161 Methanogenesis reduction ability of monensin and essential oils from two Nigerian citrus species. Musibau A. Bamikole[1,2], Ibukun M. Ogunade*[1], Felipe Amaro[1], Yun Jiang[1], Thiago F. Bernardes[1], Darren D. Henry[3], Vania R. Vasconcelos[1], F. O. Ugiagbe[2], U. J. Ikhatua[2], Nicolas DiLorenzo[3], and Adegbola T. Adesogan[1], *[1]University of Florida, Gainesville, FL, [2]University of Benin, Benin City, Nigeria, [3]North Florida Research and Education Center, University of Florida, Marianna, FL.*

The effects of essential oils from sweet orange (*Citrus sinensis*, EOS) and tangerine (*Citrus tangerina*, EOT) on rumen fermentation, methane production and digestibility were studied. A corn silage-based TMR (0.5 g; CP 16.6%; NDF 35.9%) was treated with EOT or EOS at rates of 0 (Control), 10 (Low), 20 (Med) and 30 (High) µL/50 mL of rumen fluid-buffer inoculum (ratio 1:2) and with monensin (0.6 mg/50 mL). Each suspension was incubated in a 120-mL gas-tight culture bottle in triplicate at 39oC for 24 h in each of 2 runs. Fermentation parameters, gas and methane production, in vitro DM digestibility (DMD), and fermentation efficiency (FE; DMD g kg^{-1}/gas volume) were measured. Data for each EO were separately analyzed with the Glimmix procedure of SAS. Adding EOS or EOT did not depress DMD (g/kg; 541 and 548, respectively) but adding monensin did (555 vs. 526; $P < 0.05$). Gas volume (mL/g DM) was increased by Low EOS or EOT (84.5 vs. 92.8 and 96.3) and decreased by High rates or monensin (75.3, 73.6 and 66.8), respectively. Hence, FE was reduced by Low EOS or EOT (6.58 vs. 5.81 and 5.70) and increased by High rates or monensin (7.52, 7.43 and 7.92), respectively. Methane production (mg/g DM digested) was increased by Low EOS and EOT (11.4 vs. 14.4 and 15.3) and reduced by High rates and monensin (7.10, 7.10 and 6.58; decreases of 37.7, 37.7 and 42.2%), respectively. Ammonia-N concentration (mg/dL) was increased by Med EOS (21.43) and EOT (20.6) versus monensin (4.63) or Control (11.3). Ruminal pH was increased by monensin (5.66 vs 5.75) but not by EOT (5.63 – 5.72) or EOS (5.67 to 5.71). Total VFA concentrations (mmol) of EOS (54.7 to 69.2), EOT (68.24 to 121.8), monensin (71.0) and control (80.2) treatments did not differ ($P > 0.05$). Monensin decreased acetate molar proportion and increased that of valerate, and Low EOT reduced the molar proportion of propionate. High doses of EO from *Citrus sinensis* and *Citrus tangerina* reduced in vitro methane production without adverse effects on feed digestibility and VFA production. By comparison, monensin reduced methane production and digestibility.

Key Words: essential oil, citrus, in vitro fermentation

162 Changes in fermentation and biohydrogenation intermediates in continuous cultures fed corn grains differing in rates of starch degradability. Kaylin Young[1], Louisa Bowen[1], Mariano Alende[1], Gustavo Lascano[1], Mark D. Holt[2], and Thomas Jenkins*[1], *[1]Clemson University, Clemson, SC, [2]Matrix Nutrition LLC, Chandler, AZ.*

Excessive amounts of starch in diets for lactating dairy cattle is a known risk factor for milk fat depression but little is known about how these risks are altered by differences in rates of starch degradability (K_d) in the rumen. The objective of this study was to compare accumulation of biohydrogenation intermediates causing milk fat depression, including conjugated linoleic acid (CLA), when corn with low or high K_d were fed to continuous cultures. Diets contained (DM basis) 50% forage (alfalfa pellets and grass hay) and 50% concentrate with either no added fat (LF) or 3.3% added soybean oil (HF). Three LF and 3 HF diets contained corn sources with either low, medium, or high K_d (48.4, 66.2, or 84.0% in a 7 h in vitro test) giving 6 diet treatments with a 2 × 3 factorial arrangement. Each diet was fed to dual-flow continuous fermenters 3 times daily at 0800, 1600, and 2400 h. Diets were fed for 4 10 d periods, with 7d for adaptation and 3 d for sample collection. No fat × starch interactions occurred ($P > 0.05$) so main effects are presented. Starch effects were tested by linear (L) or quadratic (Q) contrasts. The LF and HF treatments differed ($P < 0.05$) in acetate (53.0 vs. 49.0 mol/100 mol), acetate/propionate (2.00 vs. 1.70), *trans*-10 18:1 (2.7 and 13.6% of total), and *trans*-10,*cis*-12 CLA (0.15 and 0.41% of total), respectively. Increasing starch K_d from low to high increased ($P < 0.05$) culture pH (L, 6.22, 6.23, 6.38) and acetate (Q, 48.7, 50.6, 53.9 mol/100 mol) but decreased ($P < 0.05$) butyrate (Q, 16.4, 15.0, 12.2) mol/100 mol). Changes in biohydrogenation intermediates (expressed as % of total fatty acids) from low to high K_d included decreases ($P < 0.05$) in *trans*-11 18:1 (Q, 8.58, 4.78, 4.46) and *cis*-9,*trans*-11 CLA (Q, 0.40, 0.34, 0.20) but an increase ($P = 0.07$) in *trans*-10,*cis*-12 CLA (L, 0.23, 0.24, 0.37). The results show that increasing the starch K_d in continuous culture while holding starch level constant causes elevation of some biohydrogenation intermediates linked previously to milk fat depression.

Key Words: lipid, biohydrogenation, starch

163 Effects of functional oils and monensin supplementation on ruminal fermentation and milk production and composition in Holstein cows under heat stress. Maurício F. Martins[1], Arlindo S. Netto[1], Paulo R. Leme[1], Maria G. Pinheiro[2], Joan Torrent*[3], Katiéli C. Welter[1], and Isadora Arruda[4], *[1]Univ. São Paulo, Pirassununga, SP, Brazil, [2]Agência Paulista de Tecnologia dos Agronegócios, Riberão Preto, SP, Brazil, [3]Oligo Basics USA LLC, Cary, NC, [4]Univ. Estadual Paulista, Botucatu, SP, Brazil.*

Eight Holstein lactating cows (68 ± 3.46 d in milk) were assigned to 2 contemporary Latin squares in a 2 × 2 factorial design during the summer months. The 4 treatments were (1) no additive, (2) monensin supplementation at a rate of 30 mg/kg DM, (3) supplementation of 0.5 g/kg DM of a commercial blend of functional oils containing cashew nut shell liquid and castor oil as active ingredients (Essential, Oligo Basics Agroind. Ltda., Cascavel, Brazil), and (4) supplementation of both monensin and functional oils at the rates supplemented in treatments 2 and 3. Average temperature heat indexes ranged between 70 and 90. Whereas the inclusion of functional oils increased intake (15.30 vs. 16.67 kg; $P < 0.001$), monensin decreased it (16.89 vs. 15.57 kg; $P < 0.001$). Feeding functional oils increased 3.5% fat corrected milk ($P < 0.001$) but only when cows were not supplemented with monensin (interaction monensin × functional oils: $P < 0.01$). Also, the supplementation of functional oils increased both the protein and fat yield ($P < 0.01$) and the protein percentage in the milk ($P < 0.01$). Monensin supplementation improved milk production efficiency ($P < 0.01$) but decreased fat percentage ($P < 0.05$) and total solids in milk ($P < 0.01$). Only the supplementation of monensin changed the ruminal fermentation parameters, increasing propionate ($P < 0.05$), and consequently decreasing the acetate to propionate ratio ($P < 0.05$). Rectal and skin temperatures were not affected by any treatment. However, the respiratory frequency was increased by the supplementation of functional oils ($P < 0.05$). In conclusion, whereas the inclusion of functional oils improved the cows' productive parameters without altering rumen fermentation, monensin supplementation decreased the amount of milk fat.

Key Words: functional oil, monensin, heat stress

164 Shifts in methanogen archaea and anaerobic fungi in the rumen of dairy cows during the transition period. Sanjay Kumar*, Nagaraju Indugu, Bonnie Vecchiarelli, and Dipti Pitta, *Department of Clinical Studies, School of Veterinary Medicine, New Bolton Center, University of Pennsylvania, Kennett Square, PA.*

Anaerobic rumen fungi (ARF) play an important role in the degradation of dietary plant cellulosic material. Subsequent decomposition products (mainly H_2 and CO_2) are utilized by other microbes, including methanogens. In the present study, we investigated the shift in ARF and methanogenic communities in dairy cows fed S1 diet (80% forage) 4 weeks before calving and moved to S2 diet (50% forage) after calving. Five cows from 2 study groups (SG: primiparous and multiparous) were sampled for ruminal contents before and after calving using a stomach tube. The genomic DNA from all rumen samples were amplified using archaeal and fungal specific primers, sequenced on a 454 Jr Roche platform and analyzed using QIIME pipeline. Approximately 18,317 and 35,582 reads were analyzed from 20 archaeal and ARF communities, respectively, resulting in 180 and 310 OTUs for archaea and ARF, respectively. Community comparisons (the Bray-Curtis distance matrix) revealed the effect of diet ($P < 0.001$) on ARF composition, while archaea communities differed between primiparous and multiparous cows ($P < 0.05$). Among ARF lineages, genus *Cyllamyces* was higher on S2 diet whereas, *Cecomyces* and *Orpinomyces* were higher on S1 diet, irrespective of parity. *Methanobrevibacter* showed >95% abundance across all samples. A co-occurrence analysis using dice index was performed, incorporating taxa from bacteria (published recently) and archaea and fungi from this study to determine the effect of diet and parity on inter-microbial relationships within the rumen. The co-existence patterns both within and between bacteria, archaea and ARF were more influenced by SG than by diets. In conclusion, the findings presented here indicate the influence of dry matter intake, stage of production and parity on rumen microbial communities.

Key Words: anaerobic fungi, co-occurrence, diet

165 Effects of stocking density and source of forage fiber on short-term responses in ruminal fermentation and behavior of Holstein dairy cows. Mackenzie A. Campbell*[1,2], Kurt W. Cotanch[1], Catherine S. Ballard[1], Heather M. Dann[1], and Richard J. Grant[1], *[1]The William H. Miner Agricultural Research Institute, Chazy, NY, [2]The University of Vermont, Department of Animal Science, Burlington, VT.*

Understanding the interaction of stocking density and diet is vital for dairy cow well-being and ruminal health. Multiparous (n = 11) and primiparous (n = 5) ruminally cannulated Holstein cows (116 ± 84 d in milk and 46 ± 9 kg milk/d) were assigned to 1 of 4 pens to determine the short-term effects of stocking density and source of forage fiber on ruminal fermentation and behavior. Pens were assigned to treatments in a 4 × 4 Latin square with 14-d periods using a 2 × 2 factorial arrangement. Two stocking densities (STKD; 100 or 142% of stalls and headlocks) and 2 diets (straw; S and no straw; NS) resulted in 4 treatments: (1) 100NS, (2) 100S, (3) 142NS, and (4) 142S. Dietary forage content consisted of 39.7% corn silage and 6.9% haycrop silage versus 39.7% corn silage, 2.3% haycrop silage, and 3.5% chopped straw (dry matter; DM basis) for NS and S, respectively. Both diets were formulated for 16% crude protein, 28% neutral detergent fiber (NDF), and 28% starch (DM basis). Alterations in forage fiber source resulted in physically effective NDF values of 18.8% and 20.1% for NS and S, respectively. Ruminal pH measurements were recorded on d 12–14 of each period using indwelling pH loggers. Time spent feeding and ruminating were measured using 72-h direct observation on d 8–10 of each period. Data were analyzed using the MIXED procedure in SAS with pen as the experiment unit. Eating time (248 min/d, SEM = 9) and rumination time (496 min/d, SEM = 23) did not differ ($P > 0.05$) among treatments. Higher STKD tended ($P < 0.07$) to have a lower mean and maximum pH and significantly reduced ($P < 0.01$) time that pH <5.8. Area under the curve (AUC) and time spent below pH 5.8 were significantly reduced with S. Higher STKD reduces ruminal pH and S tends to counteract this effect.

Table 1 (Abstr. 165). Ruminal pH in Holstein cows fed 2 stocking densities (STKD; 100 or 142% of stalls and headlocks) and 2 diets (straw; S and no straw; NS)

	100%		142%			*P*-value		
Item	NS	S	NS	S	SEM	STKD	Diet	STKD × Diet
Mean pH	6.17	6.13	6.09	6.10	0.03	0.07	0.62	0.39
Minimum pH	5.70	5.67	5.62	5.59	0.05	0.11	0.53	0.95
Maximum pH	6.63	6.58	6.56	6.53	0.04	0.07	0.22	0.68
ph <5.8, h/d	2.29	1.90	4.12	2.77	0.41	<0.01	0.01	0.10
AUC <5.8, pH units × min/d	0.38	0.19	0.58	0.34	0.10	0.06	0.03	0.75

Key Words: overcrowding, physically effective fiber, ruminal pH

166 Rumen bacterial communities in three breeds of dairy cattle shift from early to peak lactation. Melissa L. Bainbridge*[1], Laura M. Cersosimo[1], André-Denis G. Wright[2], and Jana Kraft[1], *[1]University of Vermont, Burlington, VT, [2]University of Arizona, Tucson, AZ.*

Rumen bacteria form a dynamic, complex symbiotic relationship with their host, degrading fibrous forages to provide volatile fatty acids (VFA) as energy to the animal. The objective of this study was to characterize rumen bacteria and VFA in 3 breeds of primiparous dairy cattle, Holstein (HO, n = 7), Jersey (JE, n = 8), and HO x JE crossbred (CB, n = 7), at early (3 DIM) and peak lactation (93 DIM). All cows were fed a consistent TMR at a 70:30 forage to concentrate ratio. Rumen digesta were collected via esophageal intubation at 3 and 93 DIM. Microbial DNA was extracted and sequenced using Illumina MiSeq (v. 3) following PCR amplification of the V1-V3 region of the 16S rRNA gene. Sequences were analyzed using Mothur. The 16S copy numbers of rumen bacterial densities were quantified by real-time PCR. Data were analyzed using a repeated measures general linear mixed model in SAS. Breed (B) had no effect on rumen VFA, however, molar concentrations of acetate, butyrate, and propionate were lower at 93 DIM (74.7, 10.7, and 20.8 m*M*, respectively) than at 3 DIM (93.8, 14.7, and 26.9 m*M*, respectively; $P < 0.01$). The quantity of bacteria in rumen digesta was unaffected by B or lactation stage (LS). Overall, Bacteroidetes (Bd) was the predominant phylum, accounting for 54–78% of total bacteria, followed by the phyla Firmicutes (Fc; 19–42%) and Proteobacteria (1–4%). *Prevotella* was the predominant genus of the Bd phylum and was unaffected by B, however, *Prevotella* species did increased with LS (49.8% vs. 67.3% for 3 DIM and 93 DIM, respectively; $P < 0.01$). At 93 DIM there was a lower abundance of Fc (38.5%) than at 3 DIM (25.0%; $P < 0.01$), with bacteria belonging to the genera *Butyrivibrio* and *Coporococcus* decreasing from 3 DIM (1.74% and 1.33%) to 93 DIM (0.26% and 0.30%; $P < 0.01$). Bacteria belonging to the genera *Mogibacterium* and *Ruminoccocus* within the Fc phylum were affected by B ($P < 0.05$), HO had less *Mogibacterium* species than CB and JE (0.58% vs. 1.22% and 1.26%), and HO had higher abundance of *Ruminoccocus* species than CB and JE (2.3% vs. 1.5% and 1.3%; $P <$

0.05). In conclusion, LS had a greater effect on bacterial communities and VFA than host genetics.

Key Words: volatile fatty acid, bacterial diversity

167 Effect of 3-nitrooxypropanol on ruminal fermentation, methane and hydrogen emissions, and methane isotopic composition in dairy cows. Laiz F. de Matos[1], Michael T. Harper[1], Juliana Lopes*[1], Fabio Giallongo[1], Joonpyo Oh[1], Danielle Gruen[2], Alexander N. Hristov[1], Maik Kindermann[3], and Stephane Duval[4], *[1]Department of Animal Science, The Pennsylvania State University, University Park, PA, [2]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, [3]DSM Nutritional Products, Animal Nutrition and Health, Basel, Switzerland, [4]DSM Nutritional Products France, Research Centre for Animal Nutrition and Health, Saint Louis Cedex, France.*

The objective of this crossover experiment was to investigate the effect of a methane inhibitor, 3-nitrooxypropanol (3NOP), on rumen fermentation and enteric CH_4 emission in lactating dairy cows. Six ruminally-cannulated late-lactation (235 DIM; SD = 20 d) Holstein cows were assigned to 2 treatments: control and 3NOP (60 mg/kg DMI). Each experimental period consisted of 10 d for adaptation and 4 d for sample collection. Compared with the control, 3NOP decreased ($P < 0.001$) CH_4 emission by 31% (487 vs. 335 g/d, respectively) and increased ($P < 0.001$) that of H_2 from 0.005 to 1.33 g/d. CH_4 emissions per kg of DMI or milk yield were also decreased ($P < 0.001$) 34 and 37%, respectively, by 3NOP. The isotopic composition of CH_4 was similar between treatments: control, $\delta^{13}C_{CH4} = -20.91 \pm 0.32‰$, $\delta D_{CH4} = -266.92 \pm 0.14‰$, and $\Delta^{13}CH_3D = -1.96 \pm 1.78‰$; and 3NOP, $\delta^{13}C_{CH4} = -24.91 \pm 1.72‰$, $\delta D_{CH4} = -266.94 \pm 0.27‰$, and $\Delta^{13}CH_3D = -1.72 \pm 2.97‰$. Concentrations of total VFA and propionate in ruminal fluid were not affected by treatment. Acetate concentration tended to be lower ($P = 0.08$) and acetate:propionate ratio was lower ($P < 0.001$) for 3NOP compared with the control. Butyrate and isovalerate concentrations tended to be or were increased ($P \leq 0.08$) by 3NOP. Methanogenic archaea (*Methanobrevibacter, Methanosphaera*, and *Methanomicrobium*) were not affected ($P \geq 0.46$) by 3NOP. *Prevotella* spp., the predominant bacterial genus in ruminal contents (22 to 23% of the total isolates), was also not affected ($P = 0.54$) by 3NOP. Compared with the control, *Ruminococcus* and *Clostridium* spp. were decreased ($P \leq 0.03$) and *Butyrivibrio* spp. was increased by 3NOP: 8.2 vs. 6.5%, 6.2 vs. 4.1%, and 3.6 vs. 4.8%, respectively. This experiment demonstrated that a substantial inhibition of enteric CH_4 emission in dairy cows resulted in increased H_2 emission and decreased acetate concentration, but had no effect on rumen archaea. The isotopic composition of CH_4 was similar between the 2 treatments, supporting the conclusion that there was little to no change in the metabolic strategy of the rumen archaeal population.

Key Words: methane, 3-nitrooxypropanol, archaea

168 Divergent fermentation patterns of grass fructan, inulin, and glucose. Mary Beth Hall*, *US Dairy Forage Research Center, USDA-ARS, Madison, WI.*

Fructans are an important nonfiber carbohydrate in cool season grasses. Their fermentation by rumen microbes is not well described, though such information is needed to understand their nutritional value to ruminants. Fermentation kinetics and product formation from orchardgrass fructan (phlein; PHL), chicory inulin (INU), and glucose (GLC) were compared when fermented in vitro with mixed rumen microbes. Studies were carried out as randomized complete block designs. All rates given are fractional exponential. Significance was declared at $P < 0.05$, and tendency at $0.05 \leq P < 0.10$. Rate of substrate disappearance tended to be greater for GLC than for PHL and INU which tended to differ from each other (0.74, 0.62, and 0.33 h^{-1}, respectively). Disappearance of GLC had almost no lag time (0.04 h) whereas the fructans had lags of 1.4 h. The maximum microbial N accumulation (a proxy for cell growth), tended to be 20% greater with PHL and INU than with GLC. The N accumulation rate with GLC (1.31 h^{-1}) was greater than with PHL (0.75 h^{-1}) and INU (0.26 h^{-1}) which also differed. More microbial glycogen (+57%) was accumulated with GLC than with PHL, though accumulation rates did not differ (1.95 and 1.44 h^{-1}, respectively); little glycogen accumulated with INU. Rates of organic acid formation were 0.80, 0.28, and 0.80 h^{-1} for GLC, INU, and PHL, respectively, with PHL tending to be greater than INU. Lactic acid production was more than 7-fold greater for GLC than for the fructans. The ratio of microbial cell carbon to organic acid carbon tended to be greater with PHL (0.90) and INU (0.86) than with GLC (0.69) indicating a greater yield of cell per amount of substrate fermented with fructans. Reduced microbial yield with GLC may relate to the greater glycogen production which requires ATP, and lactate production which yields less ATP; together, these processes could have reduced ATP available for cell growth. Acetate molar proportion was less with GLC than with fructans, and less for PHL than for INU. Rumen microbes ferment PHL differently than other plant sugars or fructans.

Key Words: rumen fermentation, fructans, glycogen

169 The effect of lactic acid bacteria as probiotics or silage inoculants on in vitro rumen digestibility, total gas and methane production. Jennifer L. Ellis*[1,2], Andre Bannink[3], Ida K. Hindrichsen[4], Robert D. Kinley[1], Wilbert F. Pellikaan[1], Nina-Lotte Milora[4], and Jan Dijkstra[1], *[1]Animal Nutrition Group, Wageningen University, Wageningen, the Netherlands, [2]Centre for Nutrition Modelling, Department of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada, [3]Animal Nutrition, Wageningen UR Livestock Research, Wageningen, the Netherlands, [4]Chr. Hansen A/S, Horshølm, Denmark.*

Lactic acid bacteria (LAB) included as a probiotic or silage inoculant may affect rumen fermentation, OM digestibility and methane (CH_4) emissions in cattle. Therefore, 2 in vitro gas production trials were conducted to pre-screen several potential LAB inoculants at several inoculation levels, using different LAB mixtures, and on different silage substrates. In Experiment 1 the dose-response effects of 3 LAB inoculants added as probiotics (0.0, 5×10^5, 1×10^6 and 5×10^6 cfu/mL) on in vitro total gas and CH_4 production were examined using grass silage as the substrate. In Experiment 2, 3 LAB inoculant mixtures were examined while varying the substrate. Substrates were inoculated with LAB before ensiling, and were ryegrass/clover (RCS), corn (CS) and ryegrass (RS) silage. Data were analyzed with proc MIXED of SAS with LAB inoculant × dose as a fixed effect, and dose was analyzed via orthogonal polynomial contrasts (Experiment 1), and using substrate, inoculation and substrate × inoculation as fixed effects (Experiment 2). Results showed that not all LAB affected in vitro fermentation. In Experiment 1, *L. plantarum* (LP) but not *L. lactis* (LL) or a 1:1 mixture of LL and LP, resulted in significant increases in OM digestibility ($P = 0.023$), and there was a trend for several dose related responses. In Experiment 2, LAB showed both strain and substrate-specific responses. In RS, an inoculation of a mixture of *L. plantarum*, *L.buchneri* and *L. lactis* (LM1) increased OM digestibility, while inoculations of *L. buchneri* and *L.lactis* (LM2) and *L. plantarum*, *L. lactis* and *E. faecium* (LM3) decreased OM digestibility in RCS (inoculation $P < 0.001$). These effects were generally mirrored by changes in gas and CH_4 production. In CS, no effects were observed on OM digestibility, total gas or CH_4 production. From these results we conclude that LAB

may be most effective in grass based silages (compared with corn) for altering OM digestibility, and that the LP treatment from Experiment 1, or the LM1 treatment from Experiment 2, may be most promising for evaluation in vivo.

Key Words: in vitro, lactic acid bacteria, cattle

170 Influence of diet change frequency on growth, rumen fermentation, and behavior of prepubertal dairy heifers. Tana S. Dennis*[1], Jason E. Tower[1], Hans F. P. Schmitz[1], Amanda M. Mosiman[1], and Tamilee D. Nennich[1,2], *[1]Purdue University, West Lafayette, IN, [2]Famo Feeds, Freeport, MN.*

The objective of this study was to evaluate the effects of diet change frequency on dairy heifer performance, rumen fermentation, and feeding behavior. Ninety Holstein heifers (141.8 ± 11.7 kg of BW) in 15 pens were randomly assigned to treatments designed to change diets using rapid (30 to 60% hay; 1STEP), moderate (30 to 45 to 60% hay; 2STEP), or gradual steps (30 to 40 to 50 to 60% hay; 3STEP). Heifers were fed for 84 d, and diets were changed every 2 wk starting on d 28. Weights were taken every 2 wk, and skeletal measurements and blood samples were collected monthly. Rumen fluid was collected esophageally 6 h after feeding (2 heifers/pen) to determine pH, NH_3, and volatile fatty acids (VFA) 2 wk after each diet change. Behavior was evaluated using scan-sampling before and after diet changes for 30 min before and 120 min following feed delivery. Data were analyzed with pen as the experimental unit. On d 84, 3STEP heifers were heavier than 1STEP ($P = 0.05$) and tended to be heavier than 2STEP ($P = 0.06$). Daily gain was significantly improved for 3STEP after the second diet change ($P < 0.01$), but lower after the last diet change compared with 1STEP and 2STEP ($P = 0.05$). Feed intake was greater ($P = 0.02$) for 3STEP from d 35 to 63, yet similar among treatments from d 63 to 84. Skeletal growth was similar with the exception of heart girth, which was greatest for 3STEP on d 84 ($P = 0.01$). Blood glucose was greatest for 3STEP after the first diet change ($P = 0.02$) and greatest for 2STEP after the last diet change ($P = 0.04$). Rumen fermentation profiles were altered following the first diet change, as proportions of acetate ($P < 0.01$) and isoacids ($P = 0.10$) were greatest and total VFA, propionate ($P < 0.01$), and valerate ($P < 0.01$) were lowest for 1STEP. Heifers fed using 1STEP spent 51% more time feeding than 3STEP heifers 3 d after the first diet change ($P < 0.01$). Time spent feeding was 18% ($P = 0.01$) and 14% ($P = 0.01$) greater 6 d before the second diet change for 1STEP and 2STEP, respectively, compared with 3STEP. Rapid diet changes appear to alter rumen fermentation and feeding behavior, which potentially reduces performance of growing dairy heifers.

Key Words: heifer, feeding, growth

171 Effects of rumen inoculum adapted and unadapted to *Saccharomyces cerevisiae* fermentation product, culture pH, and starch fermentability on the biohydrogenation of unsaturated fatty acids in batch culture. Yan Sun*, Michael S. Allen, and Adam L. Lock, *Michigan State University, East Lansing, MI.*

The effect of rumen fluid (RF) inoculum either unadapted (U-RF) or adapted (A-RF) to *Saccharomyces cerevisiae* fermentation product (SCFP; Diamond V Original XPC) on the biohydrogenation (BH) of unsaturated fatty acids (FA) at 2 pH levels and starch sources with different fermentabilities (SF) were evaluated. Rumen inocula for batch cultures were collected at the end of each 4-wk feeding period in a crossover design (n = 6). U-RF or A-RF cultures (4 replicates/treatment) were incubated for 24 h at pH 5.8 or 6.2 and included alfalfa hay (55% of DM), and either dry ground corn (DC) or high moisture corn (HMC) as starch sources (45% of DM). The alfalfa hay was treated with corn oil (2% of DM) to increase the total unsaturated FA content of cultures. Effects of RF, culture pH, SF, and their interactions were determined. For main effects of treatments, A-RF compared with U-RF and pH 6.2 compared with pH 5.8 increased extent of BH for *cis*-9,*cis*-12 18:2 (41 vs. 38% and 47 vs. 32%, respectively; both $P < 0.001$) and NDFD (14 vs. 12% and 16 vs. 10%, respectively; both $P < 0.001$). Compared with DC, HMC increased BH extent for *cis*-9,*cis*-12 18:2 (41 vs. 39%, $P = 0.06$), and decreased NDFD (12 vs. 14%, $P < 0.001$). Overall, compared with U-RF, A-RF decreased *trans*-10,*cis*-12 18:2 (CLA) by 17% ($P < 0.001$), and increased *trans*-10 18:1 by 10% ($P < 0.001$). HMC compared with DC, and pH 5.8 compared with pH 6.2, increased content of CLA by 15 and 56%, respectively (both $P < 0.01$), and increased *trans*-10 18:1 by 23 and 26%, respectively (both $P < 0.001$). RF interacted with SF for CLA and *trans*-10 18:1 (both interactions $P < 0.01$); in particular, for cultures containing HMC, A-RF decreased the content of CLA and increased the content of *trans*-10 18:1 compared with U-RF. Results demonstrate that under the conditions tested, rumen fluid from cows adapted to SCFP (A-RF) had positive effects on the extent of BH of unsaturated FA and NDFD. A-RF decreased CLA across culture pH, especially when HMC was the starch source.

Key Words: culture pH, dry ground corn, high moisture corn

172 Effects of *Saccharomyces cerevisiae* fermentation products on performance of mid-lactation dairy cows. Subash Acharya*[1], Jon P. Pretz[1], Ilkyu Yoon[2], Mark F. Scott[2], and David P. Casper[1], *[1]South Dakota State University, Brookings, SD, [2]Diamond V, Cedar Rapids, IA.*

This study was conducted to evaluate *Saccharomyces cerevisiae* fermentation products (Diamond V Original XPC and 2 prototypes) on production efficiency of mid-lactation dairy cows. Eighty mid-lactation (164.5 DIM ± 67.5) Holstein cows (56 multiparous and 24 primiparous) were blocked by parity, days in milk, and milk production, and randomly assigned to one of 4 treatments. Treatments consisted of (1) Control (C): corn silage and haylage based ration; (2) XPC: C ration with Original XPC added at 14 g/hd per day; (3) Prototype 1 (P1): C ration with Prototype 1 added at 5 g/hd per day; and (4) Prototype 2 (P2): C ration with Prototype 2 added at 19 g/hd per day. Treatments were mixed with dried distillers grains and then mixed into a TMR at 454 g/hd/d. The study lasted for 70 d. The first 14 d of the study (d −14 to 0) was used to train cows to use the Calan gate feeding system and cows were fed the C ration during this period. Treatment effects were continuously monitored for the 8 wk experimental period. Dry matter intakes (DMI) were similar ($P \geq 0.10$) when cows were fed all treatments (25.7, 26.1, 25.1, and 26.2 kg/d for C, XPC, P1, and P2, respectively). Milk production (33.3, 34.4, 35.5, and 36.8 kg/d) was improved ($P < 0.05$) for cows fed P2 compared with cows fed C, with cows fed other supplements being intermediate and similar. Feed efficiency (Milk/DMI) was improved ($P < 0.08$) for cows fed P1 and P2, compared with cows fed C and XPC (1.30, 1.34, 1.49 and 1.41kg/kg). Milk fat content was reduced ($P < 0.05$) for cows fed P2 (4.17, 3.93, 4.08, and 3.85%) compared with cows fed C, with cows fed other treatments being intermediate. Milk protein and lactose percentages were similar ($P \geq 0.10$) among treatments. Cows fed P2 had lower ($P < 0.05$) molar percentages of ruminal acetate (63.8, 64, 63.1, and 62.3%) and greater ($P < 0.05$) propionate (18.9, 19.3, 19.7, and 20.6%) than cows fed other treatments. Supplementing a dairy ration with *Saccharomyces cerevisiae* fermentation products can improve milk production and feed efficiency of mid-lactation cows.

Key Words: dairy cow, *Saccharomyces cerevisiae* fermentation product, milk production