

Ruminant Nutrition: Feeding, Ruminal Fermentation, and Efficiency of Production II

W80 Effects of different feeding frequencies on feedlot performance and carcass traits of feedlot Nellore cattle. T. V. B. Carrara^{*2,3}, J. Silva², M. C. S. Pereira², A. L. N. Rigueiro², D. H. M. Watanabe², D. D. Estevam², D. P. Silva², D. V. F. Vicari², C. A. Oliveira², I. C. Batista Junior², M. D. B. Arrigoni¹, F. T. V. Pereira², D. J. C. Oliveira⁴, G. P. Mateus⁴, D. D. Millen², ¹São Paulo State University (UNESP), Botucatu, Brazil, ²São Paulo State University (UNESP), Dracena, Brazil, ³Supported by FAPESP, São Paulo, Brazil, ⁴APTA, Andradina, São Paulo, Brazil.

This study, conducted at the São Paulo State University feedlot, Dracena Campus, Brazil, was designed to determine the effects of different feeding frequencies on overall feedlot performance and carcass traits of Nellore cattle. The experiment was designed as a completely randomized block, replicated 12 times, in which 48 18-mo-old yearling Nellore bulls (358.2 ± 19.4 kg) were fed in individual pens for 94-d according to the following treatments: (1) feeding one time daily (1×; 0800), (2) feeding 2 times daily (2×; 0800 and 1400), (3) feeding 3 times daily (3×; 0800, 1100 and 1400), and (4) feeding 4 times daily (4×; 0800, 1100, 1400 and 1700). The adaptation program consisted of ad libitum feeding of 2 adaptation diets over period of 14-d with concentrate level increasing from 60% to 86% of diet DM. The finishing diet contained: 67.0% cracked corn grain, 14.0% sugarcane bagasse, 9.0% soybean hulls, 5.5% soybean meal, 4.0% supplement containing 30% of urea, and 0.5% limestone (DM basis). Orthogonal contrasts were used to assess linear, quadratic, and cubic relationship between feeding frequency and the dependent variable. Feeding frequency did not affect ($P > 0.10$) dressing percentage (1× = 55.0%; 2× = 54.6%; 3× = 56.1%; 4× = 55.6%), and DMI in kilos (1× = 7.75 kg; 2× = 7.95 kg; 3× = 8.44 kg; 4× = 8.10 kg) or as % of BW (1× = 1.91%; 2× = 1.98%; 3× = 2.04%; 4× = 1.97%). However, as feeding frequency increased, ADG (1× = 0.979 kg; 2× = 0.961 kg; 3× = 1.175 kg; 4× = 1.138 kg) final BW (1× = 449.8 kg; 2× = 445.4 kg; 3× = 467.4 kg; 4× = 463.6 kg), G:F ratio (1× = 0.128; 2× = 0.121; 3× = 0.141; 4× = 0.142) and HCW (1× = 246.9 kg; 2× = 243.0 kg; 3× = 263.1 kg; 4× = 258.1 kg) linearly increased ($P < 0.05$). The HCW was also affected ($P = 0.01$) cubically as feeding frequency increased. Thus, based on the results of this study, increasing feeding frequency affected feedlot performance and carcass traits of Nellore cattle. In a practical way, feeding yearling Nellore bulls 3 times daily seems to be the most feasible option, as beef prices are generally based on HCW.

Key Words: frequency, HCW, zebu

W81 Growth performance and carcass traits in Alpine male goat kids supplemented with hydroponic green fodder from wheat and corn. M. Guerrero Cervantes^{*1,4}, A. S. Juárez Reyes^{1,4}, F. G. Ríos Rincón^{2,4}, M. A. Cerrillo Soto^{1,4}, H. Bernal Barragán^{3,4}, and C. Angelo Montoya³, ¹Universidad Juárez del Estado de Durango, Durango, Durango, México, ²Universidad Autónoma de Sinaloa, Culiacán, Sinaloa, México, ³Universidad Autónoma de Nuevo León, San Nicolás de los Garza, Nuevo León, México, ⁴Red Internacional de Nutrición y Alimentación en Rumiantes, México.

This study was carried out to determine the effect of supplementing hydroponic green wheat (HW; *Triticum aestivum* L.), or hydroponic green corn (HGC; *Zea mays*) on growth performance and carcass traits of Alpine male goat kids fed an oat-straw (OS) based diet. Twenty-five

Alpine intact male kids (160 d of age; 20 ± 3 kg BW), were placed during 13 wk, in individual pens, assigned to 5 groups of 5 kids each, and fed with diets calculated according to the French system to balance for intestinal digestible protein (g/d), derived from nitrogen (IDPN) and from energy (IDPE). Diets were composed as follow: T1:50% OS, 35% HW, 15% rolled corn (RC); T2:50% OS, 35% HGC, 15% cottonseed meal (CSM); T3:50% OS, 30% RS and 20% CSM; T4:50% OS, 18% HW, 19% RS and 13% CSM; T5:50% OS, 18% HGC, 13% RS and 19% CSM. Data of daily weight gain, DMI, feed conversion and carcass traits were analyzed by ANOVA according to a completely randomized block design, using the initial BW as covariate. Orthogonal contrasts were used to compare diets with HW and with HGC. The T2 was lower ($P \leq 0.01$) DMI (691 g/d) and feed conversion (8.7:1) was greater ($P \leq 0.05$) than in others. Intake of IDPN (60 g/d) and IDPE (61 g/d) was higher in T4 than in others. Highest ribeye area (8.5 cm²) was registered by T5. Goat kids fed diets supplemented with HGC performed better ($P \leq 0.05$) than with HW. In conclusion, feeding growing kids with HGC supplemented diets improved feed conversion and ribeye area and is a valuable alternative to counter high costs of concentrate feeding.

Table 1. Intake, feed conversion and carcass composition traits in Alpine male kids

	T1	T2	T3	T4	T5	SEM	P-value
Daily weight gain (g)	76	81	86	67	88	15.3	0.2051
Daily DMI (g)	798 ^a	691 ^b	792 ^a	806 ^a	791 ^a	44.6	0.0001
IDPN intake (g/d)	57 ^{ab}	45 ^b	57 ^a	60 ^a	56 ^a	4.2	0.0001
IDPE intake (g/d)	60 ^a	50 ^b	59 ^a	61 ^a	57 ^{ab}	4.2	0.0001
Feed conversion ¹	10.6 ^{ab}	8.7 ^b	9.3 ^{ab}	12.1 ^a	9.4 ^{ab}	1.6	0.0011
Carcass yield (%)	51	50	51	51	52	3.6	0.5967
Ribeye area (cm ²)	6.8 ^b	8.2 ^{ab}	8.2 ^{ab}	7.1 ^{ab}	8.5 ^a	0.8	0.0025
Muscle (%)	71	71	71	72	75	2.9	0.0657
Feed cost/d (\$)	0.25	0.25	0.34	0.31	0.30		

^{a,b}Means with different superscript differ.

¹Total DM intake/total weight gain.

Key Words: hydroponic green corn, hydroponic green wheat, male kid

W82 Molecular cloning and characterization of a novel cellulase with xylanase activity from a metagenomic library of goat rumen. C. Y. Fan¹, H. Q. Jiang¹, Y. H. Zhang¹, X. Z. Sun¹, and J. B. Cheng^{*1,2}, ¹College of Animal Science and Technology, Anhui Agricultural University, Hefei, China, ²State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.

Ruminal microbiome has been as a rich source of cellulase not only for feed but also for bioenergy industry. However, this enzyme source is largely untapped because more than 85% of the ruminal microbes have not been cultivated. The objective of this study was to identify novel cellulase gene from a bacterial artificial chromosome (BAC) library and further to analyze its characteristics. BAC library was constructed using genomic DNA isolated from goat ruminal content. Screening of the clones with cellulase activity was performed on LB agar plates supplemented with 1% carboxymethyl cellulose sodium (CMC) and 12.5 mg/L chloramphenicol. The positive clones were extracted and

partially digested with Sau3AI. The 2–5kb digested DNA fragments were subcloned in pUC19 digested with *Bam*HI and introduced into *E. coli* DH5a. The gene responsible, Cel28a, contains an open reading frame consisted of 1,596 bp nucleotides that encoded 509 amino acid residues, with a typical N-terminal signal peptide of 22 amino acid residues with a molecular mass of 55 Da. A phylogenetic analysis of amino acid sequence with other cellulase enzymes suggested that cel28a belongs to glycosyl hydrolase family 5. The recombinant pET28a(+)/cel28a gene was overexpressed in *E. coli* BL21(DE3) cells to overproduce the cellulase protein with dual histidine tag at its C-terminus and N terminus. The recombinant cellulase was purified by affinity chromatography using nickel-nitrilo-triacetic acid agarose resin (Ni-NTA). The optimal substrate for cel28a to hydrolyze was CMC among CMC, oat spelt xylan, filter paper, birch wood xylan, and microcrystalline cellulose. The preference of the substrate with CMC, oat spelt xylan, and birch wood xylan indicates that cel28a is a cellulase with xylanase activity. The optimum temperature for Cel28a was 50°C, but the activity of Cel28a reduced quickly when temperature was above 60°C. The activity of Cel28a was more than 60% in the range of pH 4–6, and the optimum pH was 5.0 at 40°C using CMC and oat spelt xylan as substrate.

Key Words: cellulase, metagenome, rumen

W83 Effects of restricted versus conventional dietary adaptation over periods of 6 and 9 days on feedlot performance and carcass characteristics of Nellore cattle. A. Perdigão^{*1,3}, M. D. B. Arrigoni¹, D. D. Millen², R. S. Barducci¹, M. A. Factori¹, L. M. N. Sarti¹, M. C. S. Franzoi¹, L. C. Vieira Junior¹, M. T. Cesar¹, F. A. Ribeiro¹, D. F. Broeze¹, A. L. C. Bricchi¹, and R. F. Pessin¹, ¹São Paulo State University (UNESP), Botucatu, Brazil, ²São Paulo State University (UNESP), Dracena, Brazil, ³Supported by FAPESP, São Paulo, Brazil.

This study, conducted at the São Paulo State University feedlot, Botucatu Campus, Brazil, was designed to determine effects of restricting intake of the final finishing diet (REST) as a means of dietary adaptation compared with diets increasing in concentrate (STEP) over periods of 6-d and 9-d on overall feedlot performance and carcass traits. The experiment was designed as a randomized completely block with a 2 × 2 factorial arrangement, replicated 6 times (5 bullocks/pen), in which 120 22-mo-old yearling Nellore bulls (352.03 ± 19.61 kg) were fed in 24 pens for 84-d according to the treatments: STEP for 6-d, STEP for 9-d, REST for 6-d, and REST for 9-d. The STEP program consisted of ad libitum feeding of 2 adaptation diets over periods of 6-d or 9-d with concentrate level increasing from 61 to 85% of diet DM. The REST program consisted of restricted intake of the final diet (85% concentrate) with programmed increases in feed offered until yearling bulls reached ad libitum access over periods of 6-d or 9-d. A ($P < 0.05$) protocol main effect was observed for ADG (STEP = 1.431 kg; REST = 1.332 kg), DMI (STEP = 9.26 kg, REST = 8.72 kg) and DMI as % of BW (STEP = 2.25%, REST = 2.14%). However, no ($P > 0.10$) protocol main effect was observed for G:F (STEP = 0.154, REST = 0.153), HCW (STEP = 258.5 kg, REST = 260.7 kg) and dressing percentage (STEP = 55.1%, REST = 55.1%). No ($P > 0.10$) days main effect was observed for any of the feedlot performance and carcass traits variables evaluated: ADG (6-d = 1.393 kg; 9-d = 1.370 kg), DMI (6-d = 9.03 kg; 9-d = 8.95 kg), DMI as % of BW (6-d = 2.20%; 9-d = 2.19%), G:F (6-d = 0.154; 9-d = 0.153), HCW (6-d = 262.1; 9-d = 257.0), and dressing percentage (6-d = 55.1%; 9-d = 55.1%). Animals in STEP protocol presented greater ADG because they consumed more feed, as G:F was similar when compared with animals in REST protocol. The adaptation in 6-d

did not negatively affect overall feedlot performance and carcass traits of Nellore cattle.

Key Words: adaptation, feedlot, Nellore

W84 Effect of calf conditioning either before or at weaning during the dry season in northeast Mexico. R. G. Altamirano^{*1}, E. G. Ornelas^{2,4}, H. B. Barragán^{2,4}, R. A. Ramírez², and E. C. Gallegos³, ¹Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), Campo Experimental Las Huastecas, Altamira, Tamaulipas, México, ²Universidad Autónoma de Nuevo León, Facultad de Agronomía, General Escobedo, Nuevo León, México, ³Universidad Nacional Autónoma de México, Fac. Medicina Veterinaria y Zootecnia, Martínez de la Torre, Veracruz, México, ⁴Red Internacional de Nutrición y Alimentación en Rumiantes, México, D.F., México.

The effect of 3 conditioning strategies was evaluated from February through April 2012 upon 48 calves (27 females and 21 males) from a herd in Aldama, Tamaulipas. Twenty-eight days before weaning, calves with initial body weight of 121.0 kg were randomly assigned to 3 treatments: Control group (CG), without conditioning; Conditioning 28 d before weaning (CBW), and Conditioning at weaning (CAW). Conditioning consisted in application of internal and external parasite control, vitamins ADE via IM vaccination against common bacterial and viral diseases and offering a 35% CP supplement at 20 g/kg LW^{0.75} per day. Body weight of 12-h fasted animals was registered and sample collected at days: -28, 0 (weaning), 28, 56 and 84. Response variables were average daily gain (ADG), internal parasite load (McMaster technique), serological immune response (IBR and BVD neutralizing antibodies testing), and incidence of clinical disease. Animals grazed pastures of Guinea grass (*Panicum maximum*), 7.1% CP and 62.8% NDF and African stargrass (*Cynodon plectostachyus*), 7.4% CP and 79.3% NDF. Data were analyzed according to a completely randomized design with 2 × 3 factorial arrangement of treatments. No interaction and sex effects ($P > 0.05$) were found. During the last 28 d before weaning, ADG of CBW calves was higher ($P < 0.05$) than the other 2 treatments (1,068 vs 411 and 409 g/d). After weaning, and up to d 84, ADG of conditioned calves was higher ($P < 0.05$) than control (614, 526 and 301 g/d, for CBW, CAW and CG, respectively). There were no differences among groups ($P > 0.05$) for nematode internal parasite load. There were more sick animals ($P < 0.05$) in the CG than in the conditioning treatments (10 vs. 3). Geometric mean (GM) of neutralizing antibodies titers showed that the serological response in vaccinated animals at d 84 was higher ($P < 0.05$) against BVDV than BoHV-1, but there was no difference ($P > 0.05$) between CBW and CAW. The CG group did not develop antibodies at d 84 against both viruses. Conditioning before or at weaning during dry season had positive effect on performance of weaned calves.

Key Words: calf, conditioning, weaning

W85 Effect of TMR particle size or rumen pH on diet and feed preference in lactating dairy cows. A. D. Kmicikewycz^{*} and A. J. Heinrichs, Pennsylvania State University, University Park.

The objective of this study was to investigate effects of TMR particle size and rumen pH on diet and feed preference in lactating dairy cows. Twelve (8 ruminally cannulated) Holstein cows (91 ± 40 DIM, 695 ± 95 kg, and parity of 2.91 ± 1.16; mean ± SD) were used in a replicated 4 × 4 LSD with 4 21-d periods. Cows were assigned to squares by parity and randomly assigned to treatment. Diets contained corn silage (CS) with long (L) or short (S) particle size and were fed with 0 (L,S) or 5% (LH, SH) supplemental late cutting fine orchardgrass hay (11.7% CP, 56.0%

NDF); CS and ground corn comprised 23.2% and 11.1% of ration DM, and TMR contained 30.9% starch. Animals were housed individually, milked 2×/d, and fed 1×/d for 10% refusal rate. Each period consisted of 14 d adaptation followed by 3 d designated as baseline for feed intake. Day 17 was baseline for feed preference and rumen conditions. On d 18 DMI was restricted to 75% of baseline intake. On d 19, 4 kg (as-fed) fine ground wheat was mixed into the rumen digesta of each cow before feeding via rumen cannulas to provide a subacute rumen acidosis challenge. Data was analyzed using MIXED procedure of SAS. The rumen challenge successfully decreased rumen pH (5.39), but baseline weighted average rumen pH for all diets was very low (5.52). Average minimum rumen pH decreased from 5.06 to 4.92, and acetate, butyrate, valerate, and isobutyrate increased on challenge d. Treatments with long CS had lower DMI ($P < 0.05$) during baseline. Cows fed SH had greater DMI during challenge d compared with S, L, and LH. There was no difference in H DMI between baseline and challenge d. No differences were found for particle size selection or H preference between days for each diet. Milk yield was greatest for cows fed SH and lowest for L and LH (45.8, 44.1, 42.8 and 42.4 kg/d for SH, S, L and LH; $P < 0.05$). Milk fat, 1.49 kg/d, and protein, 1.40 kg/d, were greater ($P < 0.05$) in cows on diet SH than all other diets. Results of this study indicate prolonged low ruminal pH does not change preference for grass hay or longer forage particles.

Key Words: particle size, acidosis, ruminal pH

W86 Nutritional maintenance requirements and true absorption coefficients of calcium and phosphorus in 3/4 Zebu × 1/4 Holstein crossbred bulls. L. F. Prados*, S. C. Valadares Filho, A. N. Nunes, E. Detmann, D. Zanetti, D. R. Costa, S. A. Santos, L. D. S. Mariz, P. M. Amaral, L. C. Alves, and A. C. B. Menezes, *Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.*

The objective of this study was to determine the maintenance requirements and true absorption coefficients for calcium and phosphorus in 3/4 Zebu × 1/4 Holstein crossbred bulls fed with different levels of calcium and phosphorus in diets. Eighteen 3/4 Zebu × 1/4 Holstein bulls with an initial mean body weight of 214 ± 4 kg and a mean age of 11 ± 0.2 mo were used in this study. These animals were assigned in a completely randomized design with 3 × 3 factorial arrangement. Three levels of calcium and phosphorus (low, medium and normal) and 3 periods of feedlot (56, 112 and 168 d) were tested. The 3 levels of calcium and phosphorus were low (1.8 and 2.2 g/kg), medium (3.0 and 2.4 g/kg), and normal (4.2 and 2.6 g/kg), respectively, for calcium and phosphorus in a dry matter basis. The diets were isonitrogenous (12.6%) and consisted of corn silage and concentrate (60:40) on a dry matter basis. To assess the excretions of Ca and P total fecal collection was performed for 3 d at the end of each feedlot period. Using the relationships between absorption and intake for calcium and phosphorus were obtained the daily maintenance requirements of Ca and P of 9.55 and 14.36 mg/EBW/d. Through the same regression, the true absorption coefficients of Ca and P were found to be 0.69 and 0.66, respectively. The maintenance requirement for Ca was lower than the amount recommended by the NRC (2000) (15.4 mg/BW/d). The P level recommended by the NRC (2000) is 16 mg/BW/d and is similar to the requirement value determined in this study. The true absorption coefficient for Ca was higher than the 0.55, value recommended by BR-CORTE (2010) but was similar to the value of 0.68 recommended by the ARC (1980). The absorption coefficient of P was similar to the value used by BR-CORTE (2010) (0.68). In conclusion, the maintenance requirements of Ca and P in 3/4 Zebu × 1/4 Holstein crossbred are, respectively, 9.55 and 14.36 mg/EBW/d.

Key Words: calcium, mineral requirement, phosphorus

W87 Dynamic shifts of rumen functional bacteria associated with forage types by quantitative real-time PCR. X. L. Hu, J. Q. Wang*, S. G. Zhao, J. W. Zhao, and D. P. Bu, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

Ruminal microbiota is highly responsive to changes in diet and feeding regimen. This study was conducted to quantify the population of rumen dominant functional bacteria of Chinese Holstein cows fed forage based diets by real-time PCR. Forty-eight Chinese Holstein cows were blocked based on DIM and milk yield and randomly assigned to 3 treatments to evaluate the effect of the different diets on the quantity of rumen microorganism. The 3 treatments consisted of different roughage supplements which was MF (alfalfa plus corn silage, soybean meal), CSA (straw, soybean meal), CSB (straw, cottonseed and rapeseed meal). The experiment was conducted for 107 d and consisted of 2 periods. Period 1 lasted 91 d, during which cows were fed the 3 different diets (MF, CSA, CSB). Period 2 lasted 16 d and all animals were fed MF. Rumen fluid was collected by inserting a flexible plastic tube into the rumen before and after feeding on d 91 and 107. Then the rumen microbial DNA was extracted by CTAB plus bead beating DNA extraction method. Species-specific PCR primers were chosen from the literature to amplify partial 16S rDNA regions. The copy number of rumen microbiota was detected by quantitative real-time PCR. qRT-PCR analysis detected significant increases ($P < 0.05$) in the quantity (copies in per ml rumen fluid) of domain bacteria, *Prevotella bryanti*, *Ruminococcus albus*, *Selenomonas ruminantium*, and *Megasphaera elsdenii* in treatment MF than that of CSA and CSB on d 91 before feeding. And after feeding on d 91, *Prevotella brevis* and *Fibrobacter fuccinogene* in group CSA was significantly greater ($P < 0.05$) than group MF, *Ruminococcus albus* in group MF was significantly greater ($P < 0.05$) than CSA and CSB. There was not any difference on d 107 of period 2 among the 3 groups both before and after feeding. We concluded that the change of diets did produce an effect on the population of rumen functional bacteria, especially some bacteria which take part in the degradation of cellulose and protein.

Key Words: dietary change, population, rumen bacteria

W88 Effects of a corn straw or mixed forage diet on mRNA expression of genes related to glucose metabolism in the liver of dairy cows. W. Q. Li^{1,2}, D. P. Bu¹, J. Q. Wang*¹, X. M. Nan¹, and L. Y. Zhou¹, ¹*Institute of Animal Science, Chinese Academy of Agricultural Science, Beijing, China,* ²*College of Life Science, Henan Agricultural University, Zhengzhou, China.*

Our objective was to identify the response of genes related to hepatic glucose metabolism to diets with different forage sources. Ten Chinese Holstein dairy cows in mid-lactation (DIM 100+10 d, BW 550 ± 50 kg) were randomly assigned to mixed forage diet (MF) with Chinese wildrye, alfalfa hay and corn silage as the forage source or corn straw diet (CS) with corn straw as the forage source. Diets were formulated to be iso-energetic and iso-nitrogenous. After 30-d experimental period, biopsy section of liver and blood samples were obtained at 0630h (before feeding). Expression of 28 genes coding for rate-limiting enzymes in hepatic gluconeogenesis pathway, pentose phosphate pathway, glycogen synthesis pathway, glycogen decomposition pathway, glycolysis pathway, glucose aerobic oxidation pathway, glucose transporters was detected with qRT-PCR. Statistical significance was evaluated by unpaired *t*-test analysis with SAS 9.0 software. Significance was declared at $P < 0.05$. Results showed that MF led to marked upregulation of PEPCK and G6P involved in hepatic gluconeogenesis pathway. No significant differences were observed in mRNA expression of genes involved in other glucose

metabolism pathways. Higher relative percentage mRNA abundance of G6P (22.58%), representing the important gluconeogenic enzyme and also catalyzing the last step in glycogenolysis, underscored its importance for ruminant hepatic glucose metabolism. Relative abundance of GLUT2 was the highest among hepatic glucose transporters. It was concluded that to respond to different roughage sources, genes involved in gluconeogenesis pathway and glycogen decomposition pathway had higher mRNA abundance percentage. And different roughage sources had little effect on else bovine hepatic glucose metabolism pathways and glucose transporter protein. This research paves the way for nutrient-gene interactions in dairy cows.

Key Words: diet, gluconeogenesis, glucose

W89 PCR-DGGE analysis reveals distinct diversity in the rumen bacterial community of dairy cows fed a corn straw or mixed forage diet. D. Jin, D. P. Bu*, S. G. Zhao, and J. Q. Wang, *Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

Forage is an important component of diets for ruminant animals and vital in maintaining rumen function and health. The purpose of this study was to compare rumen bacterial community from cows fed different diets. Twelve healthy Chinese Holstein dairy cows fitted with rumen cannula and similar body weights were randomly assigned to 2 treatments: high forage diet (MF; forage:concentrate = 60:40) with Chinese wildrye, alfalfa hay, and corn silage as forage sources (n = 6) or low forage diet (CS; forage:concentrate = 40:60) as forage sources (n = 6). The solid and liquid fractions of rumen digesta were collected for the successive 3 d on the 13th week of the experiment. Total DNA were extracted and analyzed by denaturing gradient gel electrophoresis (DGGE) with subsequent cluster and sequence analysis. The DGGE profiles showed the quantity and optimal density of the DGGE bands in CS group were different from MF group. In addition, the DGGE-derived dendrograms showed that diet caused some changes both in liquid and solid-associated bacterial diversity. Shannon-Weiner index showed no difference ($P > 0.05$) between the 2 groups for liquid-associated bacteria, but it was lower ($P < 0.01$) in CS group than that in MF group for solid-associated bacteria. Some bands from CS group were less compared with MF group and sequences analysis of these different bands showed that diversity of *Prevotella* sp., *Acetivibrio ethanolgignens* and *Clostridium* sp. decreased in CS group. The other uncultured bacteria belonging to the phylum *Bacteroidetes*, *Firmicutes*, *Tenericutes* and *Proteobacteria* had some changes between the 2 groups. In conclusion, there is unique bacterial community and low diversity in the rumen of dairy cows fed the diet of corn straw.

Key Words: corn straw, DGGE, rumen bacteria

W90 Comparison of purine bases and nitrogen-15 for quantifying microbial protein synthesis using three marker systems and different sampling sites in cattle fed diets with sugar cane or corn silage. P. P. Rotta*¹, S. C. Valadares Filho¹, E. Detman¹, F. A. C. Villadiego¹, E. M. G. Burgos¹, A. A. G. Lobo¹, and J. A. Bendassoli², ¹Universidade Federal de Vicosa, Viçosa, Brazil. ²Universidade de Sao Paulo, Sao Paulo, Brazil.

This study evaluated the use of 2 microbial markers [purine bases (PB) and ¹⁵N] in 3 collection sites (abomasum, omasum and reticulum) and using 3 marker systems (single, double and triple) to estimate the synthesis of microbial nitrogen (MN) and the microbial protein synthesis

efficiency (MPSE) in growing beef cattle. Eight ruminally and abomasally crossbred (Holstein × Zebu) bulls, with an average BW of 353 ± 36.9 kg, were used in two 4 × 4 Latin squares balanced for residual effects. The experimental diets studied were as follows: (1) 60% corn silage + 40% concentrate; (2) 40% corn silage + 60% concentrate; (3) 60% sugar cane + 40% concentrate; and (4) 40% sugar cane + 60% concentrate. Eight samples of abomasal, omasal and reticular digesta were collected in 9-h intervals for 3 d. Interactions ($P < 0.05$) were observed for MN between collection sites and microbial markers. In addition, interactions were also observed ($P < 0.05$) for the MPSE between the marker systems and the microbial markers. For PB, the greatest ($P < 0.001$) value of MN was observed for the digesta collected from the abomasum and reticulum. In contrast, for ¹⁵N, the greatest ($P < 0.001$) value was observed for the digesta collected from the omasum. MN was similar ($P > 0.05$) for digesta collected from the abomasum when using both PB and ¹⁵N. However, for digesta collected in the omasum, the greatest ($P < 0.001$) value was observed when ¹⁵N was used. The triple marker system exhibited the greatest ($P < 0.01$) value for MN compared with the single and double marker systems. The use of ¹⁵N is recommended to estimate the MN and the MPSE. In addition, the omasum is the recommended site for the collection of digesta. The triple marker system (cobalt EDTA (Co-EDTA) + ytterbium acetate (YbAc) + indigestible neutral detergent fiber (iNDF) is recommended for the above mentioned estimates.

Key Words: abomasum, omasum, reticulum

W91 Characterization of the dynamics in rumen bacterial community of cows fed three different diets using PCR-DGGE and qPCR. D. Jin¹, D. P. Bu*¹, S. G. Zhao¹, J. Q. Wang¹, and Z. T. Yu², ¹Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²Department of Animal Sciences, The Ohio State University, Columbus.

Vital to the health and productivity of dairy cattle are rumen bacteria, and diet composition is the most important driver of bacterial community dynamics. This study examined bacteria communities in the rumen of dairy cows fed 3 different diets. Forty-eight Chinese Holstein dairy cows with similar days-in-milk and body weights were randomly assigned to 3 treatments mainly differing in forage source: MF diet (alfalfa hay, corn silage and soybean meal), CSA (corn straw and soybean meal) and CSB (corn straw, cottonseed and rapeseed meal). The cows were fed their assigned diet twice daily for 91 d, after which all were shifted to the MF diet. Rumen contents were collected by inserting a flexible plastic tube into the rumen and were performed at d 31, 61, 91, and 107 of the experiment before and after morning feeding. Bacterial community structure was analyzed using denaturing gradient gel electrophoresis (DGGE), with select DGGE bands being sequenced. The DGGE profiles showed clear difference among the 3 diets after feeding for 31 d, with the overall similarity being only 51%. As expected, the MF diet resulted in more unique bands than the CSA and CSB diets. The DGGE fingerprints became less difference among the 3 diets at d 61 and 91 compared with d 31, suggesting gradual adaptation of rumen bacteria to the diets. Analysis from the sequenced DGGE bands showed that genera *Vibrio*, *Prevotella*, *Brevundimonas*, and *Clostridium* were dynamic and affected by the diets. One distinct band appeared in the MF group, and sequencing of this band revealed a sequence identity being 90% identical with *Vibrio* sp. The qPCR quantification showed that this uncultured bacterium had a higher ($P < 0.001$) abundance in the MF group than in the other 2 groups at d 91, but it had a higher population in all 3 groups at d 107. In conclusion, different forage types changed

structure and populations of rumen bacterial community, and there was a unique bacterial community with high diversity in the rumen of dairy cows fed mixed forage.

Key Words: DGGE and qPCR, forage, rumen bacteria

W92 Heart rate and milk production of dairy cows fed with three different strategies in early lactation. D. A. Mattiauda*, P. Chilibroste, M. Carriquiry, J. P. Marchelli, and A. C. Espasandin, *Departamento de Produccion y Pasturas, Facultad de Agronomia, UdelaR, Uruguay.*

Heart rate (HR) was proposed as a good estimator of heat production in beef and dairy cows. Twenty-four Holstein multiparous cows (697 ± 30 kg BW, 3.3 ± 0.1 BCS, 3.3 ± 0.5 lactations) were used in a randomized block design to study the effect of feeding strategies (corn silage allocation) during early lactation on milk yield and HR. Cows were allocated in 3 different feeding strategies: T1) total mixed ration (TMR) offered in a dry lot pen; T2) pasture grazing offered one session (7 h) + TMR offered during the evening in a dry lot pen and T3) pasture grazing in 2 sessions (14 h) + TMR offered in the grazing paddock. All diets were formulated to offer 50 Mcal ENL and $> 16.5\%$ CP (dry matter basis). Heart rate ($n = 4/\text{treatment}$) (beats/min) was registered by implanted HR radiotransmitters each 15 s during 5 consecutive days at the beginning (14 ± 5 d in milk, DIM) and the end of experimental period (40 ± 5 DIM). Treatment effects were analyzed by ANOVA and LSmeans by treatment were obtained. Milk yield was greater in T1 than T2 and T3 cows (35.5 , 30.1 and 29.6 ± 0.8 kg/d for T1, T2, and T3, respectively; $P < 0.001$). Heart rate at 10 DIM did not differ among treatments (93 ± 20 , 110 ± 17 and 86 ± 25 beats/min for T1, T2, and T3, respectively; $P = 0.68$) but a trend ($P = 0.12$) was observed at 40 DIM being greater in T2 than T1 and T3 cows (89 ± 8 , 114 ± 9 and 81 ± 11 beats/min, for T1, T2 and T3, respectively). The trend for greater HR in T2 cows was not directly associated with greater energy cost for milk production (as was greater in T1 cows) or walking activity (as was greater in T3 cows). Therefore results could suggest that T2 cows spent more energy associated to stress for feed competition (during grazing or at feed-troughs).

Key Words: dairy, feeding strategy, heart rate

W93 Assessment of in vitro fermentation characteristics of grass-legume mixed pasture forages with their different composition ratios using continuous cultures. C. T. Noviandi¹, K. Neal¹, J.-S. Eun*¹, D. R. ZoBell¹, M. D. Peel², and B. L. Waldron², ¹*Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan*, ²*Forage and Range Research Laboratory, USDA-ARS, Logan, UT.*

A continuous culture experiment was performed to investigate effects of tall fescue (TF)-legume mixed pasture forages [TF-alfalfa (TF+ALF), TF-birdsfoot trefoil (TF+BFT), or TF-cicer milkvetch (TF+CMV)] with 3 different composition ratios at 25:75, 50:50, or 75:25 on a DM basis on in vitro fermentation characteristics. Nine dietary treatments were tested in a completely randomized design with a 3 (TF-legume mixtures) \times 3 (TF:legume ratios) factorial arrangement ($n = 3$). Each culture fermentor was offered a total of 15 g DM/d in 4 equal portions at 0600, 1200, 1800, and 2400 h. Average daily culture pH ranged from 6.10 to 6.29 and was affected by TF-legume mixture and composition ratio ($P < 0.01$). Total VFA concentration averaged 51.4 mM and was not affected by treatments. While acetate concentration was similar across treatments, propionate concentration increased by the TF+CMV ($P < 0.01$). Decreasing legume proportion in the forage

mixtures decreased propionate concentration ($P = 0.03$) regardless of forage types. Acetate-to-propionate ratio was higher ($P = 0.03$) with the TF+ALF compared with the TF+BFT and the TF+CMV. Ammonia-N concentration decreased ($P < 0.01$) with the TF+CMV compared with the TF+ALF, and it further decreased in cultures receiving the TF+BFT ($P < 0.01$). In addition, decrease in ammonia-N concentration ($P < 0.01$) was noticed when legume proportion in forage mixtures decreased. Offering the TF+BFT decreased methane production, whereas the methane production decreased by increasing legume proportion in all forage mixtures ($P < 0.01$). Overall results of this study indicate that TF-legume mixtures at a relatively high proportion of legume favorably shifted in vitro fermentation pathways by producing more propionate and less ammonia-N and methane. The beneficial effects with the TF+BFT may have resulted from condensed tannins in birdsfoot trefoil, while unique plant cellular structure of cicer milkvetch in the TF+CMV may contribute to the positive effects.

Key Words: continuous culture, in vitro fermentation, tall fescue-legume mixed pasture forage

W94 Cost structure and economic assessment of Spanish Assaf dairy sheep farms. M. J. Milan¹, F. Frendi¹, R. Gonzalez-Gonzalez², and G. Caja*¹, ¹*Ruminant Research Group (G2R), Universitat Autònoma de Barcelona, Bellaterra, Spain*, ²*GEO, Benavente, Zamora, Spain.*

A total of 20 dairy sheep farms of Assaf breed, located in the Spanish Autonomous Community of Castilla y León (Provinces of León, Palencia, Valladolid and Zamora) and included in a group for receiving technical support (GEO, Gestión Empresarial de Ovino), were used to study their production cost structure during 2008 and for assessing their economic profitability. On average, farms had 89.2 ± 38.0 ha (own, 38%), 592 ± 63 ewes, yielded $185.9 \pm 21.1 \times 10^3$ L/yr (316 ± 15 L/ewe) and were attended by 2.3 ± 0.2 annual working units (family, 64%). Total annual income was $\text{US}\$252.7 \pm 29.9 \times 10^3$ coming from milk (78.6%), lamb (13.2%), culled ewes (0.5%) and other sales (0.8%, wool and manure) and completed with the European Union sheep subsidy (6.9%). Total annual costs were $\text{US}\$240.2 \pm 24.6 \times 10^3$ addressed to attend feeding (62.0%), labor (18.3%), equipment maintenance and depreciation (7.6%), animal health (2.5%), financial (2.5%), energy, water and milking supplies (2.2%), milk recording (0.5%), and others costs (4.4%; assurances, shearing, association fees, etc). Mean dairy sheep farm profit per year was $\text{US}\$12.5 \pm 7.7 \times 10^3$, being $\text{US}\$12.1 \pm 10.8$ per ewe, on average, and dramatically varying between $\text{US}\$-50.3$ and 107.8 per ewe among farms. Only 60% farms were able to pay all the costs, the rest having negative exercises. Nevertheless, annual net margin was $\text{US}\$40.3 \pm 8.5 \times 10^3$ on average, varying between $\text{US}\$0.8$ and $\text{US}\$258.0 \times 10^3$ among farms. In this case, without including the opportunity costs, all farms had positive exercises. Annual cost and income (US\$/ewe) functions depended on productivity (x , L/ewe) and were: $C = 207.7 + 0.653 \cdot x$ ($r^2 = 0.50$), and $I = 101.6 + 1.027 \cdot x$ ($r^2 = 0.88$), respectively, being the break-even point 284 L/ewe. Studied farms were on general of familiar type, medium-large sized, fully devoted to milk production and, most of them, economically profitable at nowadays. Flock size, milk yield and feeding costs were a key for dairy sheep farm profitability. Finally, according to the increasing trend expected for agricultural commodity prices, a proportional increase in milk price will be necessary to maintain their future profitability.

Key Words: cost, dairy sheep, profitability

W95 Effects of feeding teff hay-based diets on growth performance and ruminal fermentation profiles of growing beef steers and dairy heifers. J. E. Creech¹, J. M. Vera², C. T. Noviani², J.-S. Eun^{*2}, A. J. Young², and D. R. ZoBell², ¹*Department of Plants, Soils, and Climate, Utah State University, Logan*, ²*Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan*.

Teff (*Eragrostis tef* [Zucc.], Poaceae) is a warm-season annual grass and has attracted much interest among hay growers in the United States due to its rapid growth, palatability, and high quality and yield. The objective of this study was to assess growth performance and ruminal fermentation of growing beef steers and dairy heifers when fed teff hay-based diets. Twelve growing beef steers and 12 dairy heifers were used in a completely randomized design to test 2 dietary treatments: alfalfa hay-based TMR (AHT) and teff hay-based TMR (THT). In beef steer diets, the AHT contained 20.5% alfalfa hay and 43.0% corn silage, whereas the THT had 44.0% teff hay and 20.7% corn silage. In dairy heifer diets, the AHT contained 54.1% alfalfa hay and 24.8% corn silage, while the THT had 8.5% alfalfa hay, 42.0% teff hay, and 11.3% corn silage. All animals were placed in individual pens, and the experiment lasted 12 wk. Intake of DM increased by feeding the THT to beef steers and dairy heifers ($P = 0.01$). Dietary treatments did not affect ADG of beef steers; however, feeding the THT to dairy heifers increased ($P = 0.02$) ADG. Dietary treatments did not affect G:F in both beef steer and heifer diets. Ruminal pH averaged 6.54 or 6.51 in beef steer or dairy heifer diets, respectively, and did not differ between diets. Feeding the THT decreased total VFA concentration by beef steers and dairy heifers ($P < 0.02$). Feeding the THT to beef steers increased acetate proportion ($P = 0.02$), but the THT decreased propionate proportion ($P < 0.01$), resulting in increased acetate-to-propionate ratio due to feeding the THT ($P < 0.01$). In contrast, feeding the THT to dairy heifers tended to decrease acetate proportion ($P = 0.10$), but the THT increased propionate proportion ($P = 0.05$). Although feeding the THT decreased ruminal fermentation by beef steers and dairy heifers evidenced by decreased VFA concentration, the THT increased DMI of beef steers and dairy heifers, leading to no negative effects on growth performance. Teff can be a viable lower-cost alternative to feeding alfalfa in growing beef steers and dairy heifer diets.

Key Words: teff hay, beef steers, dairy heifers

W96 Comparison of in situ versus in vitro methods of fiber digestion at 120 and 288 hours to quantify the indigestible NDF fraction of corn silage samples. R. W. Bender^{*}, D. E. Cook, F. Lopes, and D. K. Combs, *University of Wisconsin-Madison, Madison*.

The indigestible NDF (iNDF) as a proportion of NDF in forages is commonly calculated from the ratio: $(2.4 \times \text{acid detergent lignin})/\text{NDF}$. Our objective was to compare estimates of iNDF based on lignin ratio, to in vitro (IV) and in situ (IS) measurements. Thirteen corn silage samples were dried and ground through a 1-mm screen in a Wiley mill. Acid detergent lignin (ADL) was determined by NIR analysis. A 2×2 factorial trial was conducted, with method of iNDF analysis (IS vs. IV) and incubation time (120 vs. 288 h) as factors. Four sample replicates were utilized, and approximately 0.5 g/sample was weighed into each Ankom F57 bag (Ankom Technology, Macedon, NY; pore size = 25 μm) for all techniques. The IV-120 (37.8%) had a higher ($P < 0.01$) proportion iNDF than all other methods; IS-120 (32.1%) and IV-288 (31.2%) techniques were similar, but were both higher ($P < 0.01$) than the IS-288 technique (25.7%). Utilizing the NIR lignin values to calculate the ratio of iNDF to lignin (Table 1) yielded similar results: IV-120 had a higher ($P < 0.01$) ratio (5.9) than all other methods;

IS-120 (5.0) and IV-288 (4.8) techniques were similar, but were both higher ($P < 0.01$) than the IS-288 technique (4.0). Thus, digestibility techniques at different times yielded vastly different estimates of iNDF. All techniques also yielded ratios that were higher than the commonly used ratio of $2.4 \times \text{lignin}$.

Table 1. In situ vs. in vitro methods of fiber digestion at 120 and 288 h to quantify iNDF

	iNDF, % of NDF		iNDF / Lignin	
	in vitro	in situ	in vitro	in situ
120 h	37.8 ^a \pm 1.4	32.1 ^b \pm 1.4	5.9 ^a	5.0 ^b
288 h	31.2 ^b \pm 1.5	25.7 ^c \pm 1.2	4.8 ^b	4.0 ^c

Key Words: indigestible NDF, fiber digestion, lignin

W97 Composition of gain and its relationship to residual feed intake and gain. M. L. Nascimento^{*1}, A. S. Chaves¹, R. R. Tullio², M. M. Alencar², A. N. Rosa³, and D. P. D. Lanna¹, ¹*University of Sao Paulo, Piracicaba, SP, Brazil*, ²*Embrapa Cattle Southeast, Sao Carlos, SP, Brazil*, ³*Embrapa Beef Cattle, Campo Grande, MS, Brazil*.

Residual feed intake and gain (RIG), a combination between residual feed intake (RFI) and residual gain (RG), was recently proposed as a new index for genetic selection of beef cattle. The objective of this work was to examine the relationship between gain composition of Nellore steers and RIG. Data set from 3 years of study were used, totaling 363 steers. The animals were individually fed twice daily with 5% of orts, for at least 70 d (2.8 Mcal ME/kg DM; 13.5% CP). Body weight (BW) was measured at 14-d intervals and ultrasound measurements on 11–12th-rib (fat thickness and ribeye area) obtained at the start, middle and final of the experimental period. Final and initial empty BW energy were estimated by an equation for Nellore (EBW Energy = $-126.73 + 10.88 \times \text{ribeye area} + 70.01 \times \text{fat thickness}$; $R^2 = 0.73$), the retained energy was calculated by difference. To estimate the proportion of protein and fat in the gain, the composition of the fat-free dry matter was held constant. Daily gain was estimated by regression slope between BW and days on feed. Mixed models were used to obtain RFI and RG, where contemporary group (CG), based on year, animal origin and pen type was considered as random. The RIG was calculated as $-1 \times \text{RFI} + \text{RG}$, both standardized to a variance of 1. The animals were classified as low, medium and high RIG (mean \pm 0.5 SD). High and low classes were compared using mixed model, RFI class and CG were considered as fixed effects, sire as random, and initial age as covariate. DMI of high-RIG animals (efficient) was 11.5% lower and ADG was 24.2% greater compared with low-RIG animals ($P < 0.01$) without differences in final BW ($P > 0.10$). There was no relationship between RIG and fat thickness gain ($P > 0.05$), however, efficient animals had greater ribeye area gain ($P < 0.01$). The efficient animals retained 0.40 Mcal less energy/kg of gain ($P < 0.05$). Consequently, empty body gain composition was different, where efficient animals had less fat and more protein ($P < 0.05$). The phenotype selection based on RIG can select animals with lower DMI and higher ADG, whose higher efficiency can be partially explained by changes in body gain composition.

Key Words: beef cattle, fat thickness, ribeye area

W98 Estimation of bacterial protein in rumen digesta using DNA markers. C. J. R. Jenkins^{*}, E. Castillo-Lopez, S. C. Fernando, and P. J. Kononoff, *University of Nebraska, Lincoln*.

The objective of this study was to use DNA as bacterial markers to estimate and compare the concentration of bacterial crude protein (BCP) in solid and liquid portions of rumen digesta. Using a completely randomized design, 2 multiparous, lactating Holstein cows (average DIM 14 ± 4 d, average BW 618 ± 40 kg, average DMI 23 ± 4 kg/d, average milk yield 34 ± 10 kg/d), fitted with ruminal cannulas were fed the same diet once daily at 0930 h. Every 4 h over a 24 h period, a sample of approximately 1.5 kg of rumen contents was collected from each cow and was strained through 4 layers of cheesecloth. Particle associated bacteria (PAB) was separated from the solid portion of rumen contents by adding PBS buffer and blending the mixture in a commercial blender, followed by straining through 4 layers of cheesecloth. Fluid collected after blending, as well as fluid retained from the initial straining, each underwent differential centrifugation, yielding bacterial pellets consisting of fluid associated bacteria (FAB) and PAB. DNA was then extracted from bacterial pellets and from the non-centrifuged samples of ruminal fluid and particles. The DNA from the bacterial pellets, ruminal fluid, and ruminal particle samples were subjected to real-time PCR using the TaqMan assay. Primers and a probe were designed from DNA encoding part of the 16s rRNA. The relative abundance of bacterial DNA tended to be higher ($P = 0.09$) in the solid portion (209.5 ± 26.6 mg BCP/g DM) than in the liquid portion (106.4 ± 43.6 mg BCP/g DM). Results suggest that BCP is detected in both the solid and liquid portion of rumen digesta and that it is found in higher concentrations in the solid portion.

Key Words: bacteria, marker, PCR

W99 Effect of a commercially available natural plant extract on intake and milk production of dairy cows. Y. Ying, M. Niu, A. R. Clarke, and K. J. Harvatine*, *Penn State University, University Park.*

The objective was to determine the ability of a commercially available natural plant extract (VéO Premium; Phode Laboratories, Terssac, France) to stimulate intake and its effects on milk production and feeding behavior of dairy cows. Two experiments (EXP) were conducted. First, 11 early-lactation dairy cows were used in a switchback design (EXP 1; 77 ± 15 DIM, Mean \pm SD) and second 15 mid-lactation Holstein cows were utilized in a crossover design (EXP 2; 157 ± 44 DIM, Mean \pm SD). Treatments were control (no supplement) or VéO fed at 4 and 4.5 g per head/d in a ground corn carrier in EXP 1 and 2, respectively. Diets were formulated to 31.5 and 31.0% NDF (EXP 1 and 2, respectively) and 17% crude protein. Treatment periods were 21 and 14 d (EXP 1 and 2, respectively) with the final 7 d used for sample and data collection. There was no effect of treatment on yield of milk, 3.5% FCM, fat, protein, or lactose in either experiment. There was also no effect of treatment on DMI or feed efficiency (FCM/DMI). Mean yield of 3.5% FCM was 53.3 and 39.9 kg/d and mean DMI was 33.0 and 27.3 kg/d across treatments for EXP 1 and 2, respectively. Additionally, there was no effect of treatment on milk FA profile in EXP 1 or average meal size or number of meals per day in EXP 2, but there was a tendency for the supplement to increase eating rate. In EXP 1, plasma insulin concentration 1 h before feeding was higher for the supplement cows compared with the control (3.36 vs. 2.13 μ U/mL; $P < 0.01$). The high level of intake in EXP 1 may have caused physical fill limitation of intake and prevented an increase in intake, however the supplement also did not increase intake in mid-lactation cows with more moderate levels of intake (EXP 2). Increased insulin before feeding may indicate a change in glucose homeostasis.

Key Words: feeding pattern, intake, plant extract

W100 Productive performance, hepatic function and nutrients utilization of dairy cows fed with *Jatropha curcas* L. seed meal treated with sodium hydroxide. A. S. Oliveira*¹, J. G. Souza¹, C. V. Araujo¹, A. Takaoka¹, D. C. Moura³, M. C. Souza¹, E. Peron¹, J. T. Zerovoudakis³, L. S. Cabral³, S. Mendonca², L. F. Moreno¹, P. H. N. Cruz¹, L. M.G. Olini¹, K. R. R. Amorim¹, F. G. Ribeiro¹, ¹Mato Grosso Federal University, Campus Sinop, Sinop, Mato Grosso, Brazil, ²Brazilian Agricultural Research Corporation's, Brasilia, DF, Brazil, ³Mato Grosso Federal University, Campus Cuiaba, Cuiaba, Mato Grosso, Brazil.

Twelve Holstein \times Zebu crossbreed cows (127 ± 60 DIM, 476 ± 64 kg BW) were distributed in three 4×4 Latin squares, with 4 periods of 21 d (7 d of mensurations) to evaluate the effect *Jatropha curcas* L. seed meal treated with 7% of sodium hydroxide (JCM 20.0% of CP, 1.65% of ether extract, 0.16% of Na and 0.145 mg of phorbol esters (PE)/g DM) in concentrate (0, 10, 20 and 30% of DM) on performance, hepatic function and nutrients utilization. Cows were fed with pasture of *Panicum maximum* 'Mombaça' (15.0% of CP, 64.8% of NDF, DM allowance of 11.8% BW/d) and offering 4 kg/d of isonitrogen concentrates (19.8% of CP). Intake pasture was estimate using external marker fecal output (TiO₂) and indigestible NDF. Spot urine samples were obtained after milking on 20 d of each period. Data were analyzed using model mixed and applied Williams test to comparison of means for quantitative data. Alkaline treatment reduced 67.9% the PE in JCM. Pasture intake ($P = 0.965$; 8.2 kg DM/d) was not affected by JCM. Concentrate DM intake (3.51, 3.28, 2.73 and 1.80 kg/d) was not affected ($P = 0.143$) until 20% of JCM, but was reduced ($P = 0.029$) with 30% of JCM. PE intake increased with JCM level ($P = 0.001$; 0, 0.103, 0.166 and 0.163 mg/kg BW/d) but serum concentrations of aspartate aminotransaminase (91.4 IU/L; $P = 0.759$), alanine aminotransaminase (46.5 IU/L; $P = 0.29$) and gamma-glutamyltransferase (14.7 IU/L; $P = 0.628$) were not affected by JCM. OM digestibility (73.5, 70.9, 70.7 and 69.2%) of diet was reduced ($P = 0.014$) with 30% of JCM. Rumen microbial crude protein synthesis (1.32, 1.23, 1.10 and 1.01 kg/d) was reduced ($P = 0.049$) from 20% of JCM. Milk yield (11.0, 10.7, 9.5 and 9.4 kg/d) was not affected ($P = 0.607$) until 10% of JCM, but was reduced ($P < 0.001$) from 20% of JCM. Milk crude protein (3.18%; $P = 0.441$), milk fat (3.0%; $P = 0.895$), body condition score (2.9; $P = 0.279$) and milk N/intake N (18%; $P = 0.556$) were not affected by JCM. The JCM can be included in up to 10% in DM concentrate without affect productive performance, hepatic function and nutrients utilization of Holstein \times Zebu crossbreed cows.

Key Words: phorbol ester

W101 Effects of heat stress and plane of nutrition on fecal composition of lactating dairy cows. J. D. Allen*^{1,2}, L. W. Hall², G. Xie^{2,4}, R. J. Collier², L. H. Baumgard³, and R. P. Rhoads^{2,4}, ¹Northwest Missouri State University, Maryville, ²University of Arizona, Tucson, ³Iowa State University, Ames, ⁴Virginia Polytechnic Institute and State University, Blacksburg.

The purpose of the study was to delineate the effects between heat stress (HS) and plane of nutrition on fecal nutrient composition. In 2 replications, multiparous cows ($n = 12$; parity = 2; 305 ± 33 DIM; 665 ± 18 kg BW) housed in climate chambers were fed a TMR consisting primarily of alfalfa hay and steam-flaked corn and subjected to 2 periods (P): (1) thermoneutral (TN) conditions (18°C, 20% humidity) with ad libitum intake for 9 d and (2) either HS conditions (cyclical temperature 31–40°C, 20% humidity: min THI = 73, max THI = 86) fed for ad libitum intake ($n = 6$), or pair-fed in TN conditions (PFTN, $n = 6$) for 9 d. Rectal temperature (Tre) and respiration rate (RR) were measured thrice daily at 0600, 1400 and 1800 h. Fecal samples were collected on d 1, 3, 5, 7, and 9 of each period for analyses of DM, NDF, ADF, CP,

ash, and starch. Data was analyzed as a complete random design, with cow as experimental unit, day as repeated measure, and each cow's P1 fecal concentration as a covariate. During P2, HS cows had a 1.8°C increase in Tre and a 3-fold increase in RR compared with PFTN cows ($P < 0.01$). Heat stress reduced ($P < 0.01$) DMI by 20% and by design PFTN cows had similar intake reductions. Milk yield was decreased 12% during HS and 8% in PFTN cows. Fecal dry matter tended ($P < 0.10$) to be higher in PFTN cows (16.6%) compared with P1 (15.8%) and HS (15.8%) cows. Fecal fiber components, NDF and ADF, were lower ($P < 0.01$) in PFTN cows (44.5 and 29.0%, respectively) compared with P1 (48.5 and 33.9%) and HS (47.1 and 32.6%) cows. Fecal starch was lower ($P < 0.05$) in HS cows (1.90%) compared with P1 (2.4%) and PFTN (2.8%) cows. There was no difference ($P > 0.10$) in fecal ash and CP. A period by day effect was seen in NDF, ADF, and starch ($P < 0.05$). Results indicate heat stress reduces fecal starch concentration, and lowered DMI reduces fecal NDF and ADF concentrations.

Key Words: dairy cow, fecal composition, heat stress

W102 Long-term performance of growing dairy heifers fed increased dietary fat from dried distillers grains. J. L. Anderson*, K. F. Kalscheur, A. D. Garcia, and D. J. Schingoethe, *South Dakota State University, Brookings*.

The objective of this study was to determine if feeding increased dietary fat from dried distillers grains with solubles (DDGS) to pre-pubertal dairy heifers influenced long-term performance. During the pre-pubertal growth phase, 33 Holstein heifers (133 ± 18 d old) were used in a 24-wk randomized complete block design with 3 treatment diets. Diets were (1) control (C) that contained 15.9% (DM basis) ground corn and 17.9% soybean products, (2) low-fat (LFDG) that contained 21.9% reduced-fat DDGS and 11.9% ground corn, and (3) high-fat (HFDG) that contained 33.8% traditional DDGS. All diets contained 39.8% grass hay, 24.8% corn silage, and 1.5% vitamins and minerals. Although diets were isonitrogenous and isocaloric, HFDG was formulated to contain 4.8% fat versus 2.8% in C and LFDG. Previous results demonstrated that growth performance was maintained, despite differences in metabolic profiles. Also, previous results indicated that heifer fed HFDG were pubertal earlier. Post-trial production data (farm and DHIA records) for each heifer was collected during the first 4 mo of lactation. Body weights, body condition scores, and frame measurements were taken 3 wk prepartum and at calving. Treatment did not affect ($P > 0.05$) age at conception or age at calving. At calving, wither height was shorter ($P = 0.03$) for heifers fed HFDG compared with other diets. For heifers fed LFDG milk production was greater (33.04, 36.40, 34.7 kg for C, LFDG, and HFDG, respectively; SEM = 1.35; $P = 0.03$) and milk protein yields tended to be greater (0.98, 1.08, and 1.03 kg; SEM = 0.043; $P = 0.06$) compared with heifers fed C. Heifers fed HFDG had similar milk production compared with C. Milk fat and energy-corrected milk yield were similar among treatments. Feeding increased dietary fat from DDGS during the pre-pubertal growth phase maintained milk production despite previous findings indicating differences in puberty. Based on these findings, producers can feed dietary fat from DDGS as a replacement for starch from corn as an energy source for pre-pubertal heifers without detriment to long-term performance.

Key Words: dairy heifer, distillers grain, long-term performance

W103 Validation and recovery rates of an indirect calorimetry headbox system used to measure heat production of cattle. A. J. Foth*, T. Brown-Brandl², H. C. Freetly², M. D. Hayes², and P.

J. Kononoff¹, ¹University of Nebraska-Lincoln, Lincoln, ²USDA Meat Animal Research Center, Clay Center, NE.

A headbox system was constructed at the University of Nebraska-Lincoln to determine heat production from dairy cattle using indirect calorimetry. The system was designed for use in a tie-stall barn to allow the animal to be comfortable and was mounted on wheels to transport between animals between sampling days. The frame was constructed out of aluminum angle iron with sides of plexiglass for other animals to remain within sight. The system continuously sampled gas produced in the headbox and directed it into foil bags, allowing for analysis of O₂, CO₂ and methane concentrations. To validate the data collected by 3 constructed units, alcohol burning lamps containing 100% ethyl alcohol were placed inside, ignited and burned for 2 h. The rate of gas flowing out of the system was recorded and samples of gas entering and exiting each of the sealed headboxes was collected into 44 L sample bags and later analyzed. The difference between gas concentrations from incoming and outgoing air, corrected to standard temperature and pressure, was calculated and the amount of O₂ consumed and CO₂ produced during the sampling time was compared with the theoretical amount of each of these gases calculated based upon the amount of alcohol burned, giving the recovery rate of each gas. Two runs were carried out on 2 separate occasions for each unit and the results can be found in Table 1. Recovery rates for O₂ and CO₂ averaged 101.3 ± 2.72% and 100.5 ± 3.59% suggesting that these units may be used to adequately estimate gas exchange and for indirect calorimetry to indirectly determine heat production.

Table 1. Means and standard deviations of 2 lamp runs on headboxes 1, 2, and 3

	Headbox 1		Headbox 2		Headbox 3	
	Mean	SD	Mean	SD	Mean	SD
Average gas flow (m ³ /min)	0.94	0.01	0.97	0.01	1.03	0.03
O ₂ consumed (L)	175.4	21.1	144.9	12.4	134.0	1.77
CO ₂ produced (L)	116.3	11.74	95.5	4.60	89.6	4.10
Average temperature (°C)	32.5	3.95	29.8	3.43	29.0	1.90
Average dew point (°C)	16.6	4.04	13.1	3.31	13.1	1.87
O ₂ recovery rate (%)	101.19	2.17	104.12	0.57	98.71	1.65
CO ₂ recovery rate (%)	100.80	0.19	103.11	3.32	97.64	4.81

Key Words: indirect calorimetry, headbox, lamp run

W104 Energy requirement of Holstein calves. J. C. M. Lima¹, J. P. P. Rodrigues¹, M. I. Marcondes*¹, F. S. Machado², A. S. Treece¹, M. M. D. Castro¹, J. L. C. Dias¹, and T. Araújo¹, ¹Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, ²Embrapa Gado de Leite, Juiz de Fora, Minas Gerais, Brazil.

This study aimed to evaluate energy requirements in dairy calves. Forty-two male Holstein calves, at 3 d of age and with an average live weight of 35.56 ± 5.86 kg, were used. Ten animals were slaughtered to compose the reference group, and the remaining animals were distributed into a completely randomized design. The treatments consisted of different amounts of milk, which were: 2, 4, 6 and 8 L milk/head/d, fed twice a day, in 8 replications. The animals were fed milk until they reached 58 d. Four animals per treatment were slaughtered at 59 d, while others started to receive Coast cross hay plus starter, and they were subsequently slaughtered at 87 d. After slaughter, 2 samples were obtained for each animal, called carcass and non-carcass. The retained energy was estimated by determining energy concentration in carcass

and non-carcass samples, and diminishing by the initial body energy concentration. The HP of each animal was estimated as: $HP = \beta_0 \times e^{(\beta_1 \times MEI)}$, where MEI is metabolizable energy intake. Digestible energy intake (DEI) was obtained by controlling protein, fat and carbohydrates daily intake, which were multiplied by 5.6, 9.4, and 4.2 Mcal/kg, respectively, and by their respectively digestibilities. MEI of each animal was obtained by the equation: $MEI = DEI \times (0.96 \times DMI + 0.88 \times (1 - DMI))$, where DMI is the proportion of milk intake in dry matter intake. Net (NEm) and metabolizable (ME_m) energy requirements for maintenance were obtained as a function of heat production (HP) and metabolizable energy intake (MEI), while net energy requirements for gain (NEg) were obtained as a function of empty body weight (EBW) and empty body gain (EBG). The NEm and ME_m were respectively 85.2 and 143.4 kcal/EBW^{0.75}/d. The efficiency of utilization of metabolizable energy for maintenance (k_m) was 59.41%. The equation obtained for NEg and efficiency of utilization of metabolizable energy for gain (k_g) were, respectively, NEg (Mcal/d) = $0.0931 \times EBW^{0.75} \times EBG^{1.454}$, and 38.07%. The efficiencies of energy deposition as protein and fat were 67.69% and 60.73%, respectively. The equations suggest that net and metabolizable energy requirements for maintenance of Holstein calves exceed those commonly use in the dairy industry.

Key Words: calf, gain, maintenance

W105 Brown marmorated stink bug odor compounds do not transfer into milk in lactating dairy cattle by feeding bug-contaminated corn silage. R. L. Baldwin VI¹, A. Zhang², S. W. Fultz³, S. Abubeker², C. Harris², E. E. Connor¹, and D. L. Van Hekken⁴, ¹USDA, ARS, BFG, Beltsville MD, ²USDA, ARS, IIBBL, Beltsville MD, ³University of Maryland Extension, Frederick, ⁴USDA, ARS, EERC, Wymdmoor, PA.

Brown marmorated stink bug (BMSB), *Halyomorpha halys*, is an emerging invasive species of grave concern to agriculture as a polyphagous plant pest with potential negative effects on the dairy industry. We sought to determine the risk of including BMSB contaminated silage in lactating dairy cow rations. First, 6 dairies, either highly infested ($n = 3$; 30 to 100 bugs per stalk) or not infested ($n = 3$) were sampled to assess prevalence of bug secretion compounds tridecane and E-2-decenal (odor component) in silage and milk. Second, using wild BMSB, a mini-silo dose response experiment (adding 100, 50, 25, 10, and 1 fresh crushed bugs/0.5 kg chopped corn) was conducted to assess the effect of ensiling on BMSB odor compounds. Finally, synthetic BMSB secretion compounds (10 g tridecane and 5 g E-2-decenal) were ruminally infused 2 times daily over 3 d and samples of milk, urine, and rumen fluid were collected to evaluate disposition. Samples were analyzed by solid phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS). Milk production and feed composition were unaffected ($P > 0.05$) when BMSB contaminated silage was fed. Moreover, no E-2-decenal was detected in silage nor milk (detection threshold = 0.00125 ppm). Dose response of tridecane in mini-silo samples exhibited a linear relationship ($R^2 = 0.78$) with BMSB added; however, E-2-decenal was completely decomposed and undetectable in spiked mini-silos after ensiling. Both synthetic secretion compounds infused into rumen were

undetectable in all milk and urine samples. Content of E-2-decenal was also not detectable in rumen fluid; however, tridecane was detected at 15 min post-infusion but not present thereafter. Feed intake was unaffected by infusion treatment and BMSB secretion compounds were not observed in milk. Compounds from the methathoracic gland of BMSB are not able to contaminate milk due to either the ensiling process or metabolism within the rumen. Concern over BMSB odor compounds contaminating the fluid milk supply even on highly infested farms is not warranted.

Key Words: brown marmorated stink bug, milk taint, lactating dairy cow

W106 Effects of restricted versus conventional dietary adaptation over periods of 9 and 14 days on total-tract digestibility of dry matter and starch of feedlot Nellore cattle. A. L. N. Rigueiro², D. H. M. Watanabe², M. C. S. Pereira², J. Silva², T. V. B. Carrara¹, M. C. S. Franzoi¹, R. S. Barducci¹, M. D. B. Arrigoni¹, F. Perna Junior⁴, M. Caetano³, D. P. D. Lanna³, and D. D. Millen^{*2}, ¹São Paulo State University (UNESP), Botucatu, São Paulo, Brazil, ²São Paulo State University (UNESP), Dracena, São Paulo, Brazil, ³University of São Paulo (USP), Piracicaba, São Paulo, Brazil, ⁴University of São Paulo (USP), Pirassununga, São Paulo, Brazil.

This study was designed to determine effects of restricting DMI of the final finishing diet (REST) as a means of dietary adaptation compared with diets increasing in concentrate (STEP) over periods of 9-d and 14-d on total-tract digestibility of DM and starch of feedlot Nellore cattle. The experiment was designed as a completely randomized block with 2×2 factorial arrangement, replicated 6 times (5 bullocks/pen), in which one hundred twenty 22-mo-old yearling Nellore bulls (361.3 ± 30.2 kg) were fed in 24 pens for 84 d according to the treatments: STEP for 9-d and 14-d, REST for 9-d and 14-d. Measures over time were taken on d 5, 10, 15, and 20 of experimental period. The STEP program consisted of ad libitum feeding of 3 adaptation diets over periods of 9-d or 14-d with concentrate level increasing from 55% to 85% of diet DM. The REST program consisted of restricted intake of the final diet (85% concentrate containing 55% of high moisture corn) with programmed increases in feed offered until yearling bulls reached ad libitum access over periods of 9-d and 14-d. Fecal samples were collected just before morning (0800 h) and afternoon (1500 h) meals, and a composite sample per pen in each day was made. It was observed ($P < 0.05$) an interaction between protocols, length of protocols and days for DM and starch digestibility. Yearling bulls adapted for 14-d had greater DM digestibility on the first day of the finishing period (15-d: STEP in 14-d = 79.05%, REST in 14-d = 78.05%) than those adapted for 9-d (10-d: STEP in 9-d = 68.04%, REST in 9-d = 69.39%); however, no differences ($P > 0.10$) between treatments were observed on d 15. Moreover, yearling bulls in REST for 14-d and STEP during 9-d did not present differences ($P > 0.10$) in starch digestibility over days of collection. However, yearling bulls adapted in REST for 9-d and STEP during 14-d ($P < 0.05$) only proved to be able to digest starch like those in REST for 14-d and STEP for 9-d on d 15. Thus, according to present data, yearling Nellore bulls should be adapted in 14 d, regardless of the protocol.

Key Words: adaptation, digestibility, Nellore