all rumen fermentation characteristics ($P > 0.05$). The rumen pH values and concentrations of NH₃-N and total VFA were fluctuated at certain sampling days after the abrupt change of diets, however, at the end of the adaptation period the rumen fermentation characteristics were similar to the values before diets changes. The result also indicated that the type of cereal and forage had apparent effects on rumen fermentation characteristics, but no interactions were observed.

Key Words: cereal, forage, rumen fermentation

W413 Effect of dietary energy source and level on nutrient digestibility, rumen microbial protein synthesis, and milk performance in lactating dairy cows. X. Q. Zhou^{1,2}, J. Q. Wang¹, D. P. Bu^{*1,3}, Y. D. Zhang¹, M. Zhao¹, P. Sun^{1,4}, and T. Zhang¹, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²College of Animal Science and Technology, Northeast Agricultural University, Harbin, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, ⁴CAAS-ICRAF Joint Lab on Agroforestry and Sustainable Animal Husbandry, Beijing, China.

This study examined the effects of dietary energy source and level on feed intake, digestion, rumen microbial protein synthesis and milk performance of lactating dairy cows fed corn stover as the main forage

source. Eight primiparous Chinese Holstein cows (138 ± 19.4 DIM, 29 ± 0.8 kg/d milk, and 589 ± 57.6 kg of BW), 4 of which were fitted with ruminal cannula, were used in a replicated 4 × 4 Latin square design with a 2 × 2 factorial treatment arrangement (energy level: NE_L 1.52–1.53 Mcal for LE and 1.71–1.72 Mcal for HE; energy source: SFC and GC). The NE_L was calculated based on Chinese recommendation (2004). Changes to dietary energy level were induced by feeding the cows diets of either 35.6% corn stover plus 1.24% EB100 or 13% corn stover, 22% corn silage plus 1.84% EB100 (a saturated free fatty supplement). Milk yield [27.8 vs. 24.6 kg/d (0.45 SEM), *P* = 0.007], milk protein content and yield [0.86 vs. 0.76 kg/d (0.01 SEM), *P* = 0.006], and milk lactose yield [1.34 vs. 1.20 kg/d, (0.02 SEM) *P* = 0.008] increased in response to increased levels of dietary energy, while contents of milk fat [4.22 vs. 4.24% (0.06 SEM), *P* = 0.433] and milk lactose [4.94 vs. 4.90% (0.08 SEM), *P* = 0.323] were not affected. Cows fed HE diets had a higher microbial protein yield [1.57 vs. 1.34 kg/d (0.54 SEM), *P* = 0.003] than those fed LE diets. Apparent digestibilities of nutrients were higher in HE than in LE diets. Milk yield [25.8 vs. 23.3 kg/d (0.434 SEM), *P* = 0.047], milk protein yield [0.79 vs. 0.72 kg/d (0.02 SEM), *P* = 0.043] and microbial protein yield [1.42 vs. 1.25 kg/d (0.33 SEM), *P* = 0.038] were also higher when SFC was used to replace GC as the main energy source for lactating cows fed with LE diets. This study suggest that increased dietary energy level and ruminal degradation rate are beneficial to milk protein production when cows are fed corn stover as a forage source, and this can be attributed to the resulting increased supply of microbial protein.

Key Words: energy, corn stover, microbial protein

W414 Physico-molecular structures and metabolic characteristics of protein in brown and yellow flaxseed with altered nutrient traits for dairy cattle. Nazir A. Khan¹, Helen Booker², Yajing Ban¹, and Peiqiang Yu*¹, ¹Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, ²Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK, Canada.

Flaxseed (*Linum usitatissimum* L.), also known as linseed, is one of the most important commercial oilseed crop of Western Canada, providing valuable inputs for food, feed, manufacturing and pharmaceutical industries. The objectives of this study were to investigate chemical profiles; protein subfractions; ruminal CP degradation and intestinal digestibility of RUP of flaxseed in dairy cattle; and protein molecular structures of newly developed yellow-seeded flax. Four flaxseed genotypes with 2 yellow breeding lines and 2 brown varieties obtained from Crop Development Center were evaluated. Each genotype were sampled from 2 replicate plots at 2 different locations. The flaxseed samples were analyzed for protein molecular profiles in terms of amide I and II, α -helix and β sheet structures using a JASCO FT/IR-ATR. The rumen and intestinal digestion of flaxseed were determined using in situ and 3-step in vitro methods with 4 lactating Holstein dairy cows (body weight, 680 ± 10 kg). The cows were fed TMR with forage to concentrate ratio 50 to 50. The data were analyzed as a RCBD with in situ cows as a random effect using the PROC MIXED procedure of SAS. The results showed that the yellow-seeded lines had higher (*P* < 0.001) contents of oil (44.5 vs. 41.4% DM, SEM = 0.35) and CP (24.9 vs. 20.9% DM, SEM = 0.96) compared with the brown-seeded varieties. The CP in yellow-seeds contained lower (*P* < 0.01) contents of true protein subfraction (81.3 vs. 92.7% CP, SEM = 1.46), and more (*P* < 0.001) extensively degraded (70.8 vs. 64.9% CP, SEM = 0.46) in rumen resulting in lower (*P* < 0.001) content of RUP (29.2 vs. 35.1% CP, SEM = 0.71) than the brown-seeded varieties. However, the total supply of

digestible RUP was not significantly different between the 2 seed types. Regression equations based on protein molecular structural features gave relatively good estimation for the contents of CP (*R*² = 0.87), soluble CP (*R*² = 0.92), RUP (*R*² = 0.97) and intestinal digestibility of RUP in dairy cattle (*R*² = 0.71). In conclusion, molecular spectroscopy can be used to rapidly characterize flaxseed protein molecular structures and predict their nutritive value in dairy cattle.

Key Words: protein molecular structure, protein subfraction, flaxseed

W415 Effect of rubber seed oil and flaxseed oil on milk performance, fatty acid composition and oxidative stability of milk fat. Y. Pi¹, J. Q. Wang¹, D. P. Bu*^{1,3}, L. Ma^{1,2}, Y. X. Zhu⁴, and J. C. Xu⁴, ¹Institute of Animal Science, State Key Laboratory of Animal Nutrition, Chinese Academy of Agricultural Sciences, Beijing, China, ²CAAS-ICRAF Joint Lab on Agroforestry and Sustainable Animal Husbandry, World Agroforestry Centre, East and Central Asia, Beijing, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, ⁴Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Kunming, China.

The experiment was conducted to investigate the effect of rubber seed oil compared with flaxseed oil when fed alone or in combination on the milk yield, milk composition, fatty acid composition and oxidative stability of milk fat from dairy cows. Forty-eight mid-lactation Holstein dairy cows were randomly assigned to one of 4 treatments according to a completely randomized block design. Cows were fed a basal diet (Control) or the basal diet supplemented with 4% rubber seed oil (RO), 4% flaxseed oil (FO), or 2% rubber seed oil plus 2% flaxseed oil (RFO) on a dry matter (DM) basis for 9 weeks. Feed intake (DMI), milk protein percentage, and milk fat levels did not differ among the treatments. Cows fed the RO, FO or RFO treatments had a higher (*P* < 0.001) milk yield than the control group (up to 6.5% more), while milk fat percentages were decreased. Compared with the Control, milk concentration of α -linolenic acid (ALA) content was substantially higher in cows receiving RO or RFO, and was double in cows receiving FO (*P* < 0.001). Both C_{18:1} *trans*-11 (VA) and C_{18:2} *cis*-9, *trans*-11 (CLA) levels were higher (*P* < 0.001) in cows fed added flaxseed or rubber seed oil. The increasing in VA, ALA, and CLA was greater in cows fed RFO than in cows fed RO alone. Compared with the Control, the milk fat from cows fed any of the dietary supplements had a higher concentration of unsaturated fatty acids (UFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), while the average saturated fatty acids (SFA) levels in milk fat were 30% lower. Compared with the Control, the superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) activities were all decreased (*P* > 0.05) in RO, FO and RFO treatments, while the catalase (CAT) activity was decreased (*P* < 0.05) in FO and RFO groups. The concentration of malondialdehyde (MDA) tended to increase (*P* < 0.10) in RO, FO and RFO treatments. These results indicated that the supplement of rubber seed oil and flaxseed oil in dairy diet could increase milk yield and the functional fatty acids content (ALA, VA, and CLA) in milk fat, while decrease the content of saturated fatty acids and oxidative stability of milk fat.

Key Words: milk fat, oxidative stability, rubber seed oil

W416 Varying the degrees of synchrony of energy and nitrogen release in rumen affect the synthesis of microbial protein in continuous culture system. J. Zhang¹, J. Q. Wang¹, D. P. Bu*^{1,2}, S. G. Zhao¹, P. P. Wang¹, and X. M. Nan^{1,3}, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Sciences, Chinese Academy of Agricultural Sciences, Beijing, China, ²World Agroforestry Centre,

East and Central Asia, Beijing, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China.

A continuous rumen simulation system apparatus with 16 1000 mL fermentation vessels was used to investigate the effects of different degrees of synchrony between ruminal available energy and nitrogen on rumen fermentation and microbial protein synthesis (MPS). The basal substrate was diet of (g DM/day) 18.50 corn straw, 10.00 corn, 0.26 premix, and 11.24 soybean meal containing 67.5 g N/kg DM, and diets were divided into 2 equal feedings at 09:00 and 21:00 h. The treatments were: the basal diet with (1) 10.0 g maltodextrin which was in the McDougall's buffer infused continuously into the fermenter (CONT), (2) 10.0 g maltodextrin as 2 6-h infusions starting at 09:00 and 21:00h (FAST) and (3) 10.0 g maltodextrin given as 2 6-h infusions starting at 15:00 and 03:00h (SLOW). Rumen inoculum was obtained from 4 ruminal fistulated cows in early lactation that were fed TMR with 45:55 forage to concentrate ratio. A 8-d incubation period was used, with the first 5 d serving as an adaptation period followed by 3 d of sampling with solid and liquid dilution rates in the fermenters set at approximately 10.0 and 8.0%/h, respectively. Data were analyzed using the MIXED procedure of SAS. All 3 infusion treatments had no significant effect on the apparent digestibility of OM (65.0% for CONT, 62.2% for FAST, and 61.2% for SLOW), DM (66.1%, 63.4% and 63.6%), and CP (71.5%, 68.2% and 68.6%). The pH values among 3 treatments were similar (6.70, 6.68 and 6.71). The concentrations of total volatile fatty acid for CONT and FAST treatments have higher tendency ($P = 0.05$) than SLOW (79.51 and 77.58 vs. 72.31, mmol/L). However, the CONT and FAST treatments increased ($P < 0.05$) MPS compared with SLOW (4.0 and 3.8 vs. 2.2, g/day). Compared with SLOW, the lower ($P < 0.01$) concentration of ammonia in CONT and FAST treatments (7.90 and 8.44 vs. 16.29, mg/dL) may indicate better utilization of ammonia for the growth of ruminal microbe. It is concluded that altering the degree of synchrony in the rates of ruminal release of energy and nitrogen had a marked effect on MPS.

Key Words: synchrony, energy, nitrogen

W417 Effects of wilting and additives on fermentation quality of alfalfa (*Medicago sativa* L.) silage. H. Liu^{1,2}, J. Q. Wang², D. P. Bu^{*2,4}, Z. W. Lv², and P. Sun^{2,3}, ¹College of Animal Science and Veterinary Medicine, Heilongjiang Bayi Agricultural University, Daqing, Heilongjiang, China, ²State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ³Synergetic Innovation Center Of Food Safety and Nutrition, Harbin, China, ⁴CAAS-ICRAF Joint Lab on Agroforestry and Sustainable Animal Husbandry, Beijing, China.

The effect of wilting and different additives on alfalfa silage fermentation and nutritive value were studied under laboratory conditions. Lucerne (at the early bloom stage of maturity), wilted for 3 and 12 h respectively, was ensiled at 27.4% and 39.2% dry matter (DM) contents. Chopped grasses at each moisture content were either untreated (control) or treated with (1)inoculant (LAB) containing *Lactobacillus plantarum* LP70, *Lactobacillus casei* LC05, and *Enterococcus faecium* EF08 (a final application rate of 2×10^5 cfu/g of fresh forage); (2)sugar beet pulp (SB) at 50g kg⁻¹ of fresh forage weight; (3)sodium formate (SF) at 6g kg⁻¹ of fresh forage weight; (4)a combination of inoculant and sugar beet pulp (LAB+SB), and (5)sodium formate and sugar beet pulp combined (SF+SB). Forages were packed into triplicate 1-L laboratory silos per treatment at a density of 650 g/L. Silos were opened and analyzed after 65 d of ensiling. The results showed that all treatments had lower pH and lower concentrations of acetic and ammonia-N (of % TN), but higher concentrations of lactic acid than did untreated silages ($P < 0.001$).

These effects were stronger in the LAB+M-treated silage. Addition of LAB+M resulted in silage with the highest concentrations of lactic acid (5.12 ± 0.36 ; $P = 0.011$) and the lowest ammonia-N (1.87 ± 0.07 ; $P < 0.001$) over treatments. Treated silages had similar concentrations of neutral detergent fiber (NDF), acid detergent fiber (ADF) and dry matter recovery compared with untreated silage. The addition of sugar beet pulp (SB) greatly reduced crude protein (CP) concentrations (20.53 ± 0.12 vs. 21.57 ± 0.12 ; $P < 0.001$) compared with control. Water-soluble carbohydrate concentrations were found increased in silage from alfalfa herbage treated with LAB+SB (2.09 ± 0.04 vs. 1.80 ± 0.04 ; $P < 0.001$) and SF-treated silage (2.04 ± 0.04 vs. 1.80 ± 0.04 ; $P < 0.001$) compared with untreated silage. Wilting reduced the rate of decline of silage pH ($P < 0.001$) and produced silages with lower acetic acid ($P < 0.001$) and ammonia-N contents ($P < 0.001$). As silage wilting was increased, silage quality was improved. Inoculant and sugar beet pulp combined (LAB+SB) was found to be the most effective additive.

Key Words: wilting, additive, alfalfa silage

W418 Effect of choline inclusion on lamb performance and meat characteristics. Julio Godinez-Cruz¹, Oswaldo Cifuentes-Lopez¹, Jorge Cayetano¹, Hector Lee-Rangel^{*1}, German Mendoza², Anayeli Vazquez¹, and Alejandro Roque¹, ¹Universidad Autónoma de San Luis Potosí, Facultad de Agronomía y Veterinaria, San Luis Potosí, San Luis Potosí, Mexico, ²Universidad Autónoma Metropolitana, Departamento de Producción Animal, Distrito Federal, Mexico.

The objective of this experiment was to determine the effect of rumen-protected choline (RPC Reashure; Excential RumenPass CH) and a vegetal Bio choline (Indian Herbs) on lamb performance in finishing rations. The experimental units were 24 Rambouillet lambs (23.4 ± 1.1 kg initial BW) housed in individual metabolic cages. The experiment lasted 42 d and treatments were: no choline (T1, control); 4 g/d biocholine (T2); 4 g/d RPC (T3). Lambs were assigned to one of the 3 experimental treatments according to a completely randomized design and data were analyzed using PROC MIXED with initial BW as a covariable. There were no differences ($P = 0.05$) on average daily gain and feed conversion; however, final BW (T1 = 32.7a, T2 = 33.9a, and T3 = 35.6b kg) and daily feed intake (T1 = 1.06a, T2 = 1.07a, and T3 = 1.22b kg) were different ($P < 0.05$). In carcass characteristics (cold carcass weight, hot carcass weight and rib area), only for meat color the L value were different (41.18a, 42.68b, and 42.58b to T1, T2, and T3, respectively). Therefore, addition of a choline did not change performance of finishing lambs, but could change some meat characteristics and final weight.

Key Words: lamb, choline, carcass

W419 Effects of *Yucca schidigera* extract on Rumen Fermentation Parameters in vitro. J. L. Niu¹, L. Ma^{1,2}, D. P. Bu^{*1,3}, J. N. Li¹, L. Pan¹, and J. C. Xu⁴, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²CAAS-ICRAF Joint Laboratory of Agroforestry and Sustainable Animal Husbandry, World Agroforestry Centre, East and Central Asia, Beijing, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, ⁴Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Kunming, Yunnan, China.

To investigate the effects of *Yucca schidigera* extract on fermentation characteristics in vitro, 5 treatments consisted of supplemental *Y. schidigera* extract at 0, 0.5, 2.5, 12.5 and 62.5 mg, which were assigned ran-

domly to 6 of 30 incubation bottles together with 0.5 g TMR (therefore, the adding levels of *Y. schidigera* were 0, 1, 5, 25, 125 g/kg TMR), 50 mL basal media and 25 mL rumen fluid obtained from rumen-cannulated lactation Holstein dairy cows. Cumulative gas production was continuously measured in an automated trace gas recording system (AGRS-III, Beijing) lasted for 30 h at a 39°C incubator. All fermentation vessels were cultured in shaking incubator at 39°C for 30 h. All the data were analyzed by SAS9.2. Results showed that pH and microbial crude protein (MCP) were not affected by the treatments, while the average pH in the treatments were 6.6 ± 0.05 , 6.6 ± 0.05 , 6.6 ± 0.06 , 6.6 ± 0.03 and 6.6 ± 0.04 , the average MCP were 1.58 ± 0.025 , 1.61 ± 0.034 , 1.58 ± 0.049 , 1.61 ± 0.018 and 1.67 ± 0.055 mg/mL, while the total gas production, in vitro dry matter degradability (IVDMD), neutral detergent fiber degradation rate (DNDF) and acid detergent fiber degradation rate (DADF) were improved ($P = 0.028$, $P = 0.042$) at the level of 25 and 125 g/kg TMR. The averages of the total gas production were 121.85 ± 0.034 , 119.68 ± 0.037 , 120.22 ± 0.037 , 135.29 ± 0.041 and 130.35 ± 0.042 mL/g, respectively. The average percent of IVDMD were 60.48 ± 0.888 , 62.45 ± 1.045 , 62.22 ± 0.686 , 64.55 ± 0.796 and 64.55 ± 0.765 , while the DNDF were 43.24 ± 0.004 , 43.28 ± 0.003 , 43.69 ± 0.001 , 44.72 ± 0.004 and 44.32 ± 0.003 , and the DADF were 31.66 ± 0.003 , 31.87 ± 0.007 , 32.10 ± 0.001 , 32.95 ± 0.001 and 33.01 ± 0.003 , respectively. With the increasing levels of *Y. schidigera* extract, the concentration of $\text{NH}_3\text{-N}$ was decreased ($P = 0.042$), while the acetate, propionate and total volatile fatty acids (TVFA) were increased ($P = 0.030$, $P = 0.009$, $P = 0.048$) after 30 h incubation. The mean values of $\text{NH}_3\text{-N}$ were 39.60 ± 0.839 , 36.18 ± 1.063 , 35.07 ± 1.576 , 34.28 ± 1.698 and 34.12 ± 1.073 mg/mL, while the TVFA were 65.72 ± 1.388 , 67.04 ± 1.473 , 73.52 ± 1.584 , 67.82 ± 1.824 and 72.57 ± 1.080 mmol/L, respectively. The results indicated that *Y. schidigera* extract was beneficial to manipulate rumen fermentation in vitro.

Key Words: *Yucca schidigera* extract, in vitro fermentation, gas production

W420 Influence of Indian odd fruit oil and combination with yucca saponin or rubber seed oil on in vitro rumen fermentation parameters. J. L. Niu¹, L. Ma^{1,2}, D. P. Bu^{*1,3}, L. Pan¹, and J. C. Xu⁴, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²CAAS-ICRAF Joint Laboratory of Agroforestry and Sustainable Animal Husbandry, World Agroforestry Centre, East and Central Asia, Beijing, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, ⁴Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan, China.

The objective of this experiment was to investigate the effects of Indian odd fruit oil (IO) and combination with *Yucca schidigera* (YS) or rubber seed oil (RO) on in vitro rumen fermentation parameters. The treatments were as follows: 5 doses (0, 1, 2, 3 and 4% DM) of IO, 5 doses (0, 0.5, 1, 1.5 and 2% DM) of IO mixed with YS (12.5 mg) (IO+YS), respectively, and 5 doses (0, 0.5, 1, 1.5 and 2% DM) of both IO and RO (IO+RO) (4 replicates per treatment). All treatments were evaluated in vitro 24 h batch culture of 25 mL rumen fluid with 0.5 g TMR (48% forage and 52% concentrate) and 50 mL basal medium. The cumulative gas production (GP) was continuously measured in an automated trace gas recording system (AGRS-III, Beijing). After 24 h, pH was determined, and samples were collected to analyze ammonia N ($\text{NH}_3\text{-N}$), in vitro dry matter degradability (IVDMD), neutral detergent fiber degradation rate (DNDF), acid detergent fiber degradation rate (DADF) and volatile fatty acids (VFA). Results showed that 3% and 4% DM of IO reduced the DNDF and DADF ($P < 0.05$), without effecting pH, $\text{NH}_3\text{-N}$,

IVDMD, GP, total and individual VFAs, 2% DM of IO increased the concentration of acetate and propionate ($P < 0.05$). 4% DM of IO+12.5 mg YS supplement reduced the DNDF and DADF ($P < 0.05$), and did not affect pH, IVDMD, GP, the concentration of $\text{NH}_3\text{-N}$ or total and individual VFAs. Supplementation of IO+RO increased pH ($P < 0.05$), while did not affect IVDMD, GP, the concentration of $\text{NH}_3\text{-N}$ or total and individual VFAs. However, 0.5% of IO+RO increased DNDF and DADF ($P < 0.05$), 1% of IO+RO decreased DADF ($P < 0.05$). It was concluded that supplements of IO, IO+YS and IO+RO nearly had no effect on rumen fermentation.

Key Words: Indian odd fruit oil, *Yucca schidigera*, rubber seed oil

W421 Influence of rubber seed oil on in vitro rumen fermentation parameters, fatty acid composition and methane production. J. L. Niu¹, L. Ma^{1,2}, D. P. Bu^{*1,3}, L. Pan¹, and J. C. Xu⁴, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²CAAS-ICRAF Joint Laboratory of Agroforestry and Sustainable Animal Husbandry, World Agroforestry Centre, East and Central Asia, Beijing, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, ⁴Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan, China.

A completely randomized block experiment was designed to investigate the effect of rubber seed oil on in vitro rumen fermentation, concentration of unsaturated fatty acids and gas production. Rubber seed oil was added to total mixed ration (TMR) at the rate of 0, 1, 2, 3 and 4% dry matter of the diet (4 replicates per treatment). The culture medium consisted of 25 mL rumen fluid collected from 3 fistulated Holstein cows, 50 mL basal medium and 0.5 g TMR (48% forage and 52% concentrate), and each treatment was incubated for 24 h at 39°C. Gas production, fermentation kinetics, in vitro dry matter digestibility (IVDMD), neutral detergent fiber degradation (DNDF), acid detergent fiber degradation (DADF) and volatile fatty acids (VFA) were determined. The results showed as follows, gas production, pH, $\text{NH}_3\text{-N}$, IVDMD, DNDF, DADF, total and individual VFAs were not affected by rubber seed oil ($P > 0.05$). However, the DNDF tended to decrease linearly with increasing levels of rubber seed oil ($P < 0.1$). After 24 h incubation, 3% and 4% DM of rubber seed oil increased the concentrations of t11c18:1, c9c12c18:2, c9t11CLA, C22:2 and total fatty acids (TFA) ($P < 0.05$), 4% DM of rubber seed oil increased the concentrations of t9c18:1, C18:3, t10c12CLA ($P < 0.05$). Rubber seed oil seemed to enhance the accumulation of unsaturated fatty acids in rumen but did not affect rumen fermentation.

Key Words: rubber seed oil, rumen fermentation parameter, unsaturated fatty acid

W422 Changes of the rumen microbial profiles as affected by urea and acetohydroxamic acid addition in vitro. D. Jin^{1,4}, J. Q. Wang¹, D. P. Bu^{*1,2}, P. P. Wang¹, S. G. Zhao¹, and X. M. Nan^{1,3}, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²CAAS-ICRAF Joint Laboratory of Agroforestry and Sustainable Animal Husbandry, World Agroforestry Centre, East and Central Asia, Beijing, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, ⁴Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium.

In ruminants, urea was broken down rapidly to ammonia by rumen bacteria and urease inhibitors were used for increasing the efficiency of

urea utilization by inhibiting ruminal urease. However, the effect of urea and urease inhibitors on the rumen microbes was not clear. This study investigated the effect of urea and AHA (acetohydroxamic acid) addition in the diets on rumen microbial diversity using dual-flow continuous culture systems. Eight fermenters were used in a period of 10 d (7 d for adaptation and 3 d for sampling) experiment and TMR (containing alfalfa hay 17.72%, corn silage 17.5%, steam corn 7.39%, soybean meal 2.64%) were placed into each fermenter twice a day. Based on this diet, the fermenters were assigned to a 2 × 2 factorial arrangement of treatments with urea supplemented at 0 or 0.5% dry matter intake (DMI), and AHA equivalent to 0 or 450 mg/kg DMI. While the urea and AHA were dissolved in the artificial saliva and infused into the vessels twice daily. On each sampling day, fermentation fluids were collected at 0 h, 2 h, 6 h and 10 h from each fermenter. Total DNA of rumen microbe were extracted and subjected for DGGE and 16S rRNA gene sequencing. Distinct bacterial profiles were observed with urea addition and little differences were found with AHA addition. UPGMA analysis showed that samples with urea and AHA addition were clustered together. Group with urea addition showed a higher Shannon diversity compared with other groups ($P < 0.01$). 16S rRNA gene sequencing analysis revealed that the dominant ruminal bacteria shared by all 4 groups belonged to phyla *Firmicutes*, *Bacteroidetes* and *Proteobacteria*. However, in urea adding groups, the bacteria *Lachnospiraceae*, *Clostridiaceae*, and *Succinivibrionaceae* were found in highest abundance compared with the other 2 groups ($P < 0.01$). In contrast, the *Paraprevotellaceae* and *Veillonellaceae* bacteria were abundant in treatments without urea ($P < 0.01$). Little difference of the bacteria abundance was found with AHA addition. In conclusion, adding urea to the diet could change the ruminal bacteria diversity while AHA addition had little effect on the rumen microbiota.

Key Words: rumen bacteria diversity, urea, acetohydroxamic acid (AHA)

W423 Milk production and composition responds to dietary neutral detergent fiber and starch ratio in dairy cows. M. Zhao¹, J. Q. Wang¹, D. P. Bu^{*1,3}, X. Q. Zhou¹, D. Zhu¹, and P. Sun^{1,2}, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²CAAS-ICRAF Joint Laboratory of Agroforestry and Sustainable Animal Husbandry, World Agroforestry Centre, East and Central Asia, Beijing, China, ³Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China.

The objective of this study was to investigate effects of dietary carbohydrate composition with different dietary neutral detergent fiber (NDF):starch ratio by altering the forage to concentrate ratio on milk production and milk composition synthesis in dairy cows. Eight primiparous (146 ± 21.6 d in milk) including 4 rumen cannulated dairy cows were assigned to 4 total mixed rations (TMRs) in a replicated 4 × 4 Latin square design. Each experiment period was 21 d containing 14 d of adaptation and 7 d of measurement. Four dietary treatments were designed in which corn grain was gradually replaced with corn silage and oat hay. The NDF:starch ratios of TMRs were 0.86, 1.18, 1.63 and 2.34 from group T1 to T4, respectively. Dry matter intake (DMI) and milk production was averaged 20.8 kg/d and 31.4 kg/d, and decreased by 21.1% and 14.8% from group T1 to T4 ($P < 0.01$). Digestibility of dry matter (DM), organic matter (OM), NDF, crude protein (CP) were linearly decreased from group T1 to T4 ($P < 0.01$), and averaged 69.9%, 72.1%, 50.5% and 72.8%, respectively. However, digestibility of starch showed no difference among groups and averaged 93.7% ($P > 0.05$). As NDF:starch ratio increased, milk protein content and production, and

milk lactose content and production were linearly reduced ($P < 0.01$), and averaged 3.1%, 0.97 kg/d, 4.95% and 1.56 kg/d, respectively. However, milk fat content was linearly increased from 3.72% to 4.25% from group T1 to T4 ($P < 0.01$). Quadratic effect was observed on milk fat production ($P < 0.01$), which increased from 1.23 kg/d to 1.31 kg/d from group T1 to T3, and then decreased to 1.20 kg/d in group T4. Therefore, it implied that great attention should be directed at this dietary factor (NDF:starch ratio) in practical diet formulation.

Key Words: carbohydrate composition, NDF:starch ratio, milk production

W424 Evaluation of enhanced mineral block on in vitro rumen microbial fermentation. Chang Dae Jeong, Lovelia L. Mamuad, Catherine G. Avedoza, Sang Suk Lee*, Bang Geul Kim, and Maro Lee, *Sunchon National University, Suncheon, Jeonnam, South Korea.*

Mineral block is a strategic feed supplement for ruminants that provides a constant source of minerals to promote growth of rumen microbes. Hence, this study was conducted to investigate the effect of enhanced mineral blocks on in vitro rumen fermentation. Ruminal samples were collected from 3 ruminally cannulated Holstein Friesian cattle, and a commercial concentrate substrate was offered at 2g DM/100mL buffered ruminal fluid. Five enhanced mineral blocks were investigated and the treatments were: non addition (control), commercial mineral block (T1), T1+0.6ppm selenium (T2), T1+100ppm ammonium chloride (T3), T1+300ppm sodium bicarbonate (T4) and T1+0.03% molasses (T5). Each serum bottle was filled anaerobically and sealed before incubation at 0, 3, 6, 12 and 24 h. All treatments were conducted in triplicates and analyzed by ANOVA for randomized complete block design. Duncan's multiple range test (DMRT) was used to identify differences among treatments and control. All analyses were carried out using SAS version 9.1 (SAS, 2002). All treatments resulted in decreased pH and increased gas production as incubation time increases. Total gas production was higher ($P < 0.05$) in T1 to T4 than that of T5 and control at 12 h of incubation. Ammonia-nitrogen (NH₃-N) concentration was lowest ($P < 0.05$) in T4 (11.54 mM) after 24 h incubation followed by T5 and then T3. Also, propionate concentrations were higher ($P < 0.05$) in T2 to T5 at 12 h and T1 to T5 at 24 h incubation with T4 and T3 being the highest after 12 and 24 h of incubation with 22.56 mM and 27.55 mM, respectively. Acetate to propionate ratio was inversely proportional as the time increases in all treatment groups wherein lowest concentration was observed in T3 (1.47 mM) after 24 h incubation. Total volatile fatty acid (TVFA) was relatively higher in all treatments than the control group wherein T4 have the highest result after 12 and 24 h incubation with 72.13 and 86.56 mM, respectively. In conclusion, enhanced mineral block such as sodium bicarbonate (T4) can improve gas production, propionate and total volatile fatty acid for better rumen microbial fermentation.

Key Words: enhanced mineral block, in vitro, total volatile fatty acid

W425 Effects of cassava peel as a replacement for corn on nutrient digestibility and lactating performance of dairy cows. Viviany Lúcia Fernandes dos Santos¹, Marcelo de Andrade Ferreira², Geraldo Tadeu dos Santos³, Raphael Eduardo Moretti³, Tobias Tobit de Barros Melo², Leônia Régia Costa da Silva¹, Thaynah Vasconcelos Gracindo¹, Michelle de Oliveira Maia Parente⁴, and Valdi de Lima Júnior^{*1}, ¹Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil, ²Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil, ³Universidade Estadual

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Fresh cassava peel (*Manihot esculenta*) has a potential used as a ruminant feed due to advantages such as a high amount of soluble carbohydrates with high digestibility. This agroindustrial residue could provide the energy necessary for animal production in situations where the availability of feed is limited, because it is cheaper than commodities such as corn. Eight Holstein cows (480 ± 24 kg BW and 88 ± 17 d in milk) were allotted in a double Latin-Square design (4 × 4) to evaluate the effect of the replacement of corn by cassava peel in the diets on performance of dairy cows. Each experimental period lasted 21 d, 14 d for adaptation and 7 d for sampling. Diets were isonitrogenous (12.8% ± 1.0 CP, DM basis) and composed of 37.5% concentrate and 62.5% corn silage and Tifton hay. Treatments were defined by 4 replacement levels of corn by cassava peel: 0, 33, 66, and 100% (DM basis). The data were analyzed by using the MIXED procedure (SAS Inst. Inc.). Orthogonal polynomials for diet responses were determined by linear and quadratic effects. Effects were declared significant at $P \leq 0.05$. The replacement of corn by cassava peel linearly decreased ($P \leq 0.05$) dry matter (DM) intake (17.0, 17.0, 16.0, and 16.07 kg.d⁻¹ for 0, 33, 66, and 100% of replacement) and organic matter (OM) intake. Crude protein (CP) intake and neutral detergent fiber (NDF) intake did not differ ($P \geq 0.05$) among treatments. DM digestibility (65.2, 54.4, 46.7 and 44.2% for 0, 33, 66, and 100% of replacement corn by cassava peel), CP digestibility, OM digestibility and NDF digestibility also linearly decreased ($P \leq 0.05$) with the replacement of corn by cassava peel. In addition, there was a linear decrease ($P \leq 0.05$) in milk production (20.0, 20.0, 19.0 and 18.0 kg.d⁻¹ of replacement corn by cassava peel). Although cassava peel decreased parameters evaluated, the replacement of corn with cassava peel may be interesting in locations near to starch industry, as well as cows with low nutritional requirements.

Key Words: digestibility, industry residue, milk production

W426 Creatinine excretion in Nelore heifers grazing during dry season. Jarbas Miguel da Silva Junior*, Luciana Navajas Rennó, Sebastião de Campos Valadares Filho, Edenio Detmann, Mario Fonseca Paulino, Rilene Ferreira Diniz Valadares, Taiane da Silva Martins, Lyvian Cardoso Alves, and Ricardo Marostegan de Paula, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.

The creatinine excretion through the sampling spot of urine has been studied as an indicator of urinary volume. However, no studies in the literature have reported its use in animal grazing. The aim of this study was to evaluate the excretion of creatinine in beef cattle. Five heifers with 300 ± 15 kg average body weight were distributed in three 5 × 5 Latin squares and kept in individual paddocks equipped with feeding and drinking troughs. The experimental treatments were defined to represent those commonly used in the dry season, as follows: control (mineral salt), concentrated with 20.31% crude protein (CP) on dry matter (DM) being offered (OF) level of 0.5 to 1% of body weight fasted (BWF) OF5 and OF10, respectively; and 2 concentrated self-regulating (SR) consumption, containing 69.38% CP on a DM basis (20% urea and 20% salt) offered ad libitum (SR70) and other concentrate containing 39.73% CP based on MS being offered ad libitum (SR40). The experiment included four 17-d periods; the first 12 d were for adaptation, and the remaining 5 d were for data collection. The total collection of urine was carried out between d 13 and 17 of each experimental period, for which a Foley catheter number 26 2-way was used, with 50-mL flask placed on the d 13 of each experimental period. At the free end, the probe was coupled by conductive polyethylene hose to 2 L collection bag (polyethylene bag) with secured with ropes in a sturdy cotton fabric bag to the animal's

neck in the ventral region. The animals were led to a weigh crate every 2 h from 0800 to 2000 h, and every 4 h from 2000 to 0800 h to facilitate the emptying of the bag. A urine sampling was performed every 4 h, obtaining a sample of 10 mL diluted in 0.036 N H₂SO₄. The creatinine content was assessed through an kinetic colorimetric test. Data were analyzed using the PROC MIXED procedure of SAS 9.1. The creatinine excretion was not affected by treatments or day and time of sampling ($P > 0.05$) with an average rate of 23.03 ± 0.30 (22.73 to 23.33) mg/kgBW. The spot sampling technique may be used to estimate the daily excretion of creatinine in animals kept in a pasture system.

Key Words: creatinine, bovine, urine

W427 Influence of varying level of fibrolytic enzyme on nutritive value of oat grass silage in cannulated buffalo bulls. Mahr un Nisa*¹, Osman Ahmad Khan², Sarwar Muhammad³, and Muhammad Sharif³, ¹Institute of Home and Food Science, Govt. College University, Faisalabad, Punjab, Pakistan, ²Livestock and Dairy Development, Lahore, Punjab, Pakistan, ³Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad, Punjab, Pakistan.

This experiment was conducted to examine the influence of varying levels of fibrolytic enzyme on oat grass silage nutrient digestibility and ruminal characteristic in ruminally cannulated buffalo bulls using 4 × 4 Latin square design. The enzyme used was blend of xylanase (350000 BXU/g, where 1 BXU is the amount of enzyme that will release 0.06 micromole of reducing sugar (xylose equivalent) from birch xylan per minute at pH 5.3 and 50°C) and cellulase (10000 ECU/g, where 1 ECU is the amount of enzyme that will release 0.06 micromole of reducing sugars as glucose from hydroxethyl cellulose per minute at pH 4.8 and 50°C) and was derived from *Trichoderma reesei*. The control diet (C) was without enzyme, whereas diets containing 1, 2 and 3 g enzyme per Kg of silage's dietary neutral detergent fiber (NDF) were denoted as low (LE), medium (ME) and high enzyme (HE) diets, respectively. Animals were fed only silage twice daily at 1% of their body weight. The apparent silage DM digestibility by animals fed ME diet (63.4 ± 3.70) was significantly higher ($P < 0.05$) and was lowest in animals fed C diet (60.7 ± 3.11). Similar trend was noticed in CP, NDF and ADF digestibility. The ruminal pH was higher ($P < 0.05$) in animals fed LE (6.73 ± 0.05), ME (6.64 ± 0.04) and HE (6.65 ± 0.06) diets than those fed C diet (6.52 ± 0.04). Similarly, ruminal NH₃-N concentration (mg/dL) was higher ($P < 0.05$) in animals fed LE (20.4 ± 2.05), ME (20.6 ± 2.21), HE (21.1 ± 1.96) diets than those fed C diet (18.7 ± 1.91). The blood glucose was higher ($P < 0.05$) in animals fed LE, ME and HE diets than those fed C diet at 3 and 6 h postprandial. However, blood urea nitrogen remained unaltered across all diets. In conclusion, enzyme supplementation increased nutrient digestibility, ruminal NH₃ and blood glucose.

Key Words: fibrolytic enzyme, cannulated buffalo bull, silage

W428 Adaptation of dairy cows to grazing after TMR feeding during early lactation: I. Effects on endocrine profile and hepatic expression of IGF system genes. Ana L. Astessiano*¹, Pablo Chilibroste², Diego A. Mattiauda², Ana Meikle³, and Mariana Carriquiry¹, ¹School of Agronomy, UDELAR, Montevideo, Uruguay, ²School of Veterinary Medicine, UDELAR, Paysandú (EEMAC), Uruguay, ³School of Veterinary Medicine, UDELAR, Montevideo, Uruguay.

Multiparous cows (n = 18) were used in a randomized complete block design to study endocrine profile and hepatic gene expression related to

IGF system on the adaptation to grazing after TMR feeding during early lactation. During the first 60 d postpartum (DPP), cows were assigned to 1) TMR (30 kgDM/d offered; 45% forage, 55% concentrate) and 2) 50% pasture in one (am) grazing session (6 h; pasture allowance 4 cm above ground level = 15 kgDM/d) + 50% TMR (15 kgDM/d offered) (G1). At 61 DPP and during 21 d, all cows were managed as G1 group determining 2 treatments (TREAT): PostTMR and G1. Plasma and liver biopsies were collected pre (+55 DPP) and post (+75 DPP) dietary change. Gene expression was quantified by SYBR-Green real time RT-PCR. Means from a repeated analysis using a mixed model were considered to differ when $P < 0.05$. Average milk energy output and BCS from 61 to 82 DPP did not differ between TREAT (27.5 and 25.7 ± 1.4 Mcal/d and 2.8 and 2.7 ± 0.1 units for PostTMR and G1, respectively). Plasma IGF1 concentrations at +75 DPP were greater in PostTMR than G1 cows (161 vs. 127 ± 26 ng/mL) as decreased from +55 at +75 DPP only in the latter cows. Plasma insulin and leptin as well as hepatic IGF1, IGF2 IGFBP2, and IGFBP4 mRNA were not affected by TREAT, DPP or its interaction. Before the diet change (+55 DPP), PostTMR cows had greater hepatic IGFBP1 mRNA but lower IGFBP3 mRNA than G1 cows. However, IGFBP1 mRNA had a 2.1-fold decrease while IGFBP3, IGFBP5 and IGFBP6 mRNA had 0.4 to 0.9-fold increase in PostTMR cows with the dietary change (+55 to +75 DPP). In addition, hepatic IGFBP3 mRNA decreased by 65% during this period in G1 cows. These changes determined that at +75 DPP, hepatic IGFBP3, IGFBP5 and IGFBP6 mRNA were greater while IGFBP1 mRNA was less in PostTMR than G1 cows. Decreased plasma IGF1 and hepatic IGFBP3 mRNA in G1 cows were associated with the increased milk yield from +55 to +75 DPP in these cows. In addition, while milk yield, BCS, and plasma IGF1 were maintained after the diet change in PostTMR cows, expression of IGFBP mRNA in the liver was modified in these cows

Key Words: nutrition, gene expression, grazing

W429 Effects of feeding 3-nitrooxypropanol (NOP) on rumen microbial profiles in lactating dairy cows and beef cattle. Mi Zhou*¹, Yanhong Chen¹, Jennifer Haisan¹, Atmir Romero-Perez^{1,2}, Karen A. Beauchemin², Masahito Oba¹, Maik Kindermann³, Stephanie Duval⁴, and Le Luo Guan¹, ¹Department of Agricultural, Food, and Nutritional Science, University of Alberta, Edmonton, Alberta, Canada, ²Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada, ³DSM Nutritional Products, Animal Nutrition & Health, Basel, Switzerland, ⁴DSM Nutritional Products France, Research Centre for Animal Nutrition and Health, Saint Louis Cedex, France.

3-Nitrooxypropanol (NOP) can reduce CH₄ production from the rumen of dairy cows and beef cattle, but the effect of NOP on the rumen microbiome is unknown. The current project aimed to evaluate the microbial profile changes in 4 studies with NOP fed to beef and dairy cows. Rumen contents were collected from 2 dairy (Study 1: Haisan et al., 2014; Study 2: unpublished data) and 2 beef (Study 3: Romero-Perez et al., 2014; Study 4: Romero-Perez et al., 2015) studies, and subjected to genomic DNA extraction. Bacterial, archaeal and protozoal rRNA fragments were amplified and subjected to pyrosequencing analysis using 454 Titanium FLX (Roche). The main bacteria phyla in the rumen were found to be affected by NOP treatments: in dairy, Firmicutes was greater in control than in NOP dairy cows for Study 1 (58 vs 55%, $P = 0.03$); while in beef, Bacteroidetes proportions varied among different NOP levels for Study 3 (from 31% for Control to 36% for NOP, $P < 0.01$) and among NOP treatment periods for Study 4 ($P = 0.04$). NOP also influenced other minor bacterial phyla, with the magnitude of impact differing among studies. The major methanogen genera were similar for all studies, and similar trends were found for both beef and dairy

studies: *Methanobrevibacter ruminantium* was greater ($P < 0.05$) in all 4 studies (57 vs 46%; 66 vs 51%; 52 vs 37%; 30 vs 20%) while *Mbb. gottschalkii* was less ($P < 0.01$) in cattle receiving NOP (Studies 2 to 4: 36 vs 20%; 59 vs 42%; 68 vs 54%). *Mbb. smithii* and *Methanosphaera stadtmanae* responded to NOP feeding in different ways depending upon the study. Entodiniomorphida predominated the protozoal community (>90%). The protozoa composition was not affected by NOP, and no clusters formed according to NOP dosage. In conclusion, NOP may reduce enteric CH₄ though changing rumen microbial community, but its effect of each phylotype was different, requiring further experimentation to understand its mode of action in altering the rumen microbiome.

Key Words: 3-nitrooxypropanol, rumen microbiome

W430 Effect of protein supplementation to low-quality forage diets on enteric methane production and ruminal microbial community structure of beef steers. Adam L. Shreck*¹, Nirosh D. Aluthge³, Jenny S. Jennings², Samodha C. Fernando³, and N. Andy Cole¹, ¹USDA-ARS, Bushland, TX, ²Texas Agrilife Research, Amarillo, TX, ³University of Nebraska-Lincoln, Lincoln, NE.

British-cross steers (n = 23; initial BW: 344 ± 33.9 kg) were used in a 3-period crossover design to evaluate the effect of protein supplementation to low-quality forage on ruminal methane (CH₄) and metabolic carbon dioxide (CO₂) emissions, forage intake, and microbial composition. Steers were individually given ad libitum access to low-quality bluestem hay (3.9% crude protein) and provided one of 3 supplements: (dry matter basis): no protein (CON), cottonseed meal (CSM; 0.29% of body weight (BW) daily) or dried distillers grains with solubles (DDGS; 0.41% of BW daily). Ruminal CH₄ and metabolic CO₂ fluxes were obtained 6.3 ± 1.6 times/steer daily using a GreenFeed unit (C-Lock Inc., Rapid City, SD). Microbial community structure of ruminal fluid collected using stomach tubes was determined using 16S rRNA based sequencing. Forage intake increased ($P < 0.01$) by 35.0% with protein supplementation; however, no difference ($P = 0.14$; SEM: 0.36) was observed between CSM (5.82 kg/d) and DDGS (5.50 kg/d). Flux of CO₂ (g/d) was greater ($P < 0.01$; SEM: 172.0) for steers fed CSM (5,520) and DDGS (5,453) than for steers fed CON (4,895). Steers supplemented with CSM (204.9) had greater ($P < 0.01$; SEM: 5.8) CH₄ emissions (g/d) than DDGS (189.2), both of which were greater ($P < 0.01$) than CON (174.1). Methane emissions, as a proportion of GE intake (Y_m), were lower ($P < 0.01$; SEM: 0.25) for DDGS (7.27%) and CSM steers (7.80%) than CON (10.10%). Principal coordinate analysis revealed shifts in microbial community structure with CON having greater abundance of specific operational taxonomic units (OTU) classified as Firmicutes and Streptococcus while CSM contained greater Bacteroidetes and Prevotella and DDGS steers had greater abundance of specific OTUs belonging to Clostridiales and Anaerobiviro. Results of this study suggests that the common practice of supplementing protein to cattle consuming low-quality forage increases overall gas emissions but yields beneficial decreases in greenhouse gas emissions per unit of intake and alters microbial community structure.

Key Words: enteric methane, protein, 16S rRNA

W431 Effect of a Saccharomyces cerevisiae preparation on in vitro ruminal fermentation of four fibrous substrates. Karla Y. Valdés¹, Iván Mateos¹, Cristina Saro¹, Alexey Díaz^{1,4}, María Dolores Carro², Abdelfattah Z. M. Salem³, and María José Ranilla*^{1,4}, ¹Animal Production Department, University of León, León, Spain, ²Agriculture Production Department, Technical University of Madrid, Madrid, Spain, ³Faculty of Veterinary Medicine and Animal Science,

Autonomous University of the State of Mexico, Mexico, ⁴IGM (CSIC-ULE). Finca Marzanas s/n, Grulleros, León, Spain.

Yeast cultures, especially *Saccharomyces cerevisiae*, are beneficial in the rumen, and have been progressively introduced into the feed industry. They can affect microbial activities, thus improving fiber digestion, modifying VFA production and increasing animal performance. Most of studies have focused on yeast effects when good quality and high concentrate diets are used, but much less attention has been paid to the possible effects with fibrous feeds. In this study, the effects of a preparation of *S. cerevisiae* (strain SC-47) on in vitro ruminal fermentation of 4 fibrous feeds differing in quality and chemical composition were analyzed. Two low-quality forages (barley straw and *Pennisetum purpureum* clon Cuba CT-115) and 2 medium-quality forages (alfalfa hay and grass hay) were used. Samples of the forages (500 mg) were accurately weighed into 120-mL serum bottles, and incubated with buffered rumen fluid (50 mL) at 39°C for 24 h. Based on previous experiments with the same product, 4 doses of the *S. cerevisiae* preparation were tested as feed additive in batch cultures at 0, 25, 50 and 100 µL/bottle. VFA and gas production, pH, ammonia-N concentrations and true in vitro digestibility (TIVD) were measured. There were no additive x substrate interactions ($P > 0.05$) for any variable. TIVD, ammonia-N concentration and acetate:propionate ratio were not affected ($P > 0.05$) by SC-47 addition to the batch cultures. Gas production and total VFA production were linearly increased ($P < 0.001$) by increasing amounts of SC-47, whereas pH was linearly decreased ($P = 0.010$). Also, the production of all individual VFA linearly increased with the addition of the different doses of SC-47 (acetate, $P = 0.001$; propionate, $P < 0.001$; butyrate, $P < 0.001$; and the sum of isobutyrate, isovalerate and valerate, $P < 0.001$). The results show that *S. cerevisiae* stimulate ruminal fermentation in vitro of these fibrous forages of different quality, and so, studies analyzing their possible influence on fermentation of low-quality substrates are recommended.

Key Words: *Saccharomyces cerevisiae*, batch culture, forage

W432 Nutritional evaluation of corn wet feed in cannulated Nili-Ravi buffalo bulls. M. Nisa^{*1}, M. Osman³, S. Najeeb⁴, and M. Sarwar², ¹Department of Food Science, Nutrition and Home Economics, Govt. College University, Faisalabad, Pakistan, ²Institute of Animal Sciences, University of Agriculture, Faisalabad, Pakistan, ³Livestock and Dairy Development Board, Lahore, Pakistan, ⁴Star Farm Pvt Ltd., Sargodha, Pakistan.

The study was aimed to examine the influence of replacing corn wet feed (CWF) with corn grains on feed intake, nutrient digestibility, nitrogen balance and ruminal characteristics in ruminal cannulated buffalo bulls. The animals were fed 1% of their body weight. All diets were isocaloric (2.30 Mcal/kg) and isonitrogenous (12.55%CP). The control diet CWF0 did not contain CWF, whereas CWF10, CWF20 and CWF30 diets had 10, 20, and 30% CWF, respectively. Animals were housed on concrete floor in separate pens and water was made available round the clock. The experiment lasted for 80 d. The 4 × 4 Latin square design was used in this experiment and means were compared by Duncan's new multiple range test. Dry matter (DM) and crude protein (CP) intakes were not differ ($P > 0.05$) in animals fed diets containing with and without CWF. Neutral detergent fiber (NDF) intake was higher ($P < 0.05$) in buffalo bulls fed diets contained different levels of CWF. Dry matter, CP and NDF digestibilities were highest ($P < 0.05$) in animals fed CWF10 diet than those fed CWF0, CWF20 and CWF30 diets while DM, CP and NDF digestibilities remained same ($P > 0.05$) among animals groups fed CWF0, CWF20 and CWF30 diets. All animal were in positive nitrogen balance. However, there was high nitrogen retention observed in animal

fed CWF10 and CWF20 diets. Ruminal pH in buffalo bulls at 0, 3, 6 and 9 h remained same across all diets. Ruminal NH₃-N at 0 h was also same while significant ($P < 0.05$) difference was observed in buffalo bulls at 3, 6 and 9 h across all diets. In this study 10% replacement of corn grain with CWF showed better nutrient digestibility, nitrogen balance and ruminal characteristics of Nili-Ravi buffalo bulls.

Key Words: corn wet feed, corn replacement, buffalo bulls

W433 Effect of direct-fed microbial supplementation and different diets on performance and carcass characteristics in beef feedlot heifers. Laura F. Prados^{*2,1}, Galen E. Erickson¹, Nirosh Aluthge¹, Samodha C. Fernando¹, Curtis J. Bittner¹, and Fred H. Hilscher¹, ¹University of Nebraska-Lincoln, Lincoln, NE, ²Universidade Federal de Viçosa-MG, Viçosa, Minas Gerais, Brazil.

The objective of this study was to measure feedlot performance and carcass characteristics of heifers fed a newly developed direct-fed microbial (DFM) or not within 2 different basal diets. Three hundred thirty-six heifers (348 ± 33 kg) were used in a randomized block designed study with 24 pens (6 replications/treatment). The treatment design was a 2 × 2 factorial arrangement consisting of 2 basal diets based on corn (CON) or 40% modified distillers grains plus solubles replacing corn (MDGS) and presence (1 × 10⁹ cfu/mL of each bacteria species/animal per day) or absence of DFM. The DFM was isolated from prior experiments, grown in the lab, and consisted of members of *Bacteroides* and *Lachnospiraceae* that were top-dressed on feed immediately after feeding to ensure accurate supply daily to pens. One block (4 pens) of heifers was harvested after 133 d on feed and 3 blocks (20 pens) were harvested after 147 d on feed. Hot carcass weight was obtained the day of harvest, and LM area and fat thickness collected after a 48-h chill. Carcass adjusted final BW was calculated using HCW divided by a common dressing percentage (63%), and used for ADG and G:F. All data were analyzed using the MIXED procedure of SAS with an $\alpha = 0.05$ and pen as the experimental unit. There were no interactions ($P > 0.25$) between diet and DFM supplementation for DMI, ADG, G:F, and HCW; thus, main effects of basal diet and DFM are presented. There were no differences in DMI, ADG, and carcass characteristics ($P > 0.23$) due to supplementation of DFM. Heifers fed DFM tended ($P = 0.10$) to be less efficient. Feeding MDGS increased ($P < 0.01$) DMI, ADG, and HCW of heifers. Feed efficiency was improved ($P < 0.01$) by 7% for heifers fed MDGS diets compared with CON. Heifers fed MDGS were fatter ($P < 0.01$) compared with CON likely due to greater ADG. The DFM developed for this study did not enhance performance, while feeding modified distillers grains compared with corn improved performance.

Key Words: carcass characteristics, direct-fed microbial, modified distillers grains plus solubles

W434 Effect of Econase on rumen fermentation patterns, diet digestibility and performance pre-and postpartum of primiparous dairy cows. D. N. Lobão da Silva^{*1}, R. Riewer², A. Gander¹, N. Walker², B. Ellison², M. Endres¹, and N. B. Litherland¹, ¹University of Minnesota, Saint Paul, MN, USA, ²AB Vista, Marlborough, UK.

The objective of this study was to examine the effect of feeding a fibrolytic enzyme preparation (Econase) via a molasses-based liquid feed (MLF) on digestibility, ruminal patterns and milk production of primiparous dairy cows. Thirty-six (n = 18) dairy heifers were blocked by BW, BCS, mature 305 ME and assigned to 2 treatments from d 45 pre- to 56 postpartum: 1) untreated MLF diet (CON); 2) enzyme treated MLF diet (ECO). Treated MLF preparation conferred activity of 3,500

BXU/g of xylanase. An amount of 0.5mL of treated or untreated MLF was mixed to each kg of DM of pre- and postpartum TMR before feeding. Data were analyzed using the MIXED procedure of SAS. Prepartum DMI was similar (14.2 vs. 15.0 kg/d; $P = 0.17$) between CON and ECO treatments and no differences were observed on ruminal pH (7.1 vs. 7.0; $P = 0.64$), %NDFd (60.0 vs. 57.9; $P = 0.48$) or %DMd (64.9 vs. 61.3; $P = 0.15$) for CON compared with ECO treatment, respectively. However, enzyme supplementation tended ($P = 0.09$) to increase colostrum yield by 32% (3.9 vs. 5.2 kg) although no changes were observed on total colostrum solids concentration. Postpartum DMI (20.6 vs. 20.9 kg/d; $P = 0.78$), 3.5% FCM yield (28.5 vs. 29.9 kg/d; $P = 0.27$) and milk fat (3.6 vs. 3.5%; $P = 0.59$) were similar for CON and ECO treatments, respectively. Postpartum NEFA and BHBA were also similar (181.0 vs. 161.1 $\mu\text{Eq/L}$; $P = 0.41$) and (5.8 vs. 5.6 mg/dL; $P = 0.66$), respectively for CON and ECO. Postpartum ruminal fluid pH tended ($P = 0.08$) to be greater for ECO (6.53 vs. 6.71) compared with CON, but % NDFd was similar (53.7 vs. 52.1; $P = 0.58$). Although numerical increases in milk yield (28.3 vs. 30.1 kg/d; $P = 0.15$) for ECO treatment, the design did not have enough statistical power to report a significant effect. Future research is needed to investigate whether different doses and feeding period length of this fibrolytic enzyme may affect performance and growth of first lactation animals.

Key Words: fibrolytic enzyme, primiparous, xylanase

W435 Effect of supplementation of rumen-protected vitamins (choline, riboflavin, and folic acid) in heat-stressed dairy cows in northern Mexico (La Laguna Region). Pedro A. Robles-Trillo^{*1}, Janet Garcia¹, Francisco G. Veliz-Deras¹, Carlos Arechiga-Flores², Rafael Rodriguez-Martinez¹, and Karla Fernandez¹, ¹Universidad Autonoma Agraria Antonio Narro, Torreon, Coahuila, Mexico, ²Universidad Autonoma de Zacatecas, Calera, Zacatecas, Mexico.

Purpose of present work was to evaluate the effect of supplementation of rumen-protected vitamins (choline, riboflavin and folic acid) on incidence and appearance metabolic diseases. Dairy cows ($n = 105$), on the transition period (fresh and challenged cows). Cows were randomly allotted from May to August into 2 groups: 1) Control cows (cows receiving the regular total-mixed ration without vitamin supplementation; TMR), and 2) RPV-cows (cows receiving a supplement containing rumen-protected vitamins; i.e., 50 g/cow/day). Five blood samplings were performed to determine incidence of metabolic disorders and/or postpartum diseases (d 0, 19, 30, 50, and 80 after R-PV supplementation). Three periparturient diseases were monitored: retained fetal membranes, metritis, and ketosis, defined as follows: (1) retained-fetal membranes (RFM), was considered when fetal membranes were not expelled 12 h after parturition; (2) metritis (M) was diagnosed when cows presented a blood-purulent vaginal discharge at 7 d after parturition; (3) ketosis: mount of β -hydroxybutyrate was determined through evaluation of a blood sample using reactive bands for ketone bodies (Abbott, Precision Xtra), and using a Ketometer (Ketometer Precision Xtra). Data were analyzed using a 2-independent samples comparison analysis, using a 2×2 contingency table (considering year and treatment). Supplementation of rumen-protected vitamins (RPV: choline, riboflavin and folic acid), during the transition period of dairy cows, reduced incidence of retained fetal membranes from 52.24 to 12.30%; incidence of ketosis from 29.52 to 6.67% and incidence of metritis from 79.05 to 15.24% ($P < 0.05$). In conclusion, under present study conditions, supplementation 50 g/cow/d of rumen-protected vitamins (choline, riboflavin and folic acid), during the transition period, significantly reduced incidence of

retained fetal membranes, metritis and ketosis, in heat-stressed dairy cows at northern Mexico (La Laguna dairy region).

Key Words: dairy cow, metabolic disorder, vitamins

W436 Effect of reducing dietary calcium, phosphorus and trace minerals on intake and performance of finishing Nellore bulls. Laura F. Prados^{*2,1}, Breno Silva², Herlon M. Alhadas², Marcos P. Rodrigues², Ana C. O. Lopes², Danilo F. T. Sathler², Paloma M. Amaral², Lays D. S. Mariz², Sebastião C. Valadares Filho², and Galen E. Erickson¹, ¹University of Nebraska-Lincoln, Lincoln, Nebraska, ²Universidade Federal de Viçosa-MG, Viçosa, Minas Gerais, Brazil.

Mineral nutritional studies are important to establish dietary needs and avoid excesses for improved excretion and economics. The aim of this experiment was to evaluate the effect of decreasing calcium, phosphorus and trace mineral concentration in finishing performance and carcass characteristics using weaned Nellore bulls ($n = 36$; 273 ± 37 kg) in a RCBD-designed study. Treatments A and B contained 96.3 and 97.9% of the Ca and P requirement by supplementation of limestone and dicalcium phosphate whereas treatments C and D contained 47.8 and 66.8% of the BR-CORTE published requirement for Ca and P, respectively. Treatments A and B contained 56.8 ppm of Zn, 49.2 ppm of Mn, and 15.4 ppm of Cu and C and D contained 31.2 ppm of Zn, 42.3 ppm of Mn, and 5.8 ppm of Cu. The diets were isonitrogenous (13.3% CP). Intake was monitored every day. The cattle were slaughtered (84 and 147 d) and LM area and 12th rib fat thickness measured. Feed samples were analyzed for DM, ash, CP, Ca, P, and trace minerals (Zn, Mn and Cu). Treatment differences were declared significant by Tukey's test at $P \leq 0.05$. Calcium, P and trace mineral concentration did not affect DM and OM, CP, NDF, EE, and NFC intake ($P > 0.42$). Calcium and P intake were different among the treatments ($P < 0.01$) with supplemented bulls consuming more Ca and P in treatments A and B compared with treatments C and D. Final BW, empty BW, and ADG were similar ($P > 0.16$) among treatments. Carcass characteristics were not influenced ($P > 0.70$) by dietary treatment. These data suggest that dietary mineral concentration did not influence cattle performance. These results indicate that councils overestimate the requirements of Ca, P, and trace minerals, so supplementation is not necessary in conventional feedlot diets. Dietary reductions in these minerals would represent a significant decrease in the costs of feedlot and reduction in mineral excretion.

Key Words: mineral requirement, phosphorus, trace mineral

W437 Overfeeding energy alters visceral fat miRNA profiles in Holstein cow. Afshin Hosseini¹, Hua Bao², Khuram Shahzad^{*1}, James K. Drackley¹, Leluo Guan², and Juan J. Loo¹, ¹University of Illinois, Urbana, IL, ²University of Alberta, Edmonton, AB, Canada.

MicroRNAs (miRNAs) are small regulatory molecules (~22 nt) which cause post-transcriptional gene silencing. Our objective was to examine the effect of overfeeding a moderate-energy diet on miRNA expression in mesenteric adipose tissues of dry non-pregnant cows. Fourteen Holstein cows were assigned to treatments in a randomized complete block design. All cows were fed individually a control diet (CON; NEL = 1.3 Mcal/kg) to meet 100% of NRC requirements for 3 wk, after which half of the cows were assigned to a moderate-energy diet (OVE; NEL = 1.6 Mcal/kg) and half of the cows continued on CON for 6 wk. The OVE diet was fed ad libitum and resulted in cows consuming energy at ~180% of NRC. CON cows were fed to consume only to 100% of NRC. The BW was measured from wk -3 to 6 wk. Cows were slaughtered after 6 wk, and samples of mesenteric fat collected for total RNA plus

miRNA extraction, and miRNA sequencing. The differential expression of miRNAs in OVE vs. CON was assessed using *EdgeR* with an FDR adjusted *P*-value ($P < 0.05$). The analysis of predicted miRNA target genes was performed by estimating a Total Context+ Value ($TC+V \leq -0.7$) using the TargetScan database. OVE cows had greater ($P < 0.001$) BW at slaughter (758 vs. 693 kg). Fourteen miRNAs were differentially expressed ($P < 0.05$); the OVE cows had a greater expression of miRNAs bta-miR-378, 22-3p, 107, 103, 149-5p, 378c, 30c, 1307 and 6529a, whereas, the bta-miR-199a-5p, 205, 339b, 339a and bta-miR-27a-3p were upregulated in CON cows. The TargetScan analysis predicted the transcriptional change of 47 genes related to cellular ion transport and binding (e.g., Na^+/K^+ and calcium), fat metabolism (*PPARGC1B*) and feeding behavior (*GPR178*). Overfeeding energy did not alter insulin sensitivity but seemed to affect adipogenesis and fatty acid metabolism in mesenteric adipose tissue. In OVE cows, *PPARG* was the main target gene triggered by bta-miR-30c upregulation. The results suggest that miRNAs can respond to dietary energy level and likely play a role in regulating adipose tissue metabolism and energy expenditure.

Key Words: dairy cow, plane of energy, visceral fat

W438 Microbial protein yield of Nelore bulls supplemented with protein sources associated with crude glycerin on finishing phase. Antonio Jose Neto^{*1}, Joanis Tilemahos Zervoudakis², Luciana Keiko Hatamoto-Zervoudakis², Luciano da Silva Cabral², Juliane Quenoizoré Soares², Rosemary Lais Galati², Renata Pereira da Silva-Marques², Everton Riva Donida², and Lilian Chambó Rondena Pesqueira Silva², ¹Department of Animal Science; São Paulo State University-UNESP, Jaboticabal, SP, Brazil, ²Department of Basic Sciences and Animal Production; Federal University of Mato Grosso-UFMT, Cuiabá, MT, Brazil.

Crude glycerin (Gly) has the potential to partially replace starch-based ingredients in the diet, such as corn, because glycerol is converted to propionate in the rumen and acts as a precursor for hepatic glucose synthesis. The objective of this study was to evaluate the effects of Gly combined with protein sources on microbial protein yield of Nelore bulls fed tropical pasture during the rainy season. Five Nelore bulls (448.2 ± 14 kg; 25 ± 3 mo) were evaluated in a 5 × 5 Latin square design with 5 treatments and 5 periods. The animals were allocated into 5 paddocks of 0.25 ha, consisting of *Brachiaria brizantha* 'Marandu' in the rainy season. Crude glycerin (83.9% of glycerol) was used in all supplements to replace (15% of DM) corn. The supplements were: Gly with urea (GU), Gly with soybean meal (GS), Gly with cottonseed meal (GC), and Gly with corn gluten (GG), and the control received mineral mixture ad libitum. Animals were individually supplemented at the rate of 300 g · 100 kg⁻¹ of BW, daily, at 1000 h. Urine samples were collected 4 h after the supplementation to determine the concentration of urea, creatinine, nitrogen and purine derivatives, on the last day of period. Data were analyzed using the PROC MIXED of the SAS. Purines derivatives absorbed, microbial N, microbial protein and CP intake per digestible organic matter intake was lower ($P < 0.05$) for control compared with protein sources (Table 1). Crude glycerin associated with protein sources can be efficient to improve microbial protein yield.

Contd.

Table 1 (Abstr. W438). Effect of supplemental nitrogen sources associated with crude glycerin on microbial protein yield of Nelore bull in tropical pasture

Item	Supplements					SEM	P-value
	Control	GU	GS	GC	GG		
Purines derivatives, mmol/d							
Allantoin	108.74 ^b	168.39 ^a	150.01 ^a	162.57 ^a	156.61 ^a	14.03	0.04
Uric acid	25.40 ^b	44.14 ^a	35.34 ^{ab}	27.15 ^b	24.14 ^b	5.94	0.01
Absorbed	110.13 ^b	201.99 ^a	170.54 ^a	175.93 ^a	164.69 ^a	18.02	0.02
Microbial protein yield, g/d	500.44 ^b	917.83 ^a	774.94 ^a	799.45 ^a	748.36 ^a	81.88	0.02
CP intake per DOMI ¹ , g/kg	184.36 ^b	220.39 ^a	238.93 ^a	240.75 ^a	239.05 ^a	10.31	<0.01

¹DOMI = digestible organic matter intake.

Key Words: *Brachiaria brizantha*, glycerin, supplement

W439 Effects of supplemental protein sources associated with crude glycerin in Nelore bulls finished on pasture on apparent digestibility. Antonio Jose Neto^{*1}, Joanis Tilemahos Zervoudakis², Luciana Keiko Hatamoto-Zervoudakis², Luciano da Silva Cabral², Renata Pereira da Silva-Marques², Rosemary Lais Galati², Juliane Quenoizoré Soares², Everton Riva Donida², and Felipe Cacite², ¹Department of Animal Science; São Paulo State University-UNESP, Jaboticabal, SP, Brazil, ²Department of Basic Sciences and Animal Production; Federal University of Mato Grosso-UFMT, Cuiabá, MT, Brazil.

Previous studies demonstrated that crude glycerin (Gly) was an excellent energy source and can partially replace corn grain in ruminant diets. The aim of this study was to evaluate the effect of supplemental protein sources associated with Gly on digestibility of OM, NDF and CP of Nelore bulls in tropical pasture during the rainy season. Five Nelore bulls (448.2 ± 14.8 kg) were used in a 5 × 5 Latin square design (5 periods and 5 treatments). The pastures were divided into 5 paddocks of 0.25 ha each, consisting of *Brachiaria brizantha* 'Marandu'. Crude glycerin was used in all supplements to replace (15% of DM) corn. The supplements were: T1 - Gly with urea, T2 - Gly with soybean meal, T3 - Gly with cottonseed meal, and T4 - Gly with gluten, and the control received mineral mixture ad libitum. Animals were individually supplemented at the rate of 300 g · 100 kg⁻¹ of BW, daily, at 1000 h. To estimate feed intake, chromium oxide was used as external marker, and indigestible neutral detergent fiber (iNDF) was used as internal marker (forage intake). Fecal grab samples were collected on d 15–17 in different times. Fecal samples were composited on a wet-basis by period for each bull. Fecal and ingredients samples were analyzed for OM, NDF and CP contents. Data were analyzed using the PROC MIXED of the SAS. There was no effect of Gly associated protein sources on digestibility of OM and NDF (Table 1). However, there was effect on digestibility of CP ($P = 0.04$). Crude glycerin showed be an good energy source and can partially replace corn grain (15% of DM) in ruminant diets. Independently of protein source utilized, there was an increase of 21.3% ($P = 0.04$) on digestibility of CP for animals supplemented when compared with control group. Urea associated with Gly can be effective for improving CP digestibility of Nelore bulls in tropical pasture.

Contd.

Table 1 (Abstr. W439). Effect of supplemental nitrogen sources associated with glycerin on nutrients digestibility of Nellore bulls

Item	Dietary treatments					SEM	P-value
	Control	T1	T2	T3	T4		
OM, %	54.87	62.50	60.41	59.62	59.99	2.72	0.39
NDF, %	60.58	64.56	62.05	60.07	62.05	2.11	0.45
CP, %	55.38 ^b	70.55 ^a	73.00 ^a	69.78 ^a	68.01 ^a	3.76	0.04

Key Words: *Brachiaria brizantha*, digestibility, glycerin

W440 Nutrient intake of Nellore bulls in tropical pasture supplemented with crude glycerin and different sources of protein.

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This study was aimed to evaluate the effect of supplemental protein sources associated with glycerin on DM and nutrient intake of Nellore bulls in tropical pasture during the rainy season. Five Nellore bulls (448.2 ± 14.8 kg) were used in a 5 × 5 Latin square design (5 periods composed of 17 d and 5 treatments). The pastures were divided into 5 paddocks of 0.25 ha each, consisting of *Brachiaria brizantha* 'Marandu'. All diets consisted of 15% of crude glycerin (DM) associated with protein sources: urea (GU), soybean meal (GS), cottonseed meal (GC), gluten (GG), and the control. Animals had a free access to mineral supplement. Animals were individually supplemented at the rate of 300 g:100 kg⁻¹ of BW, daily, at 1000 h. To estimate feed intake, chromium oxide was used as an external marker, and indigestible neutral detergent fiber (iNDF) was used as an internal marker to estimate forage intake. All data were analyzed using the MIXED procedure of SAS. Dry matter intake (% of BW) was higher ($P < 0.01$) when animals were supplemented with GU (Table 1). Forage intake was increased ($P = 0.02$) fed animals with GU supplements compared with other treatments. Supplement intake was similar ($P = 0.89$) among treatments. Feeding GU increased ($P < 0.01$) OM, CP, NDF and TDN intake of bulls. Crude protein intake were greater in bulls consuming supplements ($P < 0.01$) compared with control, which is logical due the lower content of CP in forage. Providing supplement with association of crude glycerin and urea for grazing cattle in the rainy season improved dry matter and nutrient intake. Crude glycerin can partially replace (15% of DM) energy source in ruminant diets.

Table 1 (Abstr. W440). Effect of supplemental nitrogen sources associated with glycerin on nutrients intake of Nellore bull in pasture

Item	Dietary treatments					SEM	P-value
	Control	GU	GS	GC	GG		
DM, intake							
% of BW	1.68 ^c	2.24 ^a	1.98 ^b	2.01 ^b	1.94 ^b	0.08	<0.01
Forage, g/d	8,363 ^b	9,416 ^a	7,975 ^b	8,034 ^b	7,865 ^b	426.72	0.02
Supplement, g/d	0.00	1,832	1,862	1,858	1,854	15.73	0.89
OM, g/d	7,656 ^c	10,309 ^a	9,002 ^b	9,067 ^b	8,877 ^b	390.65	<0.01
NDF, g/d	5,565 ^b	6,870 ^a	5,872 ^b	5,861 ^b	5,830 ^b	283.91	<0.01
CP, g/d	754.4 ^c	1,402 ^a	1,292 ^b	1,293 ^b	1,268 ^b	38.51	<0.01
TDN, g/d	4,686 ^c	6,560 ^a	5,793 ^b	5,844 ^b	5,712 ^b	239.09	<0.01

Key Words: *Brachiaria brizantha*, glycerin, nutrient intake

W441 Protein molecular structure and nutritive value of yellow and black canola seed. Katerina Theodoridou^{1,2}, Ban Yajing*², and Peiqiang Yu², ¹University of Saskatchewan, Saskatoon, SK, Canada, ²Queen's University, Belfast, UK.

Oilseeds and their products are the most valuable agricultural crops in world trade. Canola includes the yellow and the black-seeded varieties. Apart from the chemical composition of oilseed crops, their protein secondary structure profiles may also influence protein quality, nutrient utilization and availability. Although data are rare, is vital to study protein secondary structure to understand crop's digestive behavior and nutritional value. A new approach is the use of Fourier-transformed infrared-vibration spectroscopy (FT/IR), a technique for studying the secondary structural composition, stability and conformational changes. The objective was to evaluate the nutritive value of canola seed, for ruminants, in terms of: 1) chemical and nutrient profiles 2) rumen degradation kinetics, 3) in vitro intestinal protein digestibility and 4) protein molecular structures. Yellow (CS-Y) and black (CS-B) canola seeds (n = 4) were collected from 2 harvest years (2010, 2011) and used as feed sources. Three dry Holstein cows fitted with rumen cannula were used in an in situ trial; then a 3-step in vitro procedure was conducted to determine protein intestinal digestibility. CS-Y was lower in nitrogen detergent fiber and acid detergent fiber ($P < 0.05$). Crude protein content was not different between the 2 varieties but the non-protein nitrogen was lower ($P < 0.05$) for CS-Y compared with CS-B. The net energy for lactation, the digestible and metabolisable energy were higher ($P < 0.05$) for CS-Y compared with CS-B. The C20:1 eicosaenoic acid content (n-9) was lower ($P < 0.05$) while the total polyphenols were tended to be lower ($P \leq 0.10$) for the CS-Y than for the CS-B. No significant differences were observed for the effective degradability of protein and the protein's inherent molecular structural make up, between the CS-Y and the CS-B. The in vitro protein intestinal digestibility of CS-Y was higher ($P < 0.05$) compared with that of CS-B. In conclusion, the breeding of CS-Y has the potential to be a promising route to reducing fiber and hull content, while at the same time increasing the level of oil.

Key Words: canola, protein molecular structure, ruminal digestion

W442 Effect of supplementation of two sources and two levels of copper on performance, copper status and ruminal fermentation in Nellore bulls. Lisia Bertonha Correa, Marcus Antônio Zanetti, Janaina Silveira Silva, Brenda Barcelos*, and Arlindo Saran Netto, University of Animal Science and Food Engineering, Pirassununga, São Paulo, Brazil.

Thirty-five Nellore bulls were used to determine the effect of supplementation of 2 levels and 2 sources of copper (organic and inorganic) on performance, copper status in the body and ruminal parameters. The 5 treatments used were: 1) Control (C) - without copper supplementation; 2) 10 mg of Cu / kg of DM (as Cu sulfate; CuI10), 3) 40 mg of Cu/ kg of DM (as Cu sulfate; CuI40); 4) 10 mg of Cu/ kg of DM (as Cu proteinate; CuO10); 5) 40 mg of Cu / kg of DM (as Cu proteinate; CuO40), for a period of 84 d. Body weight and blood samples were collected every 28 d for copper and ceruloplasmin analysis. At slaughter samples collected consisted of rumen fluid for short chain volatile fatty acids (VFA) determinations and ammonia nitrogen, also liver and muscle samples were collected for copper analysis. The experimental design was a completely randomized design with 7 replicates. Data were analyzed using PROC GLM of SAS. Means were compared by contrasts at a 5% significance level. There were no significant effects of copper level in the muscle (4.45, 4.24, 4.82, 4.21 and 5.79 with 1.05 of SEM for C, I10, I40, O10 and O40, respectively) and copper concentrations in the serum (0.873, 0.885, 0.967, 0.896 and 0.901 with

0.03 of SEM for C, I10, I40, O10 and O40, respectively). However, there was a quadratic effect for supplementation with different sources and Cu levels, with respect to time. The Cu concentration in the liver was higher ($P < 0.05$) in animals supplemented with CuO40 with the values 237.3, 435.7, 607.5, 466.6 and 765.4 with 48.71 of SEM for C, I10, I40, O10 and O40, respectively. The CuI40 treatment showed the highest serum activity of ceruloplasmin ($P < 0.05$). There was no significant effect for feed efficiency between treatments. The ruminal pH, VFA and ammonia nitrogen were not affected by treatments. In general, copper supplementation altered the Cu "status" in the animal with a greater accumulation of Cu in the liver of animals receiving the CuO40. These results show that feeding higher amounts of organic Cu make the mineral more bioavailable.

Key Words: cattle, mineral, performance

W443 Effects of dietary tannin extracts levels during a thirteen-week period on lactating cow performance and N use efficiency. Matias J. Aguerre*¹, Benjamin D. Duval², Mark Powell¹, Peter Vadas¹, and Michel A. Wattiaux¹, ¹Department of Dairy Science, University of Wisconsin-Madison, Madison, WI, ²Department of Biological Systems Engineering, University of Wisconsin-Madison, Madison, WI.

Our objective was to determine the long-term effect of feeding tannin extracts to lactating cows on performance and nitrogen (N) utilization efficiency. Thirty-four multiparous lactating cows (711 ± 59 kg BW; 113 ± 19 DIM) were randomly assigned to 3 dietary treatments in a randomized complete block design. Following a 2-wk covariate adjustment period, cows were fed their assigned treatment diets for 13 weeks. Rice hull was removed from a 54:46 forage to concentrate ratio (%DM) TMR as a tannin extract mixture from Quebracho and Chestnut trees (2:1 ratio) was included at 0 (control), 0.45, and 1.8% of dietary DM. Urinary excretion (g/d) was calculated as $0.0283 \times \text{BW (kg)} \times \text{MUN (mg/dL)}$. There was no interaction between dietary treatments and experimental week. Overall, milk yield (48.7 kg/d), fat-and-protein corrected milk (46.7 kg/d), milk fat content (3.89%) and yield (1.86 kg/d) and true protein yield (1.45 kg/d) were not affected by dietary treatments. There was a linear increase in DMI (29.2 to 30.9 kg/d), a linear decrease in milk/DMI (1.67 to 1.57 kg/kg) and a linear decrease in MUN (12.2 to 10.8 mg/dL) with incremental levels of tannin extracts in the diet (all $P < 0.01$). There was a quadratic effect ($P < 0.01$) for milk true protein content, (2.96, 3.13, and 3.00% for control, 0.45 and 1.8% tannin extract, respectively) and a tendency for linear ($P = 0.07$) and quadratic ($P = 0.06$) response for BW gain (0.31, 0.16 and 0.44 kg/d for control, 0.45 and 1.8% tannin, respectively). Intake of N increased linearly (782, 795, and 820 g/d) and N utilization efficiency (milk N/intake N) decreased linearly (0.30, 0.30 and 0.28) for control, 0.45 and 1.8% tannin, respectively. An 11% reduction ($P < 0.01$) in estimated urinary N excretion was observed between control and 1.8% tannin extract. In this study, adding tannin to the diet reduced feed efficiency, but had a positive effect on milk protein content at 0.45% tannin extract level. Feeding tannins at 1.8% in the diet may reduce dietary protein degradation and urinary N excretion without affecting milk protein yield.

Key Words: tannin, nitrogen efficiency, dairy

W444 Evaluation of inoculation method on rumen in vitro gas production kinetics. F. O. Scarpino-van Cleef*¹ and J. P. Keim², ¹São Paulo State University, Jaboticabal, São Paulo, Brazil, ²Universidad Austral de Chile, Valdivia, Región Los Rios, Chile.

This study evaluated the effect of pooling rumen fluid (RF) or using fluid of one cow across incubations on in vitro gas production (GP) on parameters of feedstuffs. A complete randomized block design was used and arranged in a 4×2 factorial scheme. Concentrate (corn grain, barley, soybean meal, mineral and vitamin premix) grass silage, grass hay and grass pasture were dried, ground and placed into 160-mL glass bottles. Duplicates of each substrate (1g) plus 2 blanks were incubated for three 48-h runs (considered as technical replicates). Bottles with 85 mL of Goering-Van Soest buffer solution were purged with CO₂ and 10 mL of RF was added to them. One treatment was incubated with RF from one cow (different for each run; not-pooled), whereas the other, a pool of RF from the same 3 cows was used for all runs. The volume of gas was extracted with a syringe, until the pressure in the digital display of the transducer reached 0, at times 2, 3, 4, 5, 6, 8, 10, 12, 18, 24 and 48h after incubation. A generalized Michaelis-Menten (MM) model was used to estimate fermentation kinetics, considering A: asymptote of GP (mL/g OM); N: shape of the curve; C: half-life rate degradation (%/h); K: time to ferment 50% of the substrate (h); MDR: maximum degradation rate (%/h); t₂₅, t₇₅: time to ferment 25 and 75% of asymptotic GP, respectively (h); 48GP: GP at 48 h. MIXED procedure of SAS was used, with the incubation method and substrate as fixed, and the run as random effect. The variance components (substrate, incubation, and error) were determined for each method with the varcomp procedure of SAS. There was no interaction between substrates and inoculation method; therefore, the variables were analyzed independently. The use of pooled RF promoted greater values of A (218) and t₇₅ (23.3) compared with not-pooled RF (A = 212, t₇₅ = 21.4), with P values and SED of 0.02 and 2.3, and 0.03 and 0.8 for A and t₇₅, respectively. All other parameters did not differ between inoculation methods. Substrate effect was significant ($P < 0.001$) for all MM parameters. For both inoculation methods, more than 94% of the variance was due to the substrates for all MM parameters. The variance accounted for incubation-runs was similar among inoculation method. Gas production parameters of different substrates follow a same trend regardless of the inoculation method.

Key Words: batch culture, gas production

W445 In vitro evaluation of a treatment to flaxseed for reducing bio-hydrogenation of the n-3 fatty acid α -linolenic. Scott L. Kronberg*¹ and Eric J. Scholljegerdes², ¹USDA-ARS, Northern Great Plains Research Laboratory, Mandan, North Dakota, ²Department of Animal and Range Sciences, New Mexico State University, Las Cruces, New Mexico.

Given the human health benefits of increasing n-3 fatty acid intake, inadequate intake of these fatty acids by many people, and problems associated with supplying these fatty acids from marine sources, there is a need to increase amounts of n-3 fatty acids in foods that are frequently eaten and affordable. Therefore, this study evaluated the amount of the α -linolenic acid (ALA) that was bio-hydrogenated by bovine ruminal microbes to evaluate the potential effectiveness of a consumer-acceptable protective treatment to flaxseed. The proprietary treatment to flaxseed was evaluated with an in vitro fermentation trial that was conducted for 12 or 24 h. A small amount of quebracho tannin was included in the in vitro medium of some fermentation tubes to determine if this material could help reduce bio-hydrogenation of ALA. Residue from each tube was lyophilized then analyzed for fatty acids using direct trans-esterification with methanolic-HCl. The trial had a completely randomized design with a factorial arrangement of treatments. The treatment applied to flaxseed reduced ($P < 0.01$) bio-hydrogenation of ALA with 65% of ALA remaining after 24 h of fermentation versus 23% remaining for the non-treated flaxseed. Inclusion of tannin in fermentations

did not help reduce bio-hydrogenation ($P = 0.15$), and the interaction of flaxseed treatment and tannin was not significant ($P = 0.56$). These results indicate that the protective treatment applied to flaxseed may reduce bio-hydrogenation of ALA in cattle and this may lead to greater amounts of n-3 fatty acids in their muscles if they consume the treated flaxseed daily for several months before harvest.

Key Words: n-3 fatty acids, cattle, ruminants

W446 Evaluation of botanical extracts supplemented or not with live yeast compared with monensin supplementation on rumen fermentation in lactating Jersey cows. Bertrand Medina^{*1}, Phillip Meiring², Bruno Ghilardi¹, and Lourens Erasmus², ¹Laboratoires Phodé, France, ²Dept of Animal & Wildlife Sciences, University of Pretoria, South Africa.

More and more countries have banned the use of antibiotic growth promoters in livestock nutrition stimulating the neo-investigation for natural alternative additives. The objectives of this study were (i) to compare the effects of monensin sodium (MO), botanical extracts (BE) and its combination with a yeast product (BE+LY) on dairy cow performance by determining their effect on rumen pH and general rumen fermentation and (ii) to determine whether natural alternatives have the potential to replace ionophores as the primary fermentation altering feed additive for lactating Jersey cows. Four rumen cannulated lactating Jersey cows were used in a 4 × 4 Latin square design experiment. The 4 experimental treatments were: 1) Control (C), a lucerne hay/maize based TMR (10.7 MJ ME/kg, 17% CP, 32.1% NDF), 2) MO (15 mg/kg of Rumensin, Elanco Animal Health), 3) BE (1g/d/cow, Oleobiotec, Laboratoire PHODE, France) and 4) BE + LY (group 3 combined with 1x10¹⁰ cfu yeast (*Saccharomyces cerevisiae* CNCM I-1077)/d/cow. The experimental periods were 25 d with the last 4 d for milk performance, rumen sampling and the *in sacco* nutrient disappearance. Results (Table 1) suggest that the tested BE has potential to be a natural alternative to ionophore antibiotics in dairy diets.

Table 1 (Abstr. W446). Effect of feed additives

Parameter	C	MO	BE	BE + LY	SEM
DMI (kg/d)	22.0 ^{cd}	21.3 ^d	22.7 ^c	22.3 ^{cd}	0.5
Milk production (kg/d)	22.9 ^{cd}	22.4 ^d	23.2 ^c	23.4 ^c	0.37
Fat %	4.32 ^b	4.45 ^{ab}	4.52 ^a	4.46 ^{ab}	0.05
Protein %	3.93	3.93	3.91	3.91	0.25
Rumen fermentation parameters measured at 1400 h (7 h post-feeding)					
Ruminal pH	6.02 ^d	6.28 ^c	6.30 ^c	6.10 ^c	0.09
Total VFA (mmol/L)	120.6 ^{cd}	106.4 ^d	128.1 ^c	121.7 ^{cd}	6.52
<i>In sacco</i> disappearance (%)					
NDF 24 h (Lucerne)	50.6 ^d	51.8 ^{cd}	54.7 ^c	50.6 ^d	1.35
Starch 24 h (TMR)	90.5 ^b	93.1 ^{ab}	95.7 ^a	90.2 ^b	1.55
N-nitrogen 24 h (TMR)	84.5 ^{ab}	85.1 ^a	84.8 ^a	82.8 ^b	0.50

Means in the same row without a common superscript differs (^{abP} < 0.05; ^{cdP} < 0.1).

Key Words: botanical extract, monensin, lactating cow

W447 Fertilization and dried distillers grains supplementation effects on performance and nitrogen recovery by stocker cattle grazing old world bluestem. Phillip A. Gunter^{*}, Brody D. Wallis,

Phillip A. Lancaster, and Gerald W. Horn, *Oklahoma Agricultural Experiment Station, Stillwater, OK.*

A 2-yr study evaluated the efficacy of using dried distillers grains plus solubles (DDGS) as a substitute for nitrogen (N) or N and phosphorus (P) fertilizer in stocker cattle grazing Plains Old World bluestem. Cattle were allotted to 1 of 4 treatments: 1) Old World bluestem pastures with no N or P fertilizer and low stocking rate of 325 kg BW/ha (CONT), 2) Old World bluestem pastures fertilized with 90 kg/ha of N and no P with high stocking rate of 650 kg/ha (NFERT), 3) Old World bluestem pastures fertilized with 90 kg/ha of N and 40 kg/ha of P with high stocking rate of 650 kg BW/ha (NPFERT), and 4) unfertilized Old World bluestem pastures with the same stocking rate as NFERT and NPFERT with cattle receiving 0.75% BW of corn DDGS per day for a 5 d/week feeding schedule (SUPP). Average forage mass in yr 1 and 2 was 3,170 and 6,051 kg/ha, respectively. In yr 1 final BW ($P < 0.05$), total BW gain ($P < 0.05$), overall ADG ($P < 0.05$), and gain/ha ($P < 0.05$) were greater for SUPP compared with CONT, NFERT, and NPFERT. Nitrogen recovery as cattle weight gain was greatest ($P < 0.05$) for CONT (28.32%), and SUPP (14.22%) was greater than NFERT (4.42%) and NPFERT (4.77%). In yr 2 there were no differences ($P > 0.05$) between final BW, total BW gain, or overall ADG between treatments. This may have been due to greater forage mass in yr 2. Gain per ha was greater ($P < 0.05$) for SUPP, NFERT, and NPFERT compared with CONT and may be due to increased stocking rates for those treatments. Nitrogen recovery was greater ($P < 0.05$) for CONT (45.45%), intermediate for SUPP (18.20%), and lowest for NFERT (6.91%) and NPFERT (6.81%). Dried distillers grains can be used as a substitute for forage and N fertilizer by improving performance and N recovery by stocker cattle grazing Old World bluestem.

Key Words: stocker cattle, Old World bluestem, nitrogen recovery

W448 Effect of altered nitrogen excretion by condensed tannin supplementation on steer energy losses. Adam L. Shreck^{*1}, Pake J. Ebert², Eric A. Bailey³, Jenny S. Jennings², and N. Andy Cole¹, ¹USDA-ARS, Bushland, TX, ²Texas Agrilife Research, Amarillo, TX, ³West Texas A&M University, Canyon, TX.

Uncertainty remains regarding the effect of excess dietary protein on the energetic cost of urea excretion in beef cattle. We individually fed British-cross steers (n = 27; initial BW = 350 ± 32 kg) a finishing diet based on steam-flaked corn (14.4% CP) top dressed with commercially-available condensed tannin extract (CT) at 3 levels (0, 0.5, and 1.0% of diet, DM basis). Ruminal methane (CH₄) and metabolic CO₂ fluxes were measured using a GreenFeed unit (C-Lock Inc., Rapid City, SD) for two 20-d sampling periods, that coincided with fecal and urine sampling. Diet digestibility and N balance were estimated approximately 30 d after the experiment began (EARLY) and 30 d before the animals were harvested (LATE), using TiO₂ as a marker of fecal output and urinary creatinine:BW ratio as a marker for urine output, respectively. From this, we previously determined that fecal N excretion as a percentage of total N excretion increased approximately 10% as CT supplementation increased to 1.0%. Urine energy loss was estimated from urine N excretion, assuming all excreted N was urea. Heat production was estimated from the Brouwer (1965) equation. Oxygen consumption was estimated from CO₂ production assuming a respiratory quotient of 1.05. Flux of CO₂ (10,279, 10,537, and 10,478, g/d; SEM: 542.5) and CH₄ (144, 154, and 158 g/d; SEM:13.2) were similar ($P \geq 0.23$) among treatments during both sampling periods for 0, 0.5, and 1.0% CT, respectively. Percentage of GE intake lost as CH₄ was not different for 0 (3.27%), 0.5 (3.32%) or 1.0% (3.71%) CT. Proportion of GE intake lost in urine averaged 1.03, 1.01, and 0.97% for CT levels of 0, 0.5, and

1.0%, respectively but was not different among treatments ($P \geq 0.41$; SEM: 0.08). Heat production was similar across treatments (27.3, 28.0, 27.8 Mcal/d; $P \geq 0.52$; SEM: 1.37) and no difference was observed for heat production lost as a percent of GE intake (47.0%, 45.7%, 50.1%) for 0, 0.5, and 1.0% CT, respectively. The results of this study suggest that while N excretion was altered by 10% from urine to feces by tannin supplementation, no difference in energy losses was observed.

Key Words: condensed tannin, net energy, nitrogen

W449 Organ mass in pure and crossbred mature beef cows grazing different herbage allowances of grasslands. Alberto Casal*¹, Ana L. Astesiano¹, Ana I. Trujillo¹, Ana C. Espasandin², Pablo Soca², and Mariana Carriquiry¹, ¹Facultad de Agronomía, Universidad de la República, Montevideo, Uruguay, ²Facultad de Agronomía EEMAC, Universidad de la República, Paysandu, Uruguay.

The aim of this study was to evaluate the effect of controlling the intensity of grassland grazing (Campos biome), through control of herbage allowance (HA), on mass of internal organs of beef cows of different genotype. Mature beef cows (n = 32) were used in a randomized complete block design with a factorial arrangement of herbage allowance (2.5 vs. 4 kg DM/d; LO vs. HI) of native pastures (52% DM, 8.4% crude protein, 39.7% acid detergent fiber,) and cow genotype (CG; pure breed: Angus-Hereford vs. F1 reciprocal crosses; PU vs. CR). The experiment was conducted for 3 years and at the end of the third year at 192 ± 10 d postpartum cows were slaughtered and weight of all tissues and organs were collected. Means from a mixed model with repeated measure analysis were considered to differ when $P \leq 0.05$. The gastrointestinal tract (GIT) mass (kg) was greater ($P = 0.02$) and the diaphragm and lungs mass tended ($P \leq 0.09$) to be greater in HI than LO cows, while liver and heart mass were greater ($P \leq 0.01$) in CR than PU cows. Absolute kidney mass was not affected by HA or CG. However, when expressed as a proportion of the carcass, GIT and kidney weights tended to be lower ($P < 0.08$) and diaphragm weight was lower ($P = 0.04$) in CR than PU cows (151.6 vs. 161.1 ± 4.0 ; 8.2 vs. 8.9 ± 0.3 and 12.4 vs. 13.3 ± 0.3 g/kg carcass for GIT, kidney and diaphragm, respectively). In addition, relative weights of heart and kidney were lower ($P \leq 0.05$) in HI than LO cows (8.2 vs. 8.9 ± 0.2 and 8.1 vs. 9.0 ± 0.3 g/kg carcass for heart and kidney, respectively). Neither absolute nor relative head weights differed between cow groups. Absolute weight of the skin tended ($P = 0.08$) to be greater and relative weight was greater ($P = 0.01$) in LO than HI cows (30.3 vs. 32.3 ± 1.0 g/kg carcass). Although absolute weight of legs was not affected by HA or CG, its relative weight was 16.7% less in CR than PU and 14.8% less in HI than LO cows. Results suggest that LO and PU cows could have increased maintenance energy requirements through increased relative organ weights, which could affect cow-calf system productivity.

Key Words: cattle, organ mass, rangeland

W450 Effect of cow parameters on enteric methane production in dairy cows: an individual variation approach. Edward H. Cabezas-García*¹, Sophie J. Krizsan¹, Kevin J. Shingfield², and Pekka Huhtanen¹, ¹Swedish University of Agricultural Sciences, Department of Agricultural Research for Northern Sweden, Umeå, Västerbotten, Sweden, ²Aberystwyth University, Institute of Biological, Environmental and Rural Sciences, Aberystwyth, Ceredigion, UK.

The current knowledge about the biological basis of between-animal variation in methane (CH₄) production is still limited. The aim of this

study was to evaluate between-animal variability and repeatability animal factors expected to affect CH₄ emissions using a meta-analytical approach. The data set were collected from 35 studies conducted in Nordic countries involving 126 individual cows and 566 cow/period observations. All studies were conducted either using Latin square or change over designs. Diets comprised principally grass silage and cereal grain concentrates with the mean forage: concentrate ratio of 60:40 on DM basis. CH₄ emissions per mol VFA were calculated based on VFA stoichiometry (Wolin, 1960). The variance components analysis was conducted with MIXED procedure of SAS. Repeatability (R) was calculated as $R = \delta^2_{\text{cow}} / (\delta^2_{\text{cow}} + \delta^2_{\text{Resid}})$. Of animal variables affecting CH₄ emissions DMI showed the greatest variation and repeatability (Table 1), whereas both OMD and CH₄VFA displayed small variability. Efficiency of microbial N synthesis (ENS) and passage rate of iNDF were more variable and repeatable than CH₄VFA. Increased feed intake was negatively ($P < 0.001$) associated with reduced OMD and CH₄VFA and positively ($P < 0.01$) with EMPS (H₂ sink). Reduced CH₄/kg DM with increased DMI can be attributed to these factors. Efficiency of MPS decreased ($P < 0.001$) with improved OMD that can result from increased digesta retention time in the rumen. It is concluded that between-animal CV in rumen fermentation pattern cannot account observed variation in CH₄. Between-animal differences in passage rate can contribute to variation in CH₄ as it influences digestibility and partitioning of fermented substrate between VFA and microbial cells.

Table 1 (Abstr. W450). Between cow variability of variables possibly related to CH₄ production

Item	DMI ¹	OMD	ENS	iNDF-kp	Acet	Prop	CH ₄ VFA
Mean	19.4	738	23.8	0.023	648	182	356
CV							
Total	14.0	4.6	18.1	21.9	8.1	13.1	5.0
Cow	8.7	1.50	6.5	8.4	1.25	2.52	0.96
Cow ¹		1.39	6.2	8.6	1.25	2.35	0.97
Repeatability	0.71	0.37	0.40	0.39	0.42	0.11	0.10

¹DMI as covariate.

Key Words: digestibility, passage rate, rumen fermentation

W451 Rumen fermentation responses to plant extracts rich in tannins. Barbara J. M. Lemos*, Flavia M. Souza, Fabiola A. Lino, Victor R. M. Couto, and Juliano J. R. Fernandes, Universidade Federal de Goiás, Goiania, Goiás, Brazil.

Effects of extracts derived from the husk of *Lafloensia pacari* (27.5% tannins, mainly hydrolysable) and *Stryphnodendron adstringens* (52.2% tannins, mainly condensed) on rumen fermentation were evaluated in 2 independent in vitro experiments. The doses were CTL, LOW, MEDIUM and HIGH (0, 30, 300, and 3000 mg/L of buffered rumen fluid, respectively). The diet (50:50 concentrate:roughage, 91% DM, 20% CP, 1.6% EE, 39% NDF) was ground (1 mm) and incubated using filter bags for 3, 6, 12, 24, 48, 72 and 96 h. The rumen fluid donor was fed with a 50:50 diet. The incubation was repeated 4 times in each experiment. The effective degradability (ED, passage rates of 5 and 8%/h) and potential degradability (PD) of DM were calculated based on DM disappearance. Culture fluid was sampled after 96 h of incubation. The responses of CTL, LOW, MEDIUM and HIGH doses of *L. pacari* were, respectively: ED5%/h = 51, 50, 50 and 28% (SEM = 0.75, $P < 0.01$); ED8%/h = 44, 43, 42 and 26% (SEM = 0.69, $P < 0.01$); DP = 81, 82, 81 and 48% (SEM = 2.57, $P < 0.01$); N-NH₃ = 12.3, 11.7, 9.8 and 6.5 mg/L (SEM = 0.88, $P < 0.01$); Total VFA = 62.9, 57.6, 50.9 and 42.3 mM (SEM = 4.28, $P = 0.03$); Acetate = 40.6, 37.1, 33.5 and 27.3 mM (SEM = 2.02,

$P = 0.01$); Propionate = 11.9, 11.2, 9.7 and 8.4 mM (SEM = 0.81, $P = 0.05$). The HIGH dose reduced ED5%/h (46%), ED8%/h (41%) and PD (40%), compared with CTL. The N-NH₃, total VFA, acetate and propionate decreased with HIGH and also with MEDIUM and LOW doses, which were similar. In the *S. adstringens* study, responses of CTL, LOW, MEDIUM and HIGH doses were, respectively: ED5%/h = 51, 52, 52 and 25% (SEM = 1.59, $P < 0.01$); ED8%/h = 44, 45, 44 and 23% (SEM = 1.58, $P < 0.01$); DP = 81, 82, 83 and 37% (SEM = 1.74, $P < 0.01$); N-NH₃ = 10.2, 10.6, 9.8 and 6.4 mg/L (SEM = 0.83, $P = 0.01$); Total VFA = 55.7, 58.6, 52.8 and 32.7 mM (SEM = 4.40, $P < 0.01$); Acetate = 36.8, 37.1, 33.5 and 20.9 mM (SEM = 2.63, $P < 0.01$). The HIGH dose reduced the ED5%/h (52%), ED8%/h (48%), PD (54%), total VFA (41%) and acetate (43%), compared with CTL. CTL and LOW doses showed similar concentration of N-NH₃, which decreased with MEDIUM and HIGH doses. There was no effect on propionate ($P = 0.13$). In conclusion, these plant extracts can be potentially useful to modify rumen fermentation patterns.

Key Words: degradability, in vitro

W452 Carcass characteristics of Nelore beef cattle fed with whole corn diet. Andrea M. Mobiglia^{*1}, Fernando R. Camilo¹, Victor R. M. Couto¹, Wallace V. S. Santos¹, Lucas D. Silva¹, Bruno P. C. Mendonça², Flávio G. F. Castro², and Juliano J. R. Fernandes¹, ¹Escola de Veterinária e Zootecnia da Universidade Federal de Goiás, Goiânia, Goiás, Brazil, ²Agrocricia Nutrição Animal e Sementes, Goiânia, Goiás, Brazil.

The objective was to evaluate effects of virginiamycin (VM) and monensin sodium (MON) in whole corn diet, with or without the use of roughage during adaptation on carcass characteristics of feedlot cattle. The animals were kept in the feedlot in group pens for 106-d with a 21-d adaptation period. One hundred Nelore bulls were used in a randomized complete block design with a 2 × 2 factorial arrangement of 4 treatments, being 2 kinds of additive (VM and MON) and 2 adaptation strategies. Each treatment consisted of 5 pens with 5 bulls per pen. Treatments were defined by VM (25 mg/kg of DM) and MON (30 mg/kg of DM), with or without 10% (DM basis) sugarcane bagasse (SB) during adaptation period as follows: VM 10% SB; VM 0% SB; MON 10% SB and MON 0% SB. After the adaptation period, animals were fed ad libitum once daily with a diet containing 85% whole corn, 15% pelleted feed (soybean, minerals and the additive). Probability of 10% was considered as statistical difference and 15% of probability was discussed as tendency. There were no differences ($P > 0.10$) between VM and MON treatments for any variables studied (Table 1). However, differences were observed ($P < 0.10$) for average daily gain (ADG) when the animals were fed with SB in the adaptation period. There was no interaction between the additives and SB for any variables studied; in contrast, animals fed with SB at adaptation period tended ($P < 0.15$)

to have higher carcass gain (CG) and carcass daily gain (CDG) than treatments without SB, independent of the additive used. Therefore, VM and MON had a similar effect on carcass characteristics, but the treatments containing SB showed great carcass gain when the tendency was discussed. The use of roughage source (SB) may increase the performance and carcass gain due to a greater adaptation of the Nelore bulls to whole corn diet.

Table 1 (Abstr. W452). Carcass data of bulls feedlot fed with whole corn diet

Variable (kg)	MON		VM		SEM	P-value		
	10%SB	0% SB	10%SB	0% SB		Additive	Roughage	A × R
Initial carcass weight	197.24	197.37	196.99	196.99	1.375	0.827	0.9631	0.963
Final carcass weight	290.98	297.54	291.48	289.30	5.865	0.521	0.715	0.470
Average daily gain	1.455	1.384	1.577	1.354	0.075	0.551	0.074	0.331
Carcass daily gain	0.895	0.877	0.977	0.842	0.048	0.631	0.138	0.249

Key Words: adaptation, additive, feedlot

W453 Effect of the use of virginiamycin and monensin sodium in high concentrate diet on carcass characteristics of beef cattle feedlot. Fernando R. Camilo^{*1}, Andrea M. Mobiglia¹, Gustavo R. Siqueira², Flávio D. Resende², Regina K. Grizotto², Victor R. M. Couto¹, and Juliano J. R. Fernandes¹, ¹Escola de Veterinária e Zootecnia da UFG, Goiânia, Goiás, Brazil, ²APTA - Agência Paulista de Tecnologia dos Agronegócios, Colina, São Paulo, Brazil.

Beef cattle feedlot is a strategy to increase the productivity, and to offer a great feedstock for the consumers. Ionophore and non-ionophore antibiotics have been used as feed additives for enable to supply of the high concentrate diets. 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 bulls feedlot. The animals were kept in feedlot in group pens for 105-d with a 28-d adaptation period. Three hundred thirty-nine 1/2 Nelore × 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 (pens). The blocks were defined by initial BW. The treatments are defined by levels of the 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 88:12 concentrate:roughage (sugarcane bagasse) ratio. Bulls were weighted at the beginning, after the adaptation period and at the end of the trial. Nine animals

Table 1 (Abstr. W453). Carcass data of the feedlot bulls fed with virginiamycin (VM) and monensin sodium (MON) in high concentrate diets

Variables	Additive (mg/kg DM)				SEM	Contrast (P-value)				
	MON 30					VM	VM vs. MON	L	Q	VM vs. VM/MON
	0	15	25	34						
ICW (kg)	215	215	215	215	216	0.653	0.3142	0.2334	0.2706	0.2620
FCW(kg)	322	317	318	320	320	8.785	0.6798	0.7171	0.1076	0.9849
Dressing (%)	56.63	56.74	56.51	56.76	56.92	0.267	0.4125	0.8772	0.7957	0.6560
CG (kg)	106.33	102.43	102.18	105.07	104.07	3.701	0.5088	0.7079	0.1670	0.7695
BWG (kg)	166.56	159.02	160.36	162.88	159.53	5.500	0.1446	0.5162	0.1403	0.4795
GY (%)	64.04	65.63	64.19	64.53	65.38	1.203	0.4364	0.9963	0.6080	0.6206
ADCG (kg/d)	1.02	0.98	0.98	1.00	0.99	0.038	0.5029	0.7084	0.1706	0.7643

were slaughtered at the beginning of the trial to determine initial hot carcass weight (HCW). At the end of the experiment, 330 bulls were slaughtered and determined the final HCW (Table 1). There was not statistical difference ($P > 0.05$) between the treatments for all variables studied. Therefore, the use of additives, MON and VM, isolated and combined, do not influenced the carcass characteristics.

Key Words: additive, feedlot, Nellore

W454 Effect of supplementation with different levels and rates of protein degradation on performance of Nellore calves.

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The objective of the present study was to evaluate the effect of different levels and rates of protein degradation on the performance of Nellore animals in their post-weaning phase on *Brachiaria brizantha* ‘Marandu’ pastures. The following treatments were used: protein-energy supplement containing 25% CP (C-25); protein-energy supplement containing 40% CP, with 1/3 of the CP from urea, and 2/3 plant-derived (40–1/3NPN); protein-energy supplement containing 40% CP, with 1/2 CP from urea, and 1/2 plant-derived (40–1/2NPN); and protein-energy supplement containing 40% CP, with 1/3 of the CP plant-derived, and 2/3 from urea (40–2/3NPN). The experimental period was from June to September 2013, divided into a period for acclimation, and three 28-d periods. The experimental areas consisted of 12 paddocks averaging 2.3 ha, totaling 28 ha. Eighty-four (84) uncastrated Nellore cattle at 15 mo of age, with an initial weight of 332 ± 6.19 kg, were used. Animals were weighed every 28 d to determine the daily weight gain (DWG). The experimental design was completely randomized, wherein the initial animals’ BW was used as a co-variable, and paddocks were considered the experimental unit. Data were analyzed as repeated measures over time in mixed models, with means compared by the *t*-test at 10% significance. No effect of supplements was found on DWG (0.673 kg; $P = 0.96$). There was also no interaction between supplements and experimental periods ($P = 0.76$); however, the periods altered the animal performance ($P = 0.02$). The initial period provided a 30% higher DWG than the others (0.842, 0.573 and 0.603 kg/d in the first, second, and third periods, respectively). Treatment did not alter BW significantly ($380 \text{ kg} \pm 5.24$; $P = 0.90$). In conclusion, different levels and rates of protein degradation do not modify the animal performance.

Key Words: protein degradation rate, protein levels, supplement

W455 Ruminal parameters of Nellore steers fed with high grain diet containing virginiamycin or monensin sodium.

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The objective of this study was to evaluate the effects on ruminal parameters of Nellore steers fed with high-grain diet using virginiamycin

(VM) and monensin sodium (MON). Twelve Nellore steers (268 ± 38 kg BW) with ruminal cannula were used in completely randomized design with 2 treatments and 6 replicates. Treatments were defined by kind of additive used in diet, VM (25 ppm) and MON (30 ppm). The animals were kept in feedlot in individual pens for 21 d. Ruminal ammonia nitrogen (NH₃-N), short-chain fatty acids concentration (SCFA) and ruminal fluid pH were measured before feeding (T0), 6 and 12 h after feeding (T6 and T12, respectively). Animals were fed ad libitum twice daily with a diet containing 85% whole corn and 15% pelleted feed (soybean, minerals and the additive). Data are shown in Table 1. There were no effects ($P > 0.05$) on NH₃-N and SCFA concentration and pH values when MON or VM were added in diet. Acetate:propionate ratio (A:P) did not show differences ($P > 0.05$) between treatments. However, the pH value decreased after feeding for both treatments. In conclusion, VM and MON did not affect pH, NH₃-N, SCFA and A:P ratio, however, the pH values were next to 6 and there was not wide variation between the measurement times.

Table 1 (Abstr. W455). Ruminal parameters of Nellore steers fed with high-grain diet containing virginiamycin or monensin sodium

Ruminal pH	VM	MON	SEM	P-value
T 0	6.11	6.08	0.307	0.952
T 6	6.07	6.15	0.322	0.868
T 12	5.98	6.02	0.256	0.921
SCFA (mM)				
T 0	120.34	114.99	5.073	0.476
T 6	103.74	100.00	3.969	0.534
T 12	108.95	105.23	4.025	0.536
A:P ratio				
T 0	2.25	2.44	0.228	0.556
T 12	2.07	2.12	0.166	0.812
NH ₃ -N (mg/dL)				
T 0	9.28	8.76	1.491	0.813
T 6	12.31	12.98	3.28	0.889
T 12	10.63	13.88	1.545	0.187

Key Words: adaptation, additive, feedlot

W456 Characterization of the variation in linoleic acid (18:2) in corn silage and grain hybrids in test plots. Michel Baldin*, Yun Ying, Gregory Roth, and Kevin J. Harvatine, Penn State University, University Park, PA.

Dietary unsaturated fatty acids (FA) provide many challenges to ruminants as they are toxic to rumen microbes and result in formation of bioactive *trans* FA in the rumen that reduce milk fat yield. Corn silage and high moisture corn are commonly recognized as a risk factor for milk fat depression (MFD). The mechanism of increased risk of MFD is not clear, but may be due to the high concentration of linoleic acid (18:2) in corn. Corn silage and corn grain have a low concentration of FA, but due to their high inclusion rate in diets they contribute substantially to the polyunsaturated FA intake. Limited literature has reported the variation in FA profile of commercial hybrids as well as the contribution of individual plant parts to total FA in corn. To determine the location of FA in the corn plant, 4 stalks from 4 different commercial hybrids were separated into: stalk, husk + shank, leaves, cob, and kernels. On a DM basis, 80.3% of total FA were in kernels, 11.9% in leaves, 5.1% in the stalk, 1.7% in the cob, and 1.0% in husk + shank. More than 96% of the 18:1 and 92.4% of the 18:2 was in kernels, whereas 71.3% of the 18:3 was in the leaves. Second, we screened 67 corn silage and 36 corn grain hybrids from commercial test plots. Corn silage total FA (% of

DM) averaged 2.54 ± 0.41 (mean \pm SD, percentiles: 10th = 2.0 and 90th = 3.1). Corn silage 18:2 (% of DM) averaged 1.24 ± 0.24 (percentiles: 10th = 0.94 and 90th = 1.60) and 18:2 (% of FA) averaged 48.66 ± 3.0 (percentiles: 10th = 45.2 and 90th = 52.2). In the corn grains, total FA (% of DM) averaged 3.56 ± 0.27 (percentiles: 10th = 3.0 and 90th = 4.2), 18:2 (% of DM) averaged 2.05 ± 0.15 (percentiles: 10th = 1.8 and 90th = 2.4), and 18:2 (% of FA) averaged 57.5 ± 1.6 (percentiles: 10th = 53.4 and 90th = 60.8). In conclusion, moderate variation in 18:2 concentration (both % of DM and % of FA) was observed in commercially available hybrids. Corn FA profile may provide an additional tool to improve nutritional value of corn silage and other corn products for ruminants.

Key Words: corn silage, fatty acid, milk fat

W457 Performance of beef cattle fed with different levels of roughage in high whole grain diet during the adaptation period.

Andrea M. Mobiglia¹, Fernando R. Camilo^{*1}, Flávio G. F. Castro², Bruno P. C. Mendonça², Mohana D. Neves², Victor R. M. Couto¹, and Juliano J. R. Fernandes¹, ¹Escola de Veterinária e Zootecnia da UFG, Goiânia, Goiás, Brazil, ²Agrocria Nutrição Animal e Sementes, Goiânia, Goiás, Brazil.

The objective of this study was evaluated the performance of beef cattle fed with whole grain diet and different levels of roughage during the adaptation period. The animals were kept in the feedlot in group pens (6 pens/treatment) for 120-d, with 21-d adaptation period and 99-d finishing period. Seventy 2 Nellore bulls were used in a randomized complete block design with 3 treatments and 6 replicates. All animals were fed with 85% of whole grain and 15% of pelleted feed (soybean, minerals and the additive, virginiamycin)(WG), and the treatments were defined by level of roughage (R) includes in diet, as follow: 0%R (animals fed with 100%WG during adaptation and finishing period); 15%R (animals fed with 85%WG:15%R during adaptation and 100% WG during finishing period) and 5% R (animals fed with 85%WG:15% R during adaptation and 95% WG:5% R during finishing period). In this study was evaluated the dry matter intake (DMI), average daily gain (ADG) and gain:feed (G:F). There were no differences ($P > 0.05$) for those variables between treatments. All animals showed the same performance and G:F, independent of roughage level in the diet. The roughage may be a problem in finishing cattle diet due to its management and storage. Therefore, animals fed without a roughage source may show the same performance when the roughage is added in the high grain diet.

Table 1 (Abstr. W457). Performance of beef cattle fed with different levels of roughage in high whole grain diet

Variable	Treatment			SEM	P-value
	0% R	15% R	5% R		
DMI (kg/d)	7.658	7.525	7.116	0.219	0.238
IBW (kg)	316	315	316	0.765	0.658
FBW (kg)	485	479	477	7.964	0.766
ADG (kg/d)	1.412	1.365	1.348	0.064	0.773
G:F	0.187	0.182	0.190	0.007	0.748

Key Words: adaptation, feedlot, whole corn

W458 Microalgae meal affects heifer performance and plasma fatty acids.

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Microalgae meal (MA; *Schizochytrium limacinum* CCAP 4087/2) was fed to finishing heifers (n = 285; 453 ± 24 kg initial BW) to assess impact on growth performance, carcass traits, and fatty acid composition in plasma. Heifers were stratified by weight, randomly assigned to pens of 8 animals each, and fed diets based on steam-flaked corn and corn gluten feed for 89 d. Treatments consisted of 0, 50, 100, or 150 g/animal daily of MA (Alltech, Inc., Nicholasville, KY) that was included in the feed additive premix and subsequently mixed in the total ration. Approximately 6 h before feeding, blood was collected via jugular venipuncture from 3 animals/pen on d 21 and 82 for analysis of plasma concentrations of eicosapentanoic, docosapentaenoic, and docosahexaenoic acids (EPA, DPA, and DHA, respectively), which are long chain omega-3 fatty acids that are most active within the body. Feeding MA did not affect ADG ($P = 0.58$), but decreased DMI ($P = 0.16$) and increased G:F, HCW, yield grade, and percent of USDA Choice carcasses in a dose dependent manner (linear, $P < 0.08$). Plasma concentrations of EPA (3.5, 23.6, 86.3, 153.5 ± 4.64 , respectively), DPA (13.4, 15.4, 22.4, 30.8 ± 1.04 , respectively), and DHA increased in proportion to the amount of MA fed (linear, $P < 0.01$). Data were analyzed as a randomized complete block design using the PROC MIXED procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with pen as the experimental unit and animal as the observational unit. Microalgae meal has potential for improving growth performance and assimilation of omega-3 fatty acids into beef tissues.

Table 1 (Abstr. W458). Performance, hot carcass weight, and plasma DHA concentrations

Item	0	50	100	150	SEM
DMI, kg/d	9.81	9.62	9.45	9.54	0.163
Gain:Feed ¹	0.0844	0.0889	0.0873	0.0929	0.0031
HCW, kg ¹	702.0	687.6	715.0	723.1	12.2
DHA, μ g/g plasma ²	5.3	26.5	38.8	46.8	1.42

¹Linear effect ($P < 0.07$).

²Linear effect ($P < 0.01$).

Key Words: omega-3, algae, beef

W459 Effect of concentrate supplementation on milk yield and fatty acid profile of crossbred dairy cows on tropical pasture.

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The aim of this study was to evaluate the supplementation rate on yield, composition and fatty acid (FA) profile of milk from 12 crossbred (1/2 *Bos taurus* – 1/2 *Bos indicus*) dairy cows at 60 d in milk and assigned to 4 treatments: 0, 150, 300 y 450 g concentrate (as-fed basis)/kg daily milk production, in a crossover design, with 3 periods of 15d. The cows were fed grazed tropical pasture (28% native grasses, mainly *Paspalum* spp. and *Axonopus* spp. and 72% *Brachiaria* spp. and *Cynodon neumftuensis*). The trial was conducted at the research station in Martínez de la Torre, Veracruz, Mexico. The daily milk yield was recorded through the experiment and weekly milk sampling was evaluated for composition, percentages of milk fat, protein, lactose, solid not fat (SNF), density (kg/m³) and fatty acids profile (g/100 g of fat). The data were analyzed with the SAS MIXED procedure and tested by means of orthogonal polynomials. Increasing concentrate at 0, 150, 300 and 450g/kg milk, increase (linear effect, $P < 0.05$) milk yield (7.35, 8.62, 8.79, $8.75 \pm$

0.049 kg) and quadratically affected ($P < 0.05$) for SNF (6.54, 6.53, 6.64, 6.85 \pm 0.047) and density (1022.5, 1022.4, 1022.8, 1023.46 \pm 0.63). The C15:0 and C:17:0 decreased (linear effect, $P < 0.05$) with increasing concentrate. The fatty acid profile particularly beneficial for human health as oleic (18:1N9C), Trans-vaccenic (18:1N11T), linoleic (C18: 2N6C), linolenic (C18:3N3) and conjugated linoleic acid (C18: cis-9, trans-11 CLA and C18: trans-10, cis-12 CLA) were not modified ($P > 0.05$) by increasing concentrate. Overall, this study indicates that the concentrate supplementation of grazing crossbred dairy cows increase milk production without compromising the FA profile or milk composition.

Key Words: milk, fatty acid profile, crossbred cow

W460 Composition and nutritive value of palm kernel meal for ruminants. Jennifer K. Cuenca¹, Diego A. Vela¹, Darren D. Henry², Nicolas DiLorenzo², and Christian H. Ponce*¹, ¹*Departamento de Ciencias de la Vida y Agricultura, Universidad de las Fuerzas Armadas ESPE, Sangolquí, Ecuador*, ²*North Florida Research and Education Center, Department of Animal Sciences, University of Florida, Marianna, FL*.

Palm kernel meal originated from oil processing is readily available in Ecuador. However, information related to the nutritive value for ruminants is limited. Therefore, 2 experiments were conducted to evaluate the nutritive value of palm kernel meal (PKM) from oil palm extract plants for ruminants. For Exp. 1, 3 regional plants were selected, and PKM were collected weekly during 12 wk. Proximate analysis was performed on individual samples (mean values \pm standard errors across plants for DM, OM, CP, fat and crude fiber were 94.5 \pm 0.33, 95.8 \pm 0.23, 14.8 \pm 0.36, 8.9 \pm 0.47, and 68.68 \pm 2.42%, respectively). Significant variations were detected for all nutrients analyzed between plants ($P \leq 0.016$). Additionally, particle size was different between plants (403 \pm 2 μ m; $P < 0.001$). For Exp. 2, 2 ruminally cannulated cows (BW = 445 \pm 49.5) were used to determine ruminal in situ degradability of DM, OM, NDF, ADF and CP of PKM, and in vitro ruminal degradability parameters. Cows had ad libitum access to forage, composed of Pennisetum clandestinum. Composite samples of PKM within each plant, from the 12-wk period of Exp. 1 were used as substrate for determination of in situ degradation kinetics. Substrates were incubated in the ventral sac of the rumen for 0, 3, 6, 9, 12, 18, 24, 48, and 72 h, and in situ degradability was replicated in 2 different weeks. In situ digestibility fractions (i.e., immediate soluble, potentially degradable, undegradable, and effective degradability) were not affected by plant for all nutrients analyzed ($P \geq 0.231$), with exception of rate of digestion for OM and ADF (0.036 \pm 0.001; $P \leq 0.042$). Calculated effective degradability for DM and OM were 42.3 \pm 4.7, and 16.6 \pm 2.1%, respectively. Crude protein effective degradability was 16.1 \pm 3.9%. For the fiber contents, NDF and ADF effective degradability were 39.8 \pm 5.0%; and 23.1 \pm 4.2%, respectively. Additionally, 24 h IVDMD (44.7 \pm 2.8%) and total gas production (154.1 \pm 59.1 mL/g of substrate) were not different among plants ($P = 0.897$). Results from these experiments provide relevant nutritive information of PKM as feedstuff for ruminants, and reveal that significant variation between processing plants can be expected in nutrient profile.

Key Words: nutritive value, palm kernel meal, ruminants

W461 Effects of β -acid extract of hops on heifer performance and ruminal fermentation. Justin E. Axman*, Cadra L. Van Bibber-Krueger, Christian A. Alvarado-Gilis, Jake D. Thieszen, and James S. Drouillard, *Kansas State University, Manhattan, KS*.

Beta-acid extract of hops was fed to finishing heifers (n = 80; 389 \pm 23.6 kg initial BW) to assess effect on growth performance and ruminal fermentation. Heifers were randomly assigned to individual pens and fed diets based on steam-flaked corn and corn gluten feed for 147 d. Treatments consisted of a control (no additive); monensin (Elanco Animal Health, Greenfield, IN) fed at 33 mg/kg diet DM; and β -acid extract of hops (DSM Nutritional Products, France) fed at 10, 25, or 50 mg/kg diet DM. Ruminal fluid was collected on d 44 and 86 by rumenocentesis for analysis of VFA and NH₃ concentrations. Feeding β -acid or monensin did not alter ruminal fermentation, growth performance, DMI, or gain efficiency ($P > 0.05$). Performance data were analyzed using a mixed model with diet as a fixed effect and weight block as a random effect. Pair-wise comparisons were performed using the PDIF option. Categorical data were analyzed using the Glimmix procedure with diet as a fixed effect, weight block as the random effect, and feedlot pen as the experimental unit. In conclusion, under conditions of this experiment β -acid extract did not alter performance or ruminal fermentation.

Table 1 (Abstr. W461).

Item	Control	Beta acid extract, mg/kg DM			Monensin	SEM
		10	25	50		
DMI, kg/d	9.90	9.91	9.89	9.98	9.94	0.38
G:F	0.1394	0.1405	0.1465	0.1394	0.1457	0.0049
NH ₃ , mM	0.40	0.40	0.47	0.37	0.19	0.105

Key Words: β -acid, hops, rumen

W462 Effect of a ruminal acidosis challenge on methane emission rate in lactating cows. Matias J. Aguerre*, Fei Sun, Shayna Welch, and Michel A. Wattiaux, *Department of Dairy Science, University of Wisconsin-Madison, Madison, WI*.

The objective of this study was to determine the effect of a subacute ruminal acidosis (SARA) challenge on CH₄ emission rate from lactating cows. We hypothesized that low ruminal pH resulting from SARA would reduce CH₄ emission substantially especially in cows fed a low forage diet. Eleven ruminally cannulated Holstein cows (711 \pm 59 kg BW; 103 \pm 59 DIM) were randomly assigned to either a 45 or 67% forage diet (DM basis) in a complete randomized design. After 2-wks of adaptation to a GreenFeed CH₄ measuring unit, 4 cows on each treatment were selected to undergo the SARA induction protocol, which included 4 periods: baseline (4 d), feed restriction (50%; 1 d), challenge (TMR + wheat-barley pellet at 20% of baseline DMI; 2 d), and recovery (normal dietary treatments feeding; 2 d). Rumen pH was recorded every 5 min for 7 of the 9 d of protocol using wireless pH meters. Methane (g/h) was measured at 12 p.m., 5 p.m., 9 p.m., and 6 a.m. during the induction protocol. Overall, milk yield (40.4 \pm 3.6 kg/d, $P = 0.16$), DMI (23.1 \pm 1.8 kg/d, $P = 0.26$), mean ruminal pH (6.08 \pm 0.15, $P = 0.84$), nadir ruminal pH (5.49 \pm 0.15, $P = 0.31$), hours below pH 5.6 (3.2 \pm 1.78 h/d, $P = 0.31$) and CH₄ emission rate (12.2 \pm 1.0 g/h, $P = 0.29$) were not affected by dietary treatments. There was no treatment by period interaction but a significant period effect for reported variables. Compared with baseline (27.3 kg/d) DMI was not different ($P = 0.82$) during the challenge (26.1 kg/d) but was lower ($P = 0.05$) during recovery (25.2 kg/d). Milk yield dropped ($P < 0.01$) from 45.5 kg/d during baseline to 32.5 kg/d during challenge and returned almost to baseline during recovery (41.2 kg/d, $P = 0.10$). Methane emission (g/h) rate were 14 and 26% lower during challenge (11.7, $P = 0.03$) and recovery (10.1, $P < 0.01$) compared with baseline (13.6). During recovery, CH₄/DMI (g/kg) was lower (9.7, $P = 0.05$) compared with baseline (12.2). Hours below pH 5.6 increased from 1.5 to 6.4/d from baseline to challenge

($P < 0.01$). In this study, SARA reduced CH_4 emission but there was a complex temporal relationship between rumen pH and CH_4 emission during and after an acidosis episode.

Key Words: ruminal acidosis, methane, dairy

W463 Co-products (Micelio and Raffinate) from the corn processing industry for finishing cattle. Murillo Alves Porto Meschatti^{*1}, Maria Erika Picharillo¹, Camila Delveaux Batalha¹, Julia Silveira Pereira², and Flavio Augusto Portela Santos¹, ¹University of São Paulo, São Paulo, Brazil, ²Cargill.

The objective of this experiment was to evaluate the inclusion (7 and 15%, DM basis) of 2 corn co-products derived from the citric acid industry: Micelio (77% NDF, 0.5% lignin, DM basis) and Raffinate (25.5% soluble sugars, 32% soluble fiber, DM basis) in diets with high levels of flint corn fed to 200 finishing Nelore bulls (initial BW = 396.4 ± 37.7 kg). Animals were blocked based on initial BW and randomly allocated to 25 pens. The control diet contained 11.73% sugarcane bagasse, 67.2% corn, 18% corn gluten feed, 2.07% mineral supplement and 1% urea. The other 4 treatments were Micelio 7, Micelio 15, Raffinate 7 and Raffinate 15. The co-products partially replaced corn in the diets. The parameters evaluated were dry matter intake (DMI), average daily gain (ADG), feed efficiency (ADG/DMI) and carcass traits. The data were analyzed using PROC MIXED of SAS and means were compared by Tukey test considering the block as random effect and treatment as fixed effect. There was no effect of treatments ($P > 0.05$) on cattle performance and carcass traits. Average values for dry matter intake, average daily gain and feed efficiency were 10.5 kg/d, 1.6 kg/d, and 0.156 respectively. Average values for dressing (%), back fat thickness (mm) and rib eye area (cm^2) were 53.79, 2.84, and 64.08, respectively. The inclusion of 7 or 15% of Micelio or Raffinate in partial replacement of ground flint corn in finishing diets does not affect cattle performance

Key Words: co-product, feedlot, performance

W464 The effect of heating temperature on ruminal protein digestion kinetics and estimated intestinal digestibility of canola meal. Katarzyna Burakowska^{*1}, Pawel Górka², and Gregory B. Penner¹, ¹University of Saskatchewan, Saskatoon, Canada, ²University of Agriculture, Kraków, Poland.

The objective of this study was to determine the optimal heat treatment temperature of canola meal to increase the rumen undegradable protein concentration without negatively affecting intestinal digestibility. Twelve samples of canola meal (25 kg/sample) were subjected to 1 of 4 heat treatments: an unheated control (H0), or heat-treated in a tumble dryer (POS, Saskatoon) to 100°C (H100), 110°C (H110) or 120°C (H120) for 10 min after reaching the specified temperature. Canola meal was placed in nylon bags (50- μm pore size) and incubated in the rumen of 4 heifers for 0, 2, 4, 8, 12, 16, 24 and 48 h to evaluate rumen degradation kinetics. Estimated intestinal digestibility was determined using samples incubated in the rumen for 12 h, followed by an *in vitro* gastric and enzymatic digestion. Samples were analyzed for DM and CP content. Data were analyzed using SAS 9.3 as completely randomized design with polynomial contrasts to determine whether provision of heat affected the response linearly or quadratically. The rate of DM

disappearance in the rumen decreased (quadratic, $P = 0.02$, $\text{SE} = 0.214$) from 4.5%/h for H0 to 3.06 for H120. The rate of CP degradation ($P < 0.01$, $\text{SE} = 0.590$) and the degradable fractions of DM ($P < 0.01$, $\text{SE} = 1.906$) and CP responded quadratically ($P < 0.01$, $\text{SE} = 3.531$) with values of 4.89, 60.0 and 79.0 for H0, 4.59, 57.1 and 70.0 for H100, 3.54, 52.7 and 59.0 for H110, and 7.77, 34.1 and 22.3 for H120, respectively. Assuming a constant passage rate (5%/h), heat treatment decreased the effectively degradable DM (quadratic, $P < 0.01$, $\text{SE} = 0.776$) from 54.2 to 31.7% for H0 to H120 and decreased the effectively degradable CP (quadratic, $P < 0.01$, $\text{SE} = 2.652$) from 55.5 to 25.4%. The estimated intestinal CP digestibility (quadratic, $P = 0.03$, $\text{SE} = 2.550$) increased from H0 (45.9%) to H110 (51.0%) and decreased for H120 (37.2%). The results suggest that the temperature of 110°C decreases DM and CP degradation in the rumen without negative effects on intestinal digestibility.

Key Words: canola meal, heat treatment, digestibility

W465 Effects of postruminal AA supply and roughage removal on growth performance during growing phase of beef calves.

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Previous research demonstrated benefit in beef calves growth performance fed no roughage diets balanced to meet AA requirement. The study objective was to separate the effects of balancing diets for AA:effective energy (AA:EE) and roughage removal on steers growth performance (initial BW 338 ± 23 kg) during growing phase (GP; 84 d). We hypothesized balancing diets for postruminal AA:EE supply as well as roughage removal would improve feed efficiency and growth performance. Crossbred steers ($n = 117$) were randomly assigned to 3 corn-based diets. Control, common feedlot diet (CON; 13.5% CP, 20% NDF, 10% roughage, 60% corn, 27% dried distillers grains with solubles); roughage and AA:EE balanced (RBAL; 16% CP, 16% NDF, 10% roughage, 62% corn, 12% Aminoplus, 10% dried distillers grains with solubles, 2% soybean meal); or no roughage and AA:EE balanced (NRBAL; 16% CP, 10% NDF, 72% corn, 14% Aminoplus, 9% dried distillers grains with solubles, 2% soybean meal). Steers had *ad libitum* access to feed and water. Individual feed intake was measured using GrowSafe feed intake system and BW was recorded every 28 d. Data were analyzed as repeated measure. Dry matter intake (kg/d) was greater ($P < 0.01$, $\text{SEM} 0.28$) for CON (10.5) and RBAL (10.4) compared with NRBAL (9.0). Average daily gain (kg/d; 28 d) was greater ($P < 0.03$, $\text{SEM} 0.09$) for NRBAL (2.02) and RBAL (2.06) compared with CON (1.77) however throughout GP ADG did not differ among treatments ($P = 0.3$). Gain:Feed (28 d) was greater ($P < 0.01$, $\text{SEM} 0.009$) for NRBAL (0.22) compared with CON (0.18) however RBAL (0.20) did not differ. During total period (84 d) NRBAL (0.19) had greater ($P < 0.03$, $\text{SEM} 0.005$) G:F compared with RBAL (0.17) and CON (0.16). Balancing diets for postruminal AA:EE supply improved G:F by 11% and roughage removal improved G:F an additional 11%. In conclusion balancing diets for postruminal AA:EE supply can improve growth performance and feed efficiency when lean tissue deposition potential results in postruminal AA demand. Balancing diets to allow roughage removal also benefits growth performance throughout the feeding period.

Key Words: postruminal AA, feed efficiency