

Ruminant Nutrition II

562 Study of effects of conjugated linoleic acid (CLA) on milk production and composition, and milk fatty acid profile of Holstein dairy cows. A. Mahdavi,* K. Rezayazdi, A. Z. Shahneh, and M. Dehghan-Banadaky, *Department of Animal Science, College of Agriculture and Natural Resources, University of Tehran, Karaj, Tehran, Iran.*

The aim of this experiment was to determine the effects of conjugated linoleic acid (CLA) on milk production and composition, and milk fatty acid profile of dairy Holstein cows. Three lactating Holstein cows (203 ± 9 DIM; mean \pm SD) fitted with rumen fistula were used in a 3×3 Latin square experiment with 21-d periods, including a 14-d adaptation period followed by a 7-d sampling period. Treatments were: 1) control (115 g/d calcium salts of palm fatty acids), 2) rumen protected CLA (120 g/d of lipid-encapsulated CLA), and 3) unprotected CLA (40 g/d unprotected CLA that replacing and balancing by Ca salts of palm fatty acids). Each dose provided 96 g/d fatty acids. Both of CLA supplements provided 12 g/d of trans-10, cis-12 CLA. Supplements were administered intraruminally once per day immediately before morning feeding. Individual milk yield and dry matter intake were recorded daily and milk composition was determined every day. Data were analyzed by MIXED procedure of SAS. Dry matter intake and milk yield were not affected by CLA supplements. The CLA supplements reduced milk fat content compared with control ($P < 0.01$), which were 2.58, 3.51, and 3.77 for rumen protected CLA, rumen unprotected CLA and control, respectively. In contrast, there were no significant differences in content of Milk protein and lactose between treatments. The milk fatty acid profile was significantly affected by rumen protected CLA. The proportion of short- and medium-chain fatty acids decreased in rumen protected CLA compared with control whereas the proportion of long-chain fatty acids increased in rumen protected CLA. The milk fat content of trans-10, cis-12 CLA was increased by CLA supplements compared with control ($P < 0.01$) especially by rumen protected CLA. The Δ^9 -desaturase index was not affected by CLA supplements. The results of this experiment indicated that rumen protected CLA could decrease milk fat content and yield, and alter milk fatty acid profile, but has no effect on dry matter intake and milk yield during late lactation in Holstein dairy cows.

Key Words: conjugated linoleic acid, Holstein cow, milk fat

563 Measurement and regression models of methane emissions from sheep. Y.-G. Zhao, C.-G. Jiang, J. Liu, Y. Tu, K.-D. Deng, X.-H. Gao, and Q.-Y. Diao,* *Feed Research Institute of Chinese Academy of Agricultural Sciences, Beijing, China.*

This trial was designed to study the effects of dietary composition, nutrients intake, digestible nutrients, ruminal fermentable nutrients and volatile fatty acid (VFA) on rumen methane (CH_4) emissions from sheep and develop regression models. Eight rumen-fistulated adult crossbred rams [Dorper (male) \times Small Tail Han sheep (female)] with the body weight of (50.37 ± 1.13) kg, were used in an 8×4 incomplete Latin square with 8 different diets and 4 21-d periods. Eight total mixed rations (TMR) with different neutral detergent fiber (NDF) content of 51.83, 50.47, 44.58, 42.34, 38.20, 35.43, 30.10, and 27.03%, were offered to 8 sheep correspondingly and exchanged sequentially in 4 periods. The experimental duration consisted of a preliminary 8-d adaptation period followed by an 8-d period to conduct digestive trials in metabolism cages by total feces collection method and CH_4 was measured using open-circuit respiration calorimetry system with 3 sheep every 2 d,

simultaneously. Nylon bags technique was used for the evaluation of ruminal fermentable nutrients with 6 different incubation times (0, 6, 12, 24, 48 and 72 h, respectively) from d 17 to d 19. Ruminal contents were taken through rumen cannulas of each sheep at 08.00 h, 14.00 h and 20.00 h on d 20 and at 02.00 h, 05.00 h, 11.00 h, 17.00 h and 23.00 h on d 21. The concentrations of VFA were measured after the liquor was strained through 4 layers of gauze. Prediction equations for CH_4 emissions were developed as linear or multiple regression models using the PROC REG of SAS software. Correlations were declared significant at $P < 0.05$. CH_4 per kg fermentable organic matter (L/kg FOM) of 8 diets was 81.64, 87.22, 77.42, 61.87, 52.19, 54.90, 57.07 and 58.72, respectively. In linear relationships, CH_4 (L/kg FOM) was negatively related to organic matter intake (OMI), gross energy intake (GEI), crude protein intake (CPI), digestible organic matter (DOM), digestible energy (DE), digestible crude protein (DCP), digestible ether extract (DEE), FOM, Butyrate/total VFA (TVFA) and Valerate/TVFA ($P < 0.05$) and positively related to NDF intake (NDFI), ADF intake (ADFI), digestible NDF (DNDF), digestible ADF (DADF), fermentable ADF (FADF), fermentable NDF (FNDF)/FOM, FADF/FOM, and Acetate/TVFA ($P < 0.05$). The relationship between methane energy ($\text{CH}_4\text{-E}/\text{DE}$ and DADF/DOM) was $\text{CH}_4\text{-E}/\text{DE}(\%) = 0.17984 (\pm 0.02178) \text{DADF}/\text{DOM}(\%) + 5.25136 (\pm 0.43411)$ which obtained the highest R^2 (0.9191) and lowest P (0.0002) in all linear models. The multiple relationship between CH_4 and nutrients intake was CH_4 (L/kg FOM) = $0.18188 (\pm 0.07433) \text{OMI} - 0.54702 (\pm 0.09244) \text{CPI} - 1.17661 (\pm 0.12692) \text{NDFI} + 1.57775 (\pm 0.14902) \text{ADFI} - 3.39557 (\pm 0.38786) \text{EEI} + 154.94964 (\pm 40.25930)$ (all nutrients in kg) which increased R^2 to 0.9992 with a low P (0.0021). Multiple analysis of CH_4 and VFA resulted in CH_4 (L/kg FOM) = $0.82530 (\pm 0.10455) \text{Acetate} + 4.57099 (\pm 0.30178) \text{Propionate} - 7.15948 (\pm 0.30917) \text{Butyrate} - 20.30966 (\pm 1.04868) \text{Valerate} + 10.49258 (\pm 0.98749) \text{Isovalerate} + 9.02963 (\pm 5.09327)$ (all VFA in mmol/L) with a high R^2 (0.9989) and low P (0.0028). The results indicated that CH_4 (L/kg FOM), $\text{CH}_4\text{-E}/\text{GE}$ and $\text{CH}_4\text{-E}/\text{DE}$ were affected by the ratio of forage to concentrate (F:C) or dietary roughage content. In the linear regression models, NDF and ADF were more reliable than other nutrients to estimate methane emissions with higher precision. Compared with the linear regression models, the multiple regression models clearly provided a higher accuracy. Therefore, they may be useful to improve the prediction of methane emissions from sheep.

Key Words: methane, regression models, sheep

564 Response of postpartum dairy cows to contrasting feeding strategies: Grazing plus supplements versus confinement on milk and solids production. M. Sprunck^{1,2}, D. A. Mattiauda¹, G. Motta¹, M. Fajardo¹, and P. Chilibroste^{*1}, ¹Facultad de Agronomía, Paysandú, Paysandú, Uruguay, ²Agencia Nacional de Investigación e Innovación, Montevideo, Montevideo, Uruguay.

The effect of feeding strategies involving grazing plus supplements (GS) versus confinement (TMR) on performance of early lactation Holstein dairy cows was under research. The experiment was carried out in autumn 2010 in Uruguay (30° S). Dairy cows ($n=48$, LW = 593 ± 94 kg and BCS = 3 ± 0.6) were randomly assigned to one of the following treatments: TMR (ad libitum; CP = 171 ± 10 g/kg of DM, NDF = 400 ± 20 g/kg of DM) and G+S with a herbage allowance of approximately 10 kg of DM/d per 100 kg of BW. Herbage chemical composition was: CP = 173 ± 31 g/kg of DM, NDF = 465 ± 65 g/kg of DM. Grazing took place on a 2nd year mix pasture (30% legumes and

70% grasses) between am and pm milking. After pm milking G+S cows were supplemented with 8.5 kg DM of TMR. The differential treatment duration was 8 weeks (2-10 postpartum) and residual measurement was until the end of lactation (week 11-30 postpartum). Cows in TMR had higher daily production of fat and protein during the first 8 weeks than cows on G+S treatments: +209 g/d and +266 g/d, respectively. G+S cows had a higher percentage of fat and a tendency to lower percentage of protein in milk. TMR cows had higher LW during the experimental period. Cows in TMR treatment results in greater solids production (kg of solids/d of fat and protein) and LW during treatment application, but differences disappear during the post-experimental period.

Table 1. Experimental period (E) and residual effects (R)

Treatment	G+S (E)	TMR (E)	P-value	G+S (R)	TMR (R)	P-value
L/cow per day	26.2	34.36	< 0.001	25.7	27.02	0.144
% fat	3.71	3.49	0.034	3.64	3.49	0.519
% protein	3.11	3.25	0.093	3.20	3.25	0.424
Fat (kg/d)	0.960	1.169	< 0.001	0.960	0.98	0.565
Protein (kg/d)	0.819	1.2	< 0.001	0.85	0.87	0.579
LW (kg)	558	606	0.004	572	587	0.219
Pasture intake (kg/DM)	15.6	-	-	-	-	-

Key Words: confining cows, early lactation, grazing cows

565 Effects of rumen-protected γ -aminobutyric acid on feed intake, performance and antioxidant status in transition cows. D. M. Wang^{*1}, C. Wang^{1,2}, H. Y. Liu¹, and J. X. Liu¹, ¹Institute of Dairy Science, MoE Key laboratory of Molecular Animal Nutrition, College of Animal Sciences, Zhejiang University, Hangzhou, China, ²College of Forestry and Biotechnology, Zhejiang A & F University, Lin'an, Hangzhou, China.

The objective of this study was to investigate the effects of unprotected and rumen-protected γ -aminobutyric acid (GABA) addition on dry matter intake, energy balance, milk performance, and serum metabolites in transition cows. Forty cows were blocked based on previous milk production, parity, estimated calving date and body weight, and randomly assigned to one of 4 treatments: added with unprotected GABA (0 or 0.6 g/d) or rumen-protected GABA (1.2 or 2.4 g/d), respectively. The rumen-protected product was 50% GABA. The experiment lasted from 2nd week before calving to 4th week after calving. Milk yield and milk composition were recorded weekly. Serum concentrations of GABA, neuropeptide Y, cholecystokinin, leptin and biochemical and antioxidant metabolites were analyzed weekly. All the data were analyzed using the PROC MIXED of SAS with cow as the repeated subject using the covariance type AR (1). The model included week, treatment, and interaction of treatment \times week. In 3rd and 4th weeks after calving, dry matter intake was higher ($P < 0.05$) in the cows fed 2.4 rumen-protected GABA, compared with that of the control. In 4th week after calving, milk protein yield was higher ($P < 0.05$) in the cows fed 2.4 g/d rumen-protected GABA than that of the control. No significances were observed in the serum concentrations of GABA, neuropeptide Y and leptin among all the treatments, while cholecystokinin concentrations decreased ($P < 0.05$) in cows fed 2.4 g/d rumen-protected GABA in 3rd and 4th weeks after calving. Serum concentrations of total antioxidant capacity, glutathione peroxidase and superoxide dismutase were not different among cows fed rumen-protected GABA. In conclusion, addition

of rumen-protected GABA at 2.4 g/d could increase feed intake, improve milk protein yield, and be beneficial to postpartum dairy cows' health.

Key Words: γ -aminobutyric acid, dry matter intake, transition cows

566 Productive performance by lactating cows fed with different levels of Palm kernel cake. R. L. Oliveira^{*1}, R. L. N. Vaz Silva², A. C. Ferreira¹, A. G. Leão¹, M. C. A. Santana¹, A. A. Pinheiro¹, O. L. Ribeiro¹, and L. F. B. Pinto¹, ¹Universidade Federal da Bahia, Salvador, BA, Brazil, ²Instituto Federal Baiano, Catu, BA, Brazil.

With the objective of verifying the most appropriate level of inclusion of palm kernel cake in a dietary supplement for lactating cows on pasture, 16 multiparous dairy cows of the Holstein \times Gir crossbreed, with an average weight of 436.6 kg (± 59.7), were used. The experiment was conducted at the Experimental Farm of the Federal University of Bahia, Brazil, during August to October 2009. A Latin square design was utilized, with the cows distributed in 4 Latin squares, 4 \times 4 simultaneous (4 treatments \times 4 periods \times 4 animals in each treatment), data were analyzed using the GLM (General Linear Models) and REG (Regression). The growth performance was evaluated for the cows at pasture that were provided with a dietary supplement that contained levels of 0%, 25%, 50% and 75% of palm kernel cake. The available forage was *Panicum maximum* 'Massai'. A decrease in the intake of the supplement was observed ($R^2 = 0.84$, $P < 0.05$), however, the milk production and the body condition of the cows were not influenced by the levels of palm kernel cake within the supplement. The milk production and the milk production corrected for 3.5% fat (9.96 and 9.56 kg/day, respectively) can be considered normal for crossbred dairy herds in north-eastern Brazil, these values are associated with a lower degree of specialization of the experimental herd due to their low genetic potential. The body condition of the cows was not altered with the inclusion of palm kernel cake at increasing levels, as the intake of dry matter and total digestible nutrients was not suppressed and the observed body condition score mean (2.88) was close to that which would be expected (3.0 to 3.5), because the dairy farming techniques are demanding on the animals. This indicates that the nutritional requirements were met and that there was a significant mobilization of body energy reserves to produce milk. The low cost of the ingredient and the absence of the restrictive effects on the milk production and the body condition of the cows suggest that palm kernel cake is a suitable co-product for supplements designed for lactating cows at pasture, especially in scenarios of low income per kilogram of milk produced.

Key Words: co-product, milk, pasture

567 Effect of ruminal adaptation on short-chain fatty acid absorption and risk for ruminal acidosis. T. Schwaiger^{*1,2}, K. A. Beauchemin², and G. B. Penner¹, ¹University of Saskatchewan, Saskatoon, SK, Canada, ²Lethbridge Research Center, Lethbridge, AB, Canada.

This study was conducted to determine if the duration of time that cattle are fed a high-grain diet affects short-chain fatty acid (SCFA) absorption and susceptibility to ruminal acidosis. Sixteen Angus heifers (BW \pm SEM, 261 \pm 6.1 kg) were assigned to 4 blocks, and fed a backgrounding diet consisting of 60% barley silage, 30% barley grain and 10% supplement (DM basis). Cattle were then adapted, over 20 d, to a high-grain diet containing 9% barley silage, 81% barley grain and 10% supplement (DM basis). Within block, cattle were randomly assigned to 1 of 2 treatments differing in the number of days they were fed the high-grain diet before an acidosis challenge: 34 d for long adapted (LA) and 8 d for

short adapted (SA). Ruminal acidosis was induced by withholding feed to 50% of DMI for 24 h followed by an intraruminal infusion of ground barley at 0.33% BW on a DM basis. Cows were then given their regular diet allocation 1 h after the intraruminal infusion. Data were collected during the baseline period, following the acidosis challenge and after 1 wk of recovery. Absorption of SCFA was measured using the isolated washed reticulo-rumen technique. LA animals had greater fractional absorption rates of propionate (41.6 vs. 33.8%/h; $P=0.032$) and butyrate (44.9 vs. 35.2%/h; $P=0.012$) compared with SA animals. In addition, LA animals also had greater absolute butyrate absorption (94.9 vs. 76.9 mM/h; $P=0.048$). Absolute and fractional absorption of all individual SCFA increased during the recovery period ($P \leq 0.050$) relative to the challenge, except for fractional acetate absorption, which only tended to increase ($P=0.089$). Mean and minimum pH both increased during the recovery period ($P < 0.001$) while daily duration and area that pH < 5.5 both decreased during the same time period ($P < 0.001$). There were no treatment differences for pH, DMI, or ruminal fluid SCFA concentrations. This study suggests that increasing the duration that cattle are fed a high-grain diet increases SCFA absorption, without affecting susceptibility to ruminal acidosis.

Key Words: diet adaptation, ruminal acidosis, short-chain fatty acid

568 Effect of simultaneous reduction of ruminally degradable protein and ruminally undegradable protein in dairy cattle. M. Aguilar* and M. D. Hanigan, *Virginia Polytechnic Institute and State University, Blacksburg.*

Previous studies have shown that RDP and RUP (Cyriac et al., 2008; Rius et al., 2010) can be reduced independently below NRC requirements, with no effect on milk production or animal health, suggesting requirements may exceed true needs. However, because some RDP requirement is met by urea recycling which is dependent on overall protein supply, reducing both RDP and RUP simultaneously could induce an RDP deficiency. We hypothesized that dairy cattle may be able to maintain performance when fed a combination of sub-NRC requirement levels of RUP and RDP. Thirty-six mid-lactation dairy cows (24 Holstein and 12 Jersey \times Holstein cross-breds) were fed diets containing sufficient or deficient amounts of RDP and RUP in a 2×2 factorial arrangement within a 4×4 Latin Square design with 3-wk periods. Diets were formulated to contain 16.5, 15.75, or 15.0% CP (DM basis) with RUP and RDP balances of +57 and +58 g/d (High-RUP/High-RDP, 16.5% CP); +42 and -209 g/d (High-RUP/Low-RDP, 15.75% CP); -133 and +61 g/d (Low-RUP/High-RDP, 15.75% CP); or -182 and -186 g/d (Low-RUP/Low-RDP, 15.0% CP), respectively. All diets contained 46.8% forage and 53.2% concentrate on a DM basis. Milk yield and composition were measured and urinary purine output was calculated from urinary concentrations of allantoin and uric acid. Treatment had no effect on DMI, milk production, milk protein, lactose, or fat yield. Diets containing low levels of RUP had significantly reduced MUN and urinary urea N levels as compared with diets with higher RUP levels. Urinary N excretion was significantly reduced in the Low-RUP/Low-RDP diet. Microbial N flow, calculated from urinary purine derivatives, was not significantly affected by treatment. Reduced levels of dietary RUP and RDP reduced N excretion and improved N efficiency without altering microbial outflow.

Key Words: ruminally degradable protein, ruminally undegradable protein, nitrogen requirement

569 Effects of dietary forage-to-concentrate ratio and sulfur concentration on ruminal fermentation and sulfur metabolism in feedlot heifers. S. Amat,* J. J. McKinnon, G. B. Penner, E. Simko, and S. Hendrick, *University of Saskatchewan, Saskatoon, SK, Canada.*

This study was conducted to evaluate the effects of the dietary forage-to-concentrate ratio (F:C) and S concentration on ruminal fermentation, S metabolism, short chain fatty acid (SCFA) absorption, and histopathological changes suggestive of polioencephalomalacia (PEM) in the brain. Sixteen ruminally cannulated heifers (initial BW 628 ± 48 kg) were used in a randomized complete block with a 2×2 factorial treatment arrangement. Main factors included the F:C ratio (4% forage vs. 51% forage, DM basis), and the S concentration which was modified using differing sources of wheat dried distillers grains with solubles (DDGS) to achieve low and high S diets (LS = 0.30 vs. HS = 0.67% S DM basis, respectively). Elemental S was also added to increase the S content for the HS diets. Blood, rumen gas cap and urine samples were collected for serum sulfate, H_2S , and urinary sulfate analysis, respectively. Continuous rumen pH and SCFA (acetate, butyrate and propionate) absorption were measured. At the end of the study, heifers were euthanized and brain tissue was subjected to histopathological analysis. There were no interactions between the F:C and S concentration. The F:C did not ($P = 0.871$) affect DMI or ($P > 0.05$) S metabolism but ruminal pH was reduced ($P < 0.01$) and SCFA was greater ($P < 0.01$) for low-forage diets. Cows fed HS diets had reduced DMI ($P < 0.01$), greater rumen pH ($P < 0.01$) and greater concentrations of ruminal H_2S ($P < 0.01$), serum sulfate ($P < 0.01$), and urinary sulfate ($P < 0.01$) relative to low S diets. Ruminal H_2S was positively correlated with serum sulfate ($r = 0.89$; $P < 0.01$). Feeding HS diets reduced SCFA absorption ($P \leq 0.05$). No macroscopic or microscopic changes were detected in the brains of the heifers. In summary, S metabolism in feedlot heifers was not influenced by different F:C, but HS reduced DMI and inhibited SCFA absorption.

Key Words: DDGS, short chain fatty acids, sulfur metabolism

570 Intake, digestibility and microbial protein synthesis in heifers fed pasture, total mixed ration or both. A. Santana*¹, A. Perez-Ruchel², C. Cajarville², and J. L. Repetto¹, ¹*Facultad de Veterinaria, UdelaR, Depto. Bovinos, Montevideo, Uruguay.* ²*Facultad de Veterinaria, UdelaR, Depto. Nutrición, Montevideo, Uruguay.*

We evaluated the intake and digestibility of dry matter (DM), organic matter (OM) and nitrogen (N), microbial protein synthesis (MPS), efficiency of microbial protein synthesis (EMPS) and nitrogen efficiency for MPS (NEMPS), in heifers. Nine individually housed cross-breed heifers (214 ± 18 kg BW) were ad libitum fed total mixed ration based on sorghum plant silage, soybean meal, corn high moisture silage and dry corn, (TMR), fresh forage, cut daily from a temperate pasture (*Trifolium repens* and *Lolium multiflorum*) (PA) or TMR for 18h plus 6h pasture (TMR-PA) in a latin square design of 3×3 triplicate. Each experimental period consisted in 10d of adaptation and 8d for sampling. Intake was individually determined during 8d as the difference between offered and rejected food. Total feces and urine excretion were measured during 5d. The results are shown in the Table below. The TMR- PA presented similar intake, MPS, EMPS and NEMPS than TMR, being the intake of DM and OM and MPS of PA the lowest. There were no differences in DM and OM digestibility between treatments. Pasture addition for 6h allowed to maintain nutrient ingestion and did not affect microbial protein synthesis regarding to TMR.

Table 1.

	TMR	TMR-PA	PA	SEM	P-value
Intake, kg/d					
DM	5.99 ^{ab}	7.36 ^a	5.49 ^b	0.56	0.042
OM	5.84 ^{ab}	7.02 ^a	5.13 ^b	0.55	0.040
N	0.58	0.77	0.73	0.06	0.144
Digestibility, %					
DM	66.5	71.1	73.2	2.35	0.166
OM	71.6	74.2	75.4	1.70	0.329
N	61.1 ^b	69.8 ^{ab}	77.3 ^a	2.38	0.003
MPS and efficiency ¹					
MPS, gmN/d	100.6 ^a	105.6 ^a	64.9 ^b	8.9	0.018
EMPS, gmN/kg DOMI	39.8 ^a	24.7 ^{ab}	20.9 ^b	5.2	0.053
NEMPS, gmN/gN intake	0.24 ^a	0.16 ^{ab}	0.10 ^b	0.03	0.052

¹MPS = microbial protein synthesis; gmN = g of microbial N/d; DOMI = digestible OM intake; EMPS = efficiency of MPS; NEMPS = N efficiency for MPS.

Key Words: feeding systems, fresh forage, ruminant

571 A technology that enhances the utilization of low quality forages in ruminant animals. H.-L. Mao¹, H.-L. Mao¹, J. K. Wang^{*1}, J. A. Ye¹, J. X. Liu¹, and I. Yoon², ¹Institute of Dairy Science, Zhejiang University, Hangzhou, China, ²Diamond V, Cedar Rapids, IA.

Effects of various levels (0, 1, 2 and 3 g/L) of *Saccharomyces cerevisiae* fermentation product (YC; Diamond V XP) on ruminal fermentation of major forage sources of China (rice straw, corn stover, corn silage with grain and corn silage without grain) were examined in an in vitro study with a 4 × 4 factorial arrangement of treatments. Ruminal fluid was collected from 3 rumen cannulated Hu sheep fed a diet consisting of lucerne hay and concentrate mixture (50:50) twice daily. Gas pressure measurements were recorded at 3, 6, 9, 12, 24 and 48 h of incubation and then converted to gas volume. Ammonia N, pH, volatile fatty acids (VFA), and microbial crude protein (MCP) were determined at 12, 24 and 48 h. Microbial population was examined at 24 h incubation. Data were analyzed using the GLM procedure of SAS. Terminal pH varied within normal range (6.53 to 6.96) regardless of treatment or substrate. The YC showed inconsistent effect on ammonia N (8.0 to 23.1 mg/dL) with different substrates. Gas production reached peak at 2 g/L YC for rice straw and corn silage without grain, while reached peak at 1 g/L YC for corn stover and corn silage with grain. Total VFA concentration (mmol/L) at 24 h tended to increase with 1 and 2 g/L YC for rice straw, while increased ($P < 0.05$) with 1 g/L YC for corn silage with grain, 1 and 2 g/L YC for corn silage without grain, and 3 g/L YC for corn stover. Acetate, propionate and butyrate concentrations followed similar trend as total VFA. The MCP (mg/mL) increased ($P < 0.05$) with increasing level of YC at 24 h for rice straw. For corn silage without grain, MCP increased ($P < 0.05$) with 1 and 2 g/L YC at 12 h, became insignificant at 24 h, then increased ($P < 0.05$) again with all additional levels at 48 h. For corn silage with grain, 2 g/L YC increased ($P < 0.05$) MCP at 12 h, while 1 g/L YC showed the highest ($P < 0.05$) response at 24 h. Fungi population was increased ($P < 0.05$) with 1 g/L YC for all forages but corn silage without grain. Addition of YC also increased ($P < 0.05$) the percentages of protozoa, *Fibrobacter succinogenes*, *Ruminococcus albus* and *R. flavefaciens*. Although the optimum level of YC for different parameters varies depends on forage substrate and incubation time, rumen fungi was enhanced and VFA and MCP were increased with a stable rumen pH when the YC was added at a level of

1 or 2 g/L. It is suggested that addition of YC can improve the ruminal microbial utilization of low quality forages.

Key Words: forage, rumen fermentation, yeast culture

572 In vitro manipulation of Jersey cow rumen ecology with microbes from the wildebeest, horse and zebra. F. N. Fon^{*} and I. V. Nsahlai, University of KwaZulu-Natal, Pietermaritzburg, South Africa.

Ruminal microbes have the ability to convert low quality feeds into high quality protein and to utilize feeds (roughage) from land not suitable to grow crops for human consumption. Only 10–35% of energy intake is captured as net energy while 20–70% of cellulose may not be digested by herbivores. There is need to increase the amount of energy harvested by ruminant systems without necessarily increasing intake. The objective of the study was to compare fiber breakdown by microbes from the cow (CW) system (A) to its composite systems with the horse (H), wildebeest (WB) and Zebra (ZB). Four in vitro composite enzyme systems B (CW and H), C (CW and WB), D (CW and ZB) and E (CW, H, WB and ZB) were created. Exocellulase, endocellulase, xylanase and cellobiase specific activities of these systems upon incubation with cellulose, carboxymethyl cellulose (CM), xylan and cellobiose, respectively were determined by measuring the amount of reducing sugars released. The catalytic efficiency (Kcat) of the enzymes was also determined. In vitro microbial fermentation and degradability of maize stover (MS) and NDF with inocula from the 4 systems over 72 h at 39°C were determined by measuring the amount of gas released and true degradability (TD). Systems E (Kcat = 17.1 ± 1.28) and B (Kcat = 8.5 ± 1.28) were the most active ($P < 0.05$) enzyme systems upon incubation with cellulose with specific activity 9.6 ± 0.05 and 4.5 ± 0.05 µg glucose/mg/min, respectively. Upon incubation with CM, system B (Kcat = 15.4 ± 0.40) was more active ($P < 0.05$) than E (Kcat = 9.5 ± 0.40). Xylan hydrolysis was highest ($P < 0.05$) in E and D while B and C were intermediate. Gas released during MS fermentation was highest ($P < 0.05$) in system C (141 ± 9.9 mL) and intermediate in systems B, D and E (135 ± 0.4, 133 ± 0.4 and 134 ± 0.4 mL, respectively). MS fermentation was higher in B (694 ± 38.4 kg) and E (695 ± 38.4 kg) with gas volumes of 128 ± 58.1 and 118.62 ± 58.1 mL, respectively. TD of NDF showed that system D (709 ± 32.1 kg) and E (700 ± 0.4032.1 kg) were the most active ($P < 0.05$). These results suggest that mixing microbes from horses, wildebeest and zebras can improve the fibrolytic potential and digestion of roughages in cattle.

Key Words: exocellulase, in vitro fermentation, roughage digestibility

573 Growth curve analysis of Sahiwal calves up to six-month age given milk or milk replacer up to weaning. M. S. Khan¹, S. A. Bhatti^{*2}, and H. A. Ahmad³, ¹Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan, ²Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad, Pakistan, ³Dept. Biology, Jackson State University, Jackson, MS.

Data of 2 feeding trials were used to understand the growth patterns of Sahiwal calves fed different dietary treatments up to weaning and then a single treatment during post-weaning period. The objective of this study was to predict body weight changes of Sahiwal calves up to 6-month of age. The Sahiwal calves (n = 48; 24 of each sex 3 ± 2 d of age) were divided into 4 groups of 12 animals each (6 of each sex) and were given following dietary treatments up to weaning: A) whole cow milk + starter ration (SR; CP = 20%, TDN = 72%) + Berseem clover hay (H; *Trifolium alexandrinum*; CP = 21% TDN = 63%); B) whole cow milk + H; C)

Milk replacer (MR) + SR + H and D) MR + H. Milk or MR was offered at 10% of the body weight until d 56 and then gradually withdrawn until calves were weaned completely by d 84. The SR and H continued until d 84. During post-weaning period the calves were fed ad libitum a single mixed ration containing 16% CP and 70% TDN, from wk 13 to 24. Body weights were recorded weekly. Gompertz, Exponential, 3-degree Polynomial, Logistic and Sinusoidal models, using CurveExpert software, were tested to predict body weight during the experimental period. All

the models explained variation in growth of Sahiwal calves reasonably well; R^2 ranged from 91.9 to 97.9% for individual treatments and 89.4 to 89.5% on overall basis. Female calves, on average, had 3% better fit than male calves (92 vs 89%). Growth curves of milk-fed and MR-fed calves had R^2 93.1 and 89.4%, respectively. Any of the 5 tested models may be used to predict first 6-mo growth pattern in Sahiwal calves with almost equal efficiency.

Key Words: computational models, growth curve, Sahiwal calves