

plasma addition) in reducing mortality caused by epizootic rabbit enteritis. From this study it can be concluded that animal plasma is a highly palatable and digestible source of protein for early-weaned rabbits. Based on our results, the positive response to animal plasma may depend on the age, the environmental conditions and the health status of the animals.

**Key Words:** Animal Plasma, Antibiotics, Early Weaned Rabbits

**1033 Bovine follicular fluids modulate the release of transaminases, acrosome reaction and motility of rabbit sperm.** M.M. Zeitoun\*, *Faculty of Agriculture, Alexandria University, Egypt.*

This study investigates the effect of supplementing bovine follicular fluids (FF) to rabbit sperm motility, acrosome reaction and transaminases activities. Ovarian FF were collected from 46 pairs of bovine ovaries. Normal follicles were classified, according to their diameters, into small (SFF,  $\leq 4$  mm), medium (MFF,  $>4-8$  mm), large (LFF,  $> 8$  mm) and cystic (CSTFF,  $>20$  mm). Rabbit semen was collected and diluted with EBSS-P medium and incubated in a CO<sub>2</sub> incubator at 37 °C. Two levels (20 and 40%) of FF were tested. Sperm motility index (SMI), percent acrosome reaction (%AR) and the activity of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) in the extracellular

media were determined. Sperm motility was decreased by FF addition ( $P<0.01$ ). As the diameter of follicle increased the reduction in motility decreased ( $P<0.01$ ). On the other hand, the cystic FF caused the highest reduction in sperm motility. As time of incubation progressed a sharp decline was observed ( $P<0.01$ ) in sperm motility. Addition of FF increased ( $P<0.01$ ) the reacted acrosome (16.7, 16.3, 17.1, 20.1 and 13.1% for , large , medium , small, cystic FF and control, respectively). A linear increase ( $P<0.01$ ) of acrosome reaction was obtained as incubation time advanced (13.3, 15.3, 17.2 and 22.1 % at 0, 1, 2 and 4 hr, respectively). The release of AST and ALT significantly ( $P<0.01$ ) increased by FF treatment and time progression. As the FF level increased the activity of ALT increased ( $P<0.01$ ). In all cases, the addition of FF increased the release of ALT greater than in the control, however in the case of AST, large FF did not change its release compared to the control. Cystic FF always increased both enzyme activities. There was a positive correlation coefficient between ALT activity and percent of reacted acrosome. On the other hand, a significant negative correlation coefficient was found between sperm motility and acrosome reaction. In summary, bovine FF modulates rabbit sperm characteristics.

**Key Words:** Bovine Follicular Fluids, Rabbit Sperm, AST, ALT

## RUMINANT NUTRITION

**1034 Ionophores for dairy cattle: current status and future outlook.** R. K. McGuffey\*, L. F. Richardson, and J. I. D. Wilkinson, *Elanco Animal Health, Greenfield, IN.*

Ionophores are used commercially throughout the world in the beef and poultry industries. Production efficiency of cattle is increased through alteration of rumen fermentation and control of protozoa that cause coccidiosis. Ionophores act by interrupting transmembrane movement and intracellular equilibrium of ions in certain classes of bacteria and protozoa that inhabit the gastrointestinal tract. The actions of ionophores provide a competitive advantage for certain microbes at the expense of others. In general, metabolism of the selected microorganisms favors the host animal. Energy metabolism is enhanced through increased production of propionate among ruminal fatty acids with a concomitant reduction in methane. Ruminal degradation of peptides and amino acids is reduced thereby increasing the flow of protein of dietary origin to the small intestine. Total flow of protein to the lower tract is often increased with ionophore feeding. Risk of digestive disorders such as bloat and acidosis that result from abnormal rumen fermentation is reduced as are certain conditions caused by toxic products of fermentation, e.g., 3-methyl indole. Dry matter and nitrogen digestibilities are increased with ionophores thereby providing environmental benefits. Monensin and lasalocid have been the most studied in research demonstrating benefits to the dairy cow. Ionophores enhance the glucose status of dairy cows through increased production of propionate. Many of the demonstrated benefits of ionophores are associated with enhancement of the energy status of the cow in the transition period and during early lactation. The benefits include less mobilization of body fat as evidenced by reduced blood nonesterified fatty acids and ketones and increased glucose. Animal manifestations include lower incidence of ketosis and displaced abomasum, reduced loss of body condition, increased milk production and improved milk production efficiency.

**Key Words:** Ionophore, Dairy Cows, Lactation

**1035 Milk production of Holstein x Sahiwal cows receiving monensin and a sustained release formulation of methionyl bovine somatotropin.** T. P. Pelaez<sup>1</sup>, I. A. Duque<sup>1</sup>, D. Zambrano<sup>1</sup>, E. Plaza<sup>2</sup>, V. A. Reyes<sup>2</sup>, N. S. Defaz<sup>2</sup>, C. Gonzalez<sup>3</sup>, E. Bernal<sup>3</sup>, and R. K. McGuffey<sup>3</sup>, <sup>1</sup>Universidad Estatal de Quevedo, Quevedo, Ecuador, <sup>2</sup>Rey Sahiwal, Grupo Wong, Guayaquil, Ecuador, <sup>3</sup>Elanco Animal Health, Bogota, Colombia.

Monensin (M) in a dairy concentrate (0 or 100 g/ton) and bovine somatotropin (bST) (500 mg/14 days) were administered in a 2 X 2 arrangement of treatments to 112 Holstein X Sahiwal lactating cows for 112 days to determine effects on milk yield and bodyweight. Cows averaged 80.3 days in milk at the beginning of treatments. Cows grazed on pastures of African stargrass (*Cynodon nlemfuensis*) and guinea grass (*Panicum*

maximum). They were fed the medicated concentrate at milking followed by an offering of waste bananas (*Musa sp*) after milking during the experiment. Results are shown in the table. Milk production was increased by M and bST. Weight gain favored cows receiving M and bST.

Item	Control	Mon(M)	bST	M+bST
Conc,kg/d	2.23	2.15	2.44	2.33
Milk,l/d				
Pretrt (P)	13.7	12.8	13.3	13.8
Trt (T)	10.1	10.2	11.2	12.0
T/P (%)	73.5	79.7	83.9	86.7
Bwt, kg				
Start T	402	377	400	414
End T	411	392	419	435
Gain	9	15	19	21

**Key Words:** Monensin, Bovine Somatotropin, Pasture

**1036 Effects of lasalocid on the forage to concentrate ratio fed to steers maintained at pre-determined daily average ruminal pH.** D.L. Prentice\*, D.M. Schaefer, and G.R. Oetzel, *University of Wisconsin, Madison.*

Two experiments were conducted to evaluate the effects of lasalocid (325 mg·hd<sup>-1</sup>·d<sup>-1</sup>) on the forage to concentrate ratio fed to steers at a specific, pre-determined daily average ruminal pH. Eight ruminally cannulated Holstein steers were used in a two-by-two crossover trial. In both experiments corn silage was the only source of forage. Indwelling ruminal pH electrodes were used to continuously monitor ruminal pH and diets were adjusted daily for each steer to achieve the target ruminal pH. The daily average ruminal pH target was 6.0 in experiment one and 5.5 (the upper limit of subacute ruminal acidosis) in experiment two. In experiment two finely ground corn was used in a 50:50 mix with the whole kernel corn of experiment one to facilitate a lower pH. In both experiments lasalocid had no significant effect on the percent forage fed to maintain the pre-determined daily average ruminal pH. Lasalocid had no significant effect on DMI, the area of the ruminal pH curve under 5.5, ruminal pH variance, ruminal pH nadir, ruminal pH peak or overall ruminal pH range. The effects of lasalocid on total VFA concentration and VFA profiles were inconsistent in both experiments. The average ruminal pH in experiment one was 5.99 for lasalocid-fed animals and 5.98 for controls. It was possible to feed to an average daily ruminal pH of 6.0 by altering the forage and concentrate ratios on an individual basis.

The average ruminal pH in experiment two was not significantly different between treatments and was 5.82 for lasalocid and 5.74 for controls. The target pH of 5.5 in experiment two could not be achieved by altering forage to concentrate ratio. Animals in experiment two did spend more time with ruminal pH  $\leq 5.5$  compared to experiment one. Dry matter intake decreased as percent concentrate increased in experiment two. Decreasing DMI may have allowed the steers to maintain ruminal pH above the range of subacute acidosis and may have prevented them from reaching the lower pH target.

**Key Words:** Lasalocid, Ruminal pH, Subacute acidosis

**1037 Monensin has anti-foaming properties.** P. J. Moate<sup>\*1</sup>, T. Clarke<sup>2</sup>, L. Davis<sup>2</sup>, E. Bastiensen, and R. Laby<sup>2</sup>, <sup>1</sup>University of Pennsylvania, <sup>2</sup>Agriculture Victoria Ellinbank.

In recent years, monensin has been used by the Australian Dairy industry as the active ingredient in the commercially successful anti-bloat capsule (ABC) marketed by Elanco Animal Health. Although the ABC has been successful in reducing the incidence of bloat in grazing cattle, the mechanism of action of monensin against bloat is still unclear. Bloat in cattle usually occurs due to the formation in the rumen of persistent foam that prevents the eructation of fermentation gases. The other successful anti-bloat agents (detergents, oils fats and tannins) all influence the foaming properties of plant proteins within the rumen. The objective of this research was to measure the effects of monensin and hexaglycerol distearate (HGDS, the other major constituent of the ABC) and of core material from an ABC on the strength and persistence of protein foams. The foaming solution consisted of a phosphate buffer that contained 0.1% protein (purified from the leaves of red clover). Monensin, HGDS and ABC core material were added to the protein solution at final concentrations of 5 ppm. Foams were generated in a Mangan apparatus. Monensin and HGDS reduced the strength of protein foams. Core material from the ABC strongly reduced strength and persistence, indicating monensin with HGDS has a synergistic anti-foaming effect. This is the first time monensin has been reported to have direct anti-foaming properties. The mechanism of action of monensin in reducing bloat and stimulating voluntary intake in both grazing and feedlot cattle, may be in part due to its anti-foaming properties.

Solution	*Strength (g/cm <sup>2</sup> )	*Persistence (minutes)
Control	2.44a (0.21)	11.2a (2.0)
Monensin	2.09 (0.05)	9.2ab (1.2)
HGDS	2.07b (0.15)	9.5ab (1.0)
ABC Core	1.77c (0.22)	7.8b (2.0)

\*Values shown are means ( $\pm$ S.D.). Means in the same column with different letters differ significantly ( $P < 0.05$ ).

**Key Words:** Cattle, Monensin, Anti-foaming

**1038 Effects of monensin and dietary phosphorus concentration on mineral metabolism of grazing steers.** S. M. Williamson\*, E. B. Kegley, T. J. Wistuba, W. K. Coblenz, C. P. West, K. P. Coffey, and D. G. Galloway, University of Arkansas, Fayetteville.

Twenty Angus-crossbred steers (initial BW 209  $\pm$  6.3 kg) were used to evaluate the effects of monensin (0 or 175 mg/d) on performance and mineral metabolism of steers grazing continually stocked warm-season grass pastures that differed in spatial variation of soil test phosphorus ( $< 337$  kg/ha and  $> 337$  kg/ha). This resulted in a 2  $\times$  2 factorial arrangement of treatments. Steers were stratified by weight and randomly assigned to the four treatments. A soybean hull based supplement (0.88 kg) was individually fed once daily throughout the experiment to administer monensin. After 28-d, steers were divided into two collection groups for total fecal and urine collection. This consisted of a 5-d metabolism crate adaptation and a 5-d collection period. Forage for the collection period was clipped daily from pastures of the same soil test P concentrations as the grazed pastures. Concentrations of P in forage samples taken throughout the grazing period averaged 0.35 and 0.30% for high and low soil test P pastures. Phosphorus concentrations in the clipped samples that were fed during the collection periods were 0.40 and 0.27% for high and low soil test P pastures, respectively. Treatment did not affect growth performance of calves during the grazing phase or DM digestibility during the metabolism phase. Supplementation with monensin did not affect ( $P > 0.10$ ) percentage apparent absorption or

percentage retention of P. Steers fed forage from the high soil test P plot had increased P intake ( $P < 0.001$ ), and fecal P excretion ( $P < 0.05$ ). Phosphorus absorbed and retained (g/d) were increased ( $P < .01$ ) in calves fed forage from the high soil test P plot. In addition, the percentage apparent absorption (39 vs 22%,  $P < 0.001$ ) and percentage retention (26 vs 16%,  $P < 0.02$ ) were increased in the calves fed forage from the high soil test P plot. Supplementing monensin to grazing calves did not alter P balance; however, P balance of calves was affected by soil test P concentration.

**Key Words:** Phosphorus, Cattle, Monensin

**1039 Effect of salinomycin or monensin on performance and feeding behavior of cattle fed wheat- or barley-based diets.** D. J. Gibb<sup>\*1</sup>, S.M.S. Moustafa<sup>1</sup>, R. D. Wiedmeier<sup>2</sup>, and T. A. McAllister<sup>1</sup>, <sup>1</sup>Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, <sup>2</sup>Utah State University, Logan.

Feeding behavior and growth performance of cattle fed diets containing monensin or salinomycin were assessed in two trials. In trial 1, 36 Hereford  $\times$  Angus steers (267.7  $\pm$  4.3 kg) were individually fed ( $n = 12$ ) wheat-based transition and finishing diets containing no ionophore (control, C), 26 mg monensin (M) or 13 mg salinomycin (S) per kg dietary DM. Cattle fed M consumed less than those fed C or S, but their intake was more stable during transition. Overall, steers fed M had lower DM intake (8.0 vs 9.2 and 9.2 kg d<sup>-1</sup>) and rate of gain (1.21 vs 1.62 and 1.56 kg d<sup>-1</sup>) than those fed C or S. Cattle fed S required fewer ( $P < .05$ ) days to finish (to 5 mm backfat) than did those fed C or M (93.3 vs 105.8 and 105.8). Monensin-fed steers had lower ( $P < .05$ ) slaughter and carcass weights relative to controls (414.3 vs 480.5 kg, and 231.2 vs 245.8 kg, respectively). In trial 2, M (25 ppm) or S (13 ppm) were included in barley-based diets for 72 yearling steers in four pens equipped with radio frequency identification systems. Individual bunk attendance patterns were monitored during transition to a finishing diet, and while limit-feeding the finishing diet twice daily (LF2/d), limit-feeding once daily (LF1/d), and feeding to ad libitum intake once daily (AL1/d). Ionophore type did not affect ( $P > .10$ ) DM intake, rate of gain or efficiency of feed conversion. Bunk visits were more frequent ( $P < .05$ ) with M than with S during transition and limit-feeding. With M, total daily attendance (TDA) at the bunk during LF1/d and AL1/d, was higher ( $P < .05$ ) than with S, and variability in TDA was lower ( $P < .05$ ) during LF1/d. In the present study, there was no performance advantage in providing S or M in wheat-based finishing diets. Monensin moderated intake of the barley-based diets better than S, but this effect may have been strong enough to suppress intake and even reduce gain on the wheat-based diet.

**Key Words:** Ionophores, Feeding behavior, Feedlot cattle

**1040 Effect of sugars and malate on ruminal microorganisms.** S. A. Martin\*, H. M. Sullivan, and J. D. Evans, University of Georgia, Athens.

The objective of this study was to examine the effects of a commercial feed supplement that contains sugars and malate on lactate fermentation by *Selenomonas ruminantium* grown in batch culture. Experiments were also conducted to examine the effects of this feed supplement on the mixed ruminal microorganism fermentation of ground corn and soluble starch in the presence and absence of 5 ppm monensin. When *S. ruminantium* strains HD4 and H18 were incubated with only DL-lactate, little DL-lactate was utilized by either strain after 24 h. In the presence of 1 g/L sugars plus malate, both strains utilized most of the carbohydrate associated with the feed supplement between 6 and 8 h and lactate was the main end product that was produced. In ground corn fermentations by mixed ruminal microorganisms, 2.25 and 3.25 g/L sugars plus malate increased concentrations of acetate, propionate, and total VFA, while 3.25 g/L increased lactate and decreased final pH and butyrate. Fermentation of soluble starch in the presence of both concentrations of sugars plus malate increased concentrations of acetate, propionate, and total VFA and decreased the acetate:propionate ratio. In the presence of 5 ppm monensin, sugars plus malate treatment increased concentrations of propionate and total VFA in ground corn and soluble starch fermentations. Collectively, these results suggest that sugars plus malate stimulate the ruminal fermentation.

**Key Words:** sugars plus malate, rumen, microorganisms

**1041 Effect of replacing dietary starch with sucrose on milk production in lactating dairy cows.** G. A. Broderick<sup>\*1</sup>, N. D. Luchini<sup>2</sup>, W. J. Smith<sup>1</sup>, S. Reynal<sup>3</sup>, G. A. Varga<sup>4</sup>, and V. A. Ishler<sup>4</sup>, <sup>1</sup>*U.S. Dairy Forage Research Center, Madison, WI*, <sup>2</sup>*Conti-Group Co., Chicago*, <sup>3</sup>*University of Wisconsin, Madison*, <sup>4</sup>*Pennsylvania State University, University Park*.

Two sets of 24 Holstein cows (41 ± 5 kg/d of milk) were blocked by DIM and randomly assigned in two flights to four groups of 6 cows and fed TMR containing (DM basis): 40% alfalfa silage, 20% corn silage, 20.5% rolled high moisture shelled corn, 9% soybean meal, 2% fat, 1% vitamin-mineral supplement, 7.5% supplemental non-structural carbohydrate (NSC), 16.7% CP, and 29% NDF. The NSC fed in the four diets was: 7.5% corn starch, 0% sucrose; 5.0% starch, 2.5% sucrose; 2.5% starch, 5.0% sucrose; or 0% starch, 7.5% sucrose. The diet with 7.5% starch was fed for a 2-wk covariate period then cows were fed their assigned diets for 8-wk. Milk yield was measured at each milking; DMI was determined daily. Yield of milk components was determined from milk samples taken at both daily milkings one day during the covariate and every 2-wk during the experimental period. The statistical model included flight (n = 2), block (n = 12), and covariate yield of each milk component; LS means are reported below. There were linear increases (P ≤ 0.05) in DMI and milk fat content and yield as sucrose increasingly replaced corn starch in the diet; there was a linear decline (P = 0.02) in milk/DMI with increasing sucrose. No other yield trait was affected significantly.

Item	% Sugar				SEM	Linear <sup>1</sup>	Quad-ratic <sup>1</sup>
	0	2.5	5.0	7.5			
	% Starch						
	7.5	5.0	2.5	0			
DMI, kg/d	24.5	25.6	26.0	26.0	0.4	0.01	0.17
Milk, kg/d	38.9	40.4	40.0	39.4	0.7	0.74	0.15
Milk/DMI	1.60	1.58	1.54	1.52	0.03	0.02	0.96
FCM, kg/d	40.5	42.2	43.9	43.2	1.3	0.11	0.38
Fat, %	3.81	3.82	4.07	4.16	0.11	0.01	0.73
Fat, kg/d	1.47	1.53	1.65	1.62	0.06	0.05	0.47
Protein, %	3.24	3.22	3.27	3.30	0.04	0.23	0.54
Protein, kg/d	1.24	1.28	1.29	1.28	0.03	0.35	0.36
Lactose, %	4.75	4.74	4.77	4.74	0.04	0.95	0.90
Lactose, kg/d	1.84	1.91	1.90	1.85	0.06	0.95	0.37
SNF, %	8.76	8.76	8.87	8.82	0.06	0.34	0.68
SNF, kg/d	3.38	3.51	3.51	3.44	0.10	0.69	0.32

<sup>1</sup>Probability of linear and quadratic effects of dietary sucrose concentration.

**Key Words:** Sugar, Starch, Milk yield

**1042 Performance of lactating dairy cows fed citrus pulp or corn products as sources of neutral detergent-soluble carbohydrates.** E. Leiva<sup>1</sup>, M. B. Hall<sup>\*1</sup>, and H. H. Van Horn<sup>1</sup>, <sup>1</sup>*Dept. of Dairy & Poultry Sciences, University of Florida, Gainesville*.

Reversal experiments were used to examine the effects of changing the dietary profile of neutral detergent-soluble carbohydrates (NDSC) on performance of lactating dairy cows and on ruminal fermentation. Corn silage and alfalfa hay-based diets were formulated to contain 40% calculated NDSC supplied primarily by dried citrus pulp as a source of sugars and neutral detergent-soluble fiber (NDSF), or corn products (hominy or corn meal) as sources of starch. In study 1, 11 multiparous Holstein cows including 3 ruminally-cannulated animals were individually fed diets containing 23.6% citrus pulp (diet CIT) or 25.3% corn hominy (diet HOM) on a dry matter (DM) basis. In study 2, 184 animals fed as two groups received diets containing 20.5% citrus pulp (diet CIT) or 19.5% corn meal (diet CM) on a DM basis. Diets were formulated to contain similar amounts of N and NDF. Diet CIT provided more NDSF and diets HOM and CM supplied more starch. Significance was declared at P < 0.10, tendency at P < 0.15. In study 1, cows fed diet HOM had a greater milk protein percentage (2.83 vs 2.71%), and tended to yield more milk protein. Although ruminal hydrogen ion concentrations ([H<sup>+</sup>]) did not differ between diets, the change in [H<sup>+</sup>] with time was linear for H, and quadratic for CIT. Ruminal concentrations of VFA did not differ between diets. In study 2, cows fed CM had greater yields of milk, 3.5% fat- and protein-corrected milk (3.5%FPCM), fat and protein. Cows fed CIT produced greater concentrations of milk fat (3.45 vs 3.27%), and milk urea nitrogen (9.57 vs 8.81 mg/dl). Modifying the proportions of NDSF and starch in the diet can alter milk production, milk composition, and the pattern of ruminal fermentation in dairy cows.

Diets:	Study 1		Study 2	
	CIT	HOM	CIT	CM
NDSF% of diet DM	13.8	8.2	15.0	12.0
Starch% of diet DM	15.0	26.4	12.9	19.0
DM intake, kg/d	20.9	21.4	18.9	19.5
Milk, kg/d	31.3	32.8	27.9	31.8
Milk fat, kg/d	1.11	1.12	0.97	1.02
Milk protein, kg/d	0.85	0.93	0.88	0.96

**Key Words:** NSC, Starch, Soluble Fiber

**1043 Effects of conservation method of corn grain and dietary starch content on DMI and productivity of lactating dairy cows.** M. Oba<sup>\*</sup> and M. S. Allen, *Michigan State University, East Lansing*.

Effects of conservation method of corn grain and dietary starch content on DMI and productivity of lactating dairy cows were evaluated. Eight ruminally and duodenally cannulated Holstein cows (55±15.9 DIM; mean±SD) were used in a duplicated 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments. Experimental diets contained either ground high moisture corn (HM) or dry ground corn (DG) at two dietary starch contents (32 vs. 21%). Mean particle size and DM content of corn grain were 1.86 mm and 63.2%, and 0.89 mm and 89.7%, for HM and DG, respectively. True starch digestibility in the rumen was 71.1 and 46.9% for HM and DG, respectively in high starch diets, and 58.5 and 45.9% for HM and DG, respectively in low starch diets. The HM treatment decreased DMI compared to DG in high starch diets (20.8 vs. 22.5 kg/d), while there was no difference in low starch diets (19.7 vs. 19.6 kg/d). This reduction in DMI is attributed to smaller meal size for HM compared to DG in high starch diets (1.9 vs. 2.3 kg of DM for high starch diets; 2.1 vs. 2.0 kg of DM for low starch diets). Faster starch fermentation for HM in high starch diets might result in satiety sooner. Milk yield was greater for cows fed high starch diets compared to cows fed low starch diets (38.6 vs. 33.9 kg/d) regardless of corn grain treatment. HM decreased 3.5% FCM compared to DG in high starch diets (35.7 vs. 38.7 kg/d), while there was no difference in low starch diets (35.7 vs. 35.4 kg/d). This is because of lower milk fat content for cows fed HM in high starch diets (3.05 vs. 3.59% for high starch diets; 3.95 vs. 3.73% for low starch diets). Milk protein content was lower for HM in high starch diets (2.98 vs. 3.02%) but higher for HM compared to DG in low starch diets (2.94 vs. 2.87%). Reducing ruminal starch fermentation by substituting DG for HM can increase productivity of lactating cows fed high starch diets.

**Key Words:** Dry matter intake, Corn grain, Ruminal starch digestion

**1044 Effects of conservation method of corn grain and dietary starch content on starch digestibility and efficiency of microbial N production in lactating dairy cows.** M. Oba<sup>\*</sup> and M. S. Allen, *Michigan State University, East Lansing*.

Effects of conservation method of corn grain and dietary starch content on starch digestibility and efficiency of microbial N production were evaluated. Eight ruminally and duodenally cannulated Holstein cows (55±15.9 DIM; mean±SD) were used in a duplicated 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments. Experimental diets contained either ground high moisture corn (HM) or dry ground corn (DG) at two dietary starch contents (32 vs. 21%). Mean particle size and DM content of corn grain were 1.86 mm and 63.2%, and 0.89 mm and 89.7%, for HM and DG, respectively. True starch digestibility in the rumen was higher for HM compared to DG, and the difference was greater for high starch diets (71.1 vs. 46.9%) compared to low starch diets (58.5 vs. 45.9%). This interaction is attributed to a greater increase in digestion rate of starch for HM compared to DG in high starch diets (28.2 vs. 14.6 %/h) compared to low starch diets (16.8 vs. 12.2 %/h). This suggests that ruminal starch digestion is limited by enzyme activities as well as substrate availability; ruminal contents of cows fed low starch diets may have insufficient amylolytic activity for maximal starch digestion when readily fermentable starch is available. Starch digestibility in the total tract was not affected by corn grain treatment because of compensatory digestion post-ruminally. The HM treatment decreased microbial N production efficiency compared to DG (39.7 vs. 48.4 g/kg of truly ruminally fermented OM). However, post-ruminal digestibility for non-ammonia nitrogen was greater for HM compared to

DG, and the increase was greater for high starch diets (74.3 vs. 68.7%) compared to low starch diets (71.2 vs. 70.6%). This might be attributed to greater microbial N excretion as feces due to enhanced starch digestion in the large intestine for cows fed DG compared to cows fed HM or to more resistant protein for DG compared to HM. Effects of corn grain conservation method on nutrient digestion are greatly altered by starch content of diets.

**Key Words:** Corn grain, Ruminal starch digestion, Microbial N production

#### **1045 Effects of Speciality Corn Hybrids on Lactation Performance of Dairy Cows.** V. Akay\* and J. A. Jackson, *University of Kentucky, Lexington.*

Six multiparous (81 ± 9 DIM) and six primiparous (79 ± 4 DIM) lactating dairy cows were fed three diets in a replicated 3 x 6 Latin rectangle design with 28 d periods. The objective of this study was to determine the effects of speciality corn hybrids as silage and grain sources on milk yield and composition. Diets were: 1) control (normal yellow dent corn), 2) nutridense corn (high oil and protein), and 3) waxy corn (high amylopectin) diets. Diets contained 11% alfalfa silage, 33% corn silage (from the respective corn treatment), 28% cracked corn grain (from the respective corn treatment), and 28% other ingredients (DM basis). Data were analyzed using General Linear Procedure of SAS; means were separated by least significant difference. Except for body weight change (BWC), the parity x treatment interaction term in the model was not significant, and therefore data were analyzed without interaction term in the model. Multiparous cows that were fed normal corn diet gained body weight while those fed nutridense or waxy corn diets lost body weight (5.99, -9.24 and -1.29 kg, respectively). However, BWC was similar between diets for primiparous cows. Pooled data from multiparous and primiparous cows indicated that BWC, milk fat percentage and milk protein yield were similar between diets. The 3.5% fat-corrected milk (FCM) (34.2, 35.5 and 36.4 kg/d, respectively) and milk fat yield (1.23, 1.28 and 1.31 kg/d, respectively) were higher for cows fed the waxy corn diet than those fed the normal corn diet. Milk protein percentage (3.21, 3.15 and 3.22%, respectively) was higher for cows fed waxy corn diet than those fed the nutridense corn diet. Dry matter intake (DMI) (23.9, 23.8 and 24.4 kg/d, respectively) and milk yield (33.0, 34.2 and 34.9 kg/d, respectively) tended (NS) to be higher for cows fed waxy corn diet than for those fed the normal corn diet. Milk yield/DMI (1.38, 1.43 and 1.43, respectively) tended (NS) to be higher while FCM/DMI (1.43, 1.49 and 1.49, respectively) was higher for cows fed nutridense and waxy corn diets than those fed normal corn diet. Nutridense corn hybrid as grain and silage did not improve lactation performance of dairy cows; however, waxy corn hybrid as grain and silage improved lactation performance of dairy cows when compared with normal yellow dent corn hybrid.

**Key Words:** Speciality corn hybrids, Lactation, Dairy cows

#### **1046 The Lactational Response to Diets Containing Conventional or High Oil Corn Fed at Two Dietary Energy Concentrations.** L. A. Whitlock\*, D. J. Schingoethe, A. R. Hippen, and K. M. Kasperon, *South Dakota State University, Brookings.*

Milk production and composition were evaluated using 12 multiparous Holstein cows which were randomly assigned in a replicated 4 x 4 Latin square design with 4 wk periods. The four treatments consisted of a control diet (C) using conventional corn with a 50:50 ratio of forage to concentrate, a diet with high oil corn replacing the conventional corn (CHO), a low energy diet (L) using conventional corn with a 60:40 ratio of forage to concentrate, and a low energy diet with high oil corn replacing the conventional corn (LHO). Milk production (34.8, 35.4, 33.6, and 33.3 kg/d for cows fed C, CHO, L, and LHO diets, respectively) was lower ( $P < 0.05$ ) for cows fed lower energy diets but was similar ( $P > 0.05$ ) for conventional and high oil corn diets. Milk fat (3.88, 3.88, 4.00, and 4.17%), and protein (3.22, 3.26, 3.18, and 3.32%) contents were similar ( $P > 0.05$ ) for all diets. Contents of conjugated linoleic acid (CLA) and transvaccenic acid (TVA) in milk were increased 35 to 45% ( $P < 0.05$ ) when fed CHO instead of C, but increased only slightly ( $P > 0.05$ ) when fed LHO instead of L. Milk production was not increased when fed high oil corn in place of conventional corn in either normal or low energy diets.

**Key Words:** High Oil Corn, Milk, Conjugated Linoleic Acid

#### **1047 Utilization of barley in diets of lactating cows.** R. L. Kincaid\*<sup>1</sup>, J. H. Harrison<sup>2</sup>, W. Sanchez<sup>3</sup>, and C. W. Hunt<sup>4</sup>, <sup>1</sup>*Washington State University, Dept. of Animal Sciences, Pullman,* <sup>2</sup>*Washington State University, Puyallup,* <sup>3</sup>*Church and Dwight, Inc., Princeton, NJ,* <sup>4</sup>*University of Idaho, Moscow.*

The chemical composition of barley differs significantly among agronomic varieties. Baroness, Idagold, and Harrington varieties typically have high starch and low fiber contents, and Steptoe typically has lower starch and higher fiber content. Three experiments were conducted with lactating cows to determine the relative nutritive value of the barley varieties compared to corn. The first experiment evaluated Baroness, Idagold, and Steptoe barley. Forty cows in mid-lactation were blocked by parity and milk yield and composition recorded. Milk yields (kg of 3.5 FCM) were: Baroness, 24.8<sup>a</sup> corn, 23.8<sup>a,b</sup>; Idagold, 23.6<sup>a,b</sup>; and Steptoe, 22.7<sup>b</sup>. DMI of cows were lowest for Steptoe (20.5 kg) and greatest for Baroness (24 kg). A second experiment evaluated milk yield, diet digestibility, and intestinal flow of N in cows fitted with ruminal and duodenal cannulae. Cows fed Baroness had the lowest ( $P < .05$ ) total tract digestibility of starch. Flows of total N, microbial N, feed N, and ammonia N into the duodenum did not differ among treatments. However, there was significantly greater ( $P < .05$ ) flow of Met and Lys into the duodenum of cows fed Idagold and reduced flow in cows fed either Baroness or corn. Milk yields were greatest for cows fed Idagold and Harrington barley, and least for cows fed Baroness or Steptoe barley or corn. A third experiment used 48 lactating cows in a 4 x 4 Latin square design to compare corn and barley (Baroness) with two levels of dietary Ca (.6 and 1.2%). The Latin square had 4 periods of 28 d each. Milk yield did not differ among treatments, but cows fed Baroness had higher ( $P < .05$ ) percent milk fat and yield of fat. In conclusion, barley varieties differ significantly in their feeding value for lactating cows. Varieties of barley with lower fiber contents can replace corn in rations of cows in mid-lactation without affecting milk yield.

**Key Words:** Barley, Corn, Cows

#### **1048 Growth response of post-weaned dairy heifers to level of rumen undegradable protein in the total ration dry matter.** B.A. Hopkins\* and L.W. Whitlow, *North Carolina State University, Raleigh.*

Thirty-six post-weaned Holstein heifers, approximately 8 weeks of age, were assigned randomly to treatments for 112 days in a study designed to determine the optimum level of dietary rumen undegradable protein (RUP) in a 15% crude protein (CP) diet. Heifers received a total mixed ration that contained 15% CP and was formulated to contain one of the following levels of RUP as a percentage of the CP: 1). 30%; 2). 40%; 3). 50%; and 4). 60%. Least squares means for CP and ADF content of the diets were 15.1, 28.2; 14.8, 25.7; 15.5, 29.1; and 15.9, 26.8 for diets 1 through 4 respectively. Diets were formulated such that the RUP was estimated to contain lysine and methionine in a 2.7:1 ratio. Dry matter intake was not different across treatments. Feed efficiency calculated as kg of gain per kg of dry matter intake was 0.25, 0.23, 0.27, and 0.26 for calves consuming treatment diets 1 through 4 respectively. Calves receiving treatment 3 (50% RUP) had greater feed efficiency than calves receiving treatment 1 (30% RUP), ( $P < 0.05$ ) or treatment 2 (40% RUP), ( $P < 0.001$ ). Calves receiving treatment 4 (60% RUP) had greater feed efficiency than those fed treatment 2 (40% RUP), ( $P < 0.03$ ). There was a treatment effect ( $P < 0.05$ ) on body weight gain. Average daily body weight gains (ADG) were 1.02, .96, 1.13, and 1.04 kg for calves consuming treatment diets 1 through 4 respectively. The ADG for calves receiving treatment 3 (50% RUP) was higher than treatment 1 (30% RUP), ( $P < 0.06$ ) and treatment 2 (40% RUP), ( $P < 0.006$ ). In this study, early post-weaned calves fed a 15% CP diet performed best when receiving a diet containing 50% of the CP as RUP.

**Key Words:** Rumen Undegradable Protein, Heifers, Growth

**1049 Effects of dietary vitamin A and E on performance and scour incidence of milk replacer fed calves.** B.L. Miller\*<sup>1</sup>, T.E. Johnson<sup>1</sup>, H.B. Perry<sup>1</sup>, M.A. Fowler<sup>1</sup>, D.E. Housken<sup>1</sup>, B.J. Nonnecke<sup>2</sup>, and R.L. Horst<sup>2</sup>, <sup>1</sup>Land O'Lakes, Inc., Webster City, IA, <sup>2</sup>National Animal Disease Center, USDA-URS, Ames, IA.

Effects of dietary vitamin A (VA) and E (VE) on performance and scour incidence of milk replacer fed Holstein bull calves were examined. One hundred forty four (144) calves were purchased (34 hr transit) and assigned according to body weight (initial, 42.9 kg) and blood gamma globulin concentration. Calves were fed milk replacer (22% protein, 20% fat) containing 2000 (NRC), 4000 or 34000 IU of VA/d and either 20 or 100 IU of VE/d. Calves were individually housed in crates and fed 2 times daily at 700 and 1615 hours. Weight gains, daily scour score, scour duration and electrolyte/medication costs were calculated weekly and for the 4 wk trial. These data indicate that VA and VE had no effect (P>.05) on calf performance or scouring.

Vitamin A, IU	2000	2000	4000	4000	34000	34000	
Vitamin E, IU	20	100	20	100	20	100	C.V.
Total Gain, kg	12.82	12.89	12.04	12.81	12.84	12.73	16.80
F/G	1.72	1.74	1.88	1.77	1.79	1.79	18.12
Scour Score <sup>A</sup>	1.43	1.36	1.37	1.40	1.40	1.44	15.41
Total Days							
Scouring	10.10	8.27	8.35	9.00	8.61	9.57	49.22
Total Electrolyte/							
Medication, \$	16.83	14.35	16.15	15.92	17.16	19.26	55.59

<sup>A</sup> Four week average, 1-4 scale; 1=normal, 2=loose, 3=water separation, 4=3 with severe dehydration.

**Key Words:** Calf, Milk replacer, Vitamin

**1050 Effects of dietary vitamins A and E on retinol, retinyl palmitate and vitamin E concentrations in plasma and tissues from neonatal calves.** B.J. Nonnecke\*<sup>1</sup>, R.L. Horst<sup>1</sup>, M.A. Fowler<sup>2</sup>, B.L. Miller<sup>2</sup>, J.W. Young<sup>3</sup>, T.E. Johnson<sup>2</sup>, H.B. Perry<sup>2</sup>, D.E. Housken<sup>2</sup>, and D.A. Hoy<sup>1</sup>, <sup>1</sup>National Animal Disease Center, USDA-URS, Ames, IA, <sup>2</sup>Land O'Lakes Inc., Webster City, IA, <sup>3</sup>Iowa State University, Ames.

Effects of dietary vitamin A (VA) and E (VE) on retinol (ROH), retinyl palmitate (RP), and VE concentrations in plasma, liver and blood leukocytes from neonatal calves were evaluated. Male, Holstein calves entered a 4wk trial at ≤9d of age immediately after being transported for 34h. They were fed milk replacer with 2000 (NRC level), 4000, or 34,000 IU VA/d and either 20 or 100 IU of VE/d. Plasma ROH levels decreased (P<.001) with time in all groups, a possible negative response to shipping. By wk 4, plasma ROH was lower (P<.001) in calves fed ≤4000 IU VA/d (< 62 ng/ml) than in calves fed 34,000 IU VA/d (98 ng/ml). Plasma RP remained low in ≤4000 IU VA/d groups, but increased markedly in the 34,000 IU VA/d group. By wk 4, liver VA (ROH+RP) was lower (P<.001) in ≤4000 IU VA/d groups (< 9 ug/gm) than in the 34,000 IU VA/d group (33 ug/gm). Plasma, liver and leukocyte VA were unaffected by dietary VE. In the 20 IU VE/d group, plasma and liver VE remained low and were unaffected by dietary VA. In contrast, plasma VE was affected (P<0.01) by dietary VA in the 100 VE/d groups. By wk 4, plasma VE in the 2000 IU VA + 100 IU VE/d (2569 ng/ml) and 4000 IU VA + 100 IU VE/d groups (2180 ng/ml) exceeded (P<.05) concentrations in the 34,000 IU VA + 100 IU VE/d group (1681 ng/ml). Similarly, liver VE concentrations were higher (P<.05) in calves fed 2000 (8242 ug/gm) or 4000 IU VA/d (7736 ug/gm) than in calves fed 34,000 IU VA/d (4392 ug/gm). By wk 4, ROH and VE concentrations in leukocytes from the 34,000 IU VA/d group exceeded concentrations (P<.05) in leukocytes from ≤4000 IU VA/d groups. These results suggest that neonatal calves require >4000 IU VA and ≤100 IU VE/d to ensure vitamin adequacy. Although dietary VA altered VE status, this effect was not associated with changes in health or growth.

**Key Words:** Vitamin A, Vitamin E, Neonatal calf

**1051 Effect of dietary vitamin A (VA) and E (VE) on function and composition of circulating leukocyte populations from milk replacer-fed, neonatal calves.** B.J. Nonnecke\*<sup>1</sup>, M.A. Fowler<sup>2</sup>, B.A. Pesch<sup>1</sup>, B.L. Miller<sup>2</sup>, R.L. Horst<sup>1</sup>, T.E. Johnson<sup>2</sup>, H.B. Perry<sup>2</sup>, D.E. Housken<sup>2</sup>, and J.A. Harp<sup>1</sup>, <sup>1</sup>National Animal Disease Center, USDA-ARS, Ames, IA, <sup>2</sup>Land O'Lakes, Inc., Webster City, IA.

Fat-soluble vitamin status has been shown to influence broad aspects of the immune systems of a variety of animal species. Previous in vitro studies have shown that metabolites of VA and VE modulate the cellular composition and function of the bovine immune system. In the present study, effects of dietary VA and VE on the function and composition of blood leukocyte populations in neonatal calves were examined. Male, Holstein calves entered a 4wk trial at ≤9d of age immediately after being transported for 34h. During the study period, calves were fed a milk replacer providing 2000 (NRC level), 4000, or 34,000 IU VA/d and either 20 or 100 IU of VE/d. At 4 wk, the composition and function of peripheral blood mononuclear leukocyte (MNL) populations from calves (n=6/treatment group) were evaluated. Flow cytometric analysis of MNL populations indicated that percentages of B cells (P=.74) or T cells [i.e. CD4 (P=.22), CD8 (P=.43), and γδ(P=.47)T cells] or expression of activation antigens [interleukin-2 receptor, (P=.33) and MHC class II antigens (P=.13)] were unaffected by dietary VA and VE. Although DNA-synthesis and secretion of IFN-γ, nitric oxide, and polyclonal IgM by unstimulated and mitogen-stimulated MNL were unaffected (P>.05) by dietary VE, these variables were influenced (P<.05) by dietary VA. Interestingly, VE, but not VA, influenced neutrophil function (i.e. cytochrome C reductase activity, P<.05). Serum Ig (G<sub>1</sub>, G, and M) concentrations and total numbers of blood leukocytes were unaffected (P>.05) by VA or VE. These results indicate that dietary VA and VE influence broad aspects of leukocyte function in vitro and suggest that the bioavailability of these vitamins may alter immune competency and disease susceptibility of newborn calves.

**Key Words:** Neonatal calf, Vitamins A and D, Immune function

**1052 The effects of supplemental lactoferrin on calf performance.** R.S. Joslin<sup>1</sup>, H.M. Santoro<sup>1</sup>, N.L. Whitehouse<sup>1</sup>, J.J. Rejman<sup>2</sup>, P.S. Erickson\*<sup>1</sup>, and C.G. Schwab<sup>1</sup>, <sup>1</sup>University of New Hampshire, Durham, <sup>2</sup>ImmuCell Corp., Portland, ME.

Holstein calves (12 male, 9 female) were used to evaluate the effects of supplemental lactoferrin (Lf) (0, 1, or 10 g) added to colostrum (d1-2) and a commercially available milk replacer (20 % CP, 20 % fat) in a 56-d study. Calves were housed in individual pens, bedded in kiln-dried sawdust, and provided with a coarse calf starter and water ad libitum. Calves were weighed at birth and weekly thereafter. Hip height, body length, and wither height were measured weekly. Fecal scores and rectal temperatures were determined three times per week. Calves were weaned when they consumed 0.7 kg/d of calf starter for two consecutive days. Calves fed Lf tended (P< .10) to consume more starter per day preweaning (0 g, 0.19 kg; 1 g, 0.27 kg; 10 g, 0.31 kg), weighed more preweaning (≤28 to 35 d) (P< .05) (0 g, 44.7 kg; 1 g, 47.1 kg; 10 g, 47.1 kg), and tended (P< .10) to weigh more postweaning (0 g, 58.1 kg; 1 g, 64.2 kg; 10 g, 60.7 kg) compared to calves not receiving Lf. Calves fed Lf had an increased (P< .05) preweaning ADG and average daily heart girth gain compared to control calves with calves fed 1 g Lf having a greater (P< .05) preweaning ADG than calves fed 10 g Lf (0 g, 0.21 kg, 0.11 cm; 1 g, 0.32 kg, 0.19 cm; 10 g, 0.24 kg, 0.16 cm). Calves fed Lf tended (P = .12) to have higher gain/feed preweaning compared to control calves (0 g, 0.29; 1 g, 0.38; 10 g, 0.31). Overall gain efficiency tended (P< .10) to be greater for calves fed 1 g Lf vs. 10 g Lf (0 g, 0.38; 1 g 0.41; 10 g 0.36). Calves fed Lf tended (P< .10) to meet the prescribed weaning criteria at an earlier age (0 g, 33.6 d; 1 g, 31.9 d; 10 g, 31.6 d) compared to control calves. Based on improved growth and starter intake, Lf may be a beneficial additive for young calves.

**Key Words:** Lactoferrin, Calves, Growth

**1053 Growth of calves fed milk replacer containing spray-dried egg product.** D. W. Kellogg<sup>\*1</sup>, K. S. Anschutz<sup>1</sup>, Z. B. Johnson<sup>1</sup>, K. E. Lesmeister<sup>1</sup>, and A.K.M.A. Haque<sup>2</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>American Dehydrated Food, Inc., Springfield, MO.

The nutritional quality of egg protein is recognized, but it has not been tested extensively in milk replacers. Eight male Holstein calves were fed a milk replacer containing spray-dried, feed grade, egg product (49% CP, 37% fat). The medicated milk replacer was a mixture of 30% dried egg product, 36% dried whey, 20% dried skim milk, 10.7% lactose, and 3% poultry fat with vitamins and minerals. All calves were fed a commercially available, medicated milk replacer (20% CP and 20% fat) during a 4-d adjustment period, and the randomly selected control calves (10) were continued on that diet. Nutrient requirements were met or exceeded, including specific amino acid requirements. Fat content was formulated at 15%. Vitamin A, copper, and zinc were fed at elevated levels (121,000 IU, 25 mg/kg, and 100 mg/kg, respectively) since iron content of the dried egg product was 98 mg/kg. Calves were housed in outdoor hutches during the 28-d experiment. Fresh water was offered daily, and supplemental grain was limit-fed (.1 kg/d for week 1, and increased weekly by .1 kg/d) using bottles with specialized nipples. Calves were weighed initially and at weekly intervals. Feed intake was measured daily. Fecal consistency and incidence of treatments for scours were recorded daily. Body weight gains for the 28-d period were similar ( $P > .05$ ) for calves fed milk replacer containing egg protein ( $6.1 \pm .8$  kg) and for calves fed the control diet ( $6.2 \pm .7$  kg). Control calves tended to consume more grain during week 1 and did consume more grain ( $P < .05$ ) during the 2nd and 4th wk than calves fed milk replacer containing 30% dried egg product. During the 3rd wk the means were not different. There were no major disease problems, and fecal consistency scores were similar for both treatment groups. This experiment indicates that spray-dried egg product can provide protein and fat for dairy calves receiving milk replacer.

**Key Words:** Dairy Calves, Milk Replacer, Egg Protein

**1054 Variable amounts of ruminally degradable and undegradable protein for post-weaned dairy heifers.** S. L. Cole<sup>\*1</sup>, C. G. Schwab<sup>1</sup>, B. D. Garthwaite<sup>1</sup>, N. L. Whitehouse<sup>1</sup>, P. S. Erickson<sup>1</sup>, T. P. Fairchild<sup>1</sup>, and P. C. Hoffman<sup>2</sup>, <sup>1</sup>University of New Hampshire, Durham, <sup>2</sup>Marshfield Agricultural Experiment Research Station, WI.

A growth and digestibility experiment was conducted to evaluate the effects of feeding variable levels of RUP and RDP to post-weaned heifers. Forty-two Holstein heifers at 42 d of age ( $\pm 3$  d) were assigned randomly within blocks to a  $2 \times 3$  factorial arrangement of treatments. The main effects were percentages of RUP and RDP in diet DM. The six dietary treatments were 1) RUP 5.8, RDP 7.8; 2) RUP 5.8, RDP 9.8; 3) RUP 5.8, RDP 11.8; 4) RUP 8.7, RDP 7.6; 5) RUP 8.7, RDP 9.6; and 6) RUP 8.7, RDP 11.5. All diets contained 30% grass silage, 15.0% chopped grass hay, 34.6% corn meal, 2.0% minerals and vitamins, and 0.1% chromium oxide; targeted RUP and RDP levels were obtained by altering the amounts of soy hulls, soybean meal, non-enzymatically browned soybean meal, and urea. Heifers received treatments until 150 kg BW. Feed intake was measured daily. Skeletal measurements and BW were obtained weekly. Digestibility measurements were obtained on each calf every 3 wk. Intake of DM was not affected by treatment. Feeding the higher RUP diets increased ( $P < 0.05$ ) ADG (0.94 vs. 0.86 kg/d), gain:feed (346 vs. 322 g/kg DMI), and decreased days on treatment (98 vs. 108). Hip height (1.23 vs. 1.12 cm/wk) and heart girth (2.11 vs. 1.95 cm/wk) growth rates also were increased by feeding the higher RUP diets. Effects of higher RUP on growth rates were present until BW approached 110 kg. Increasing RDP increased linearly ADG (0.87, 0.92 and 0.93 kg/d), gain:feed ratios (320, 335, and 346 g/kg DMI) and decreased days on treatment (108, 102, and 99). Increasing RDP also increased linearly total tract digestibility of OM (57.8%, 59.2%, and 63.4%) and non-NDF OM (69.7%, 70.6%, and 76.1%) during the first digestibility period. Heifers  $< 150$  kg BW fed additional RUP responded with increased ADG, feed efficiency, and gain of hip height, and heart girth. Linear increments of RDP increased linearly ADG and feed efficiency.

**Key Words:** Heifers, Protein, Growth

**1055 Effect of physical form of calf starter on starter intake and days to weaning in dairy calves.** D. M. Amaral-Phillips<sup>\*</sup>, S. T. Franklin, and A. Polley, University of Kentucky, Lexington.

Weaning of calves should be determined by intake of calf starter. The more readily calves consume starter, the earlier they can be weaned which, in turn, decreases feed and labor costs. The objective of this study was to compare the performance of calves fed a ground, home-mixed calf starter to a commercially-formulated pelleted or textured starter. All starters were isonitrogenous (20% crude protein) and contained equal amounts of lasalocid. The ground starter contained oats, cracked corn, soybean meal, molasses, vitamins and minerals. Thirty calves (10 per treatment) were housed in hutches and fed 2 l of whole milk twice daily. Starter and water were provided free-choice beginning at d 3 of age with starter intake determined daily. Once calves were consuming 0.68 kg starter two days consecutively, milk was fed once daily for 4 days and calves were weaned on d 5. Calves were weighed at birth and weekly for 6 wk. Statistical comparisons were made using the Kruskal-Wallis test. No differences ( $P > 0.05$ ) were detected between treatments in total amount of milk fed or total weight gain over 6 wk (20.9, 18.4, 23.2 kg for ground, pelleted, or textured starter consecutively). Calves fed pelleted starter consumed less total grain over 6 wk compared to the ground or textured treatments (17.6, 11.2, 19.0 kg; ground vs pelleted,  $P = 0.09$  and textured vs pelleted,  $P = 0.02$ ). Calves fed pelleted starter were weaned later than calves fed ground or textured starter (31.9, 36.8, 31.1 days; ground vs pelleted,  $P = 0.09$  and textured vs pelleted,  $P = 0.02$ ). Calves fed ground or textured starter consumed more starter at an earlier age and were weaned earlier than those fed pelleted starter.

**Key Words:** dairy calves, starter, weaning age

**1056 Carnitine palmitoyltransferase activity in liver of periparturient dairy cows.** H. M. Dann<sup>\*</sup>, G. N. Douglas, T. R. Overton, and J. K. Drackley, University of Illinois, Urbana.

Holstein cows were used to determine the effects of diet and physiological state on activity of mitochondrial carnitine palmitoyltransferase (CPT) in liver during the periparturient period. Liver was biopsied at -65 (prior to dry-off), -21, 1, 21, and 65 d relative to parturition. The biopsy at -65 d was used as a covariate. In experiment 1, cows ( $n = 39$ ) were fed either a control (C) or high fat (F) diet from dry-off (60 d before expected calving) to calving at either ad libitum (A) or restricted (R; 80% of calculated NEL requirements) intake. Diets were isocaloric (NEL = 1.43 Mcal/kg). After parturition, all cows were fed the same lactation diet. Activity of CPT (nmol palmitoyl-[3H]-carnitine formed  $\cdot \text{min}^{-1} \cdot \text{mg protein}^{-1}$ ) was 7.9, 11.4, 10.1, and 7.8 (SE = 0.5) at -21, 1, 21, and 65 d relative to parturition, respectively (time effect,  $P < 0.0001$ ). Neither diet (C vs. F) nor feeding level (A vs. R) affected CPT activity, although CPT activity tended ( $P < 0.10$ ) to be greater for C than for F. A tendency ( $P < 0.06$ ) existed for a time by feeding level interaction; cows fed R had greater CPT activity at d 1 but then decreased more rapidly than those fed A. In experiment 2, the cows ( $n = 30$ ) fed C and F diets at A intake were compared with cows fed the control diet with added fat (CF; NEL = 1.58 Mcal/kg) at A intake from dry-off to calving. After parturition, all cows were fed the same lactation diet. Activity of CPT was lowest at -21 d (7.4), highest at 1 d (10.5), and gradually decreased at 21 d (9.4) and 65 d (8.0) relative to parturition (time effect,  $P < 0.0001$ ). Cows fed C had higher ( $P < 0.05$ ) CPT activity than cows fed CF (10.0 vs. 7.7; SE = 0.70); CPT activity for F was intermediate. Time by diet effects were not significant ( $P > 0.10$ ). Significant positive correlations were found between CPT activity and liver contents of total lipid ( $n=219$ ; Spearman rho = 0.40;  $P < 0.0001$ ) and triglyceride ( $n=219$ ; Spearman rho = 0.42;  $P < 0.0001$ ). Day relative to parturition has more pronounced effects on CPT activity than diet composition or feeding level during the dry period.

**Key Words:** Carnitine palmitoyltransferase, Dairy cow, Transition period

**1057 Parturition energy and protein intake of dairy cows. 2. Effect on periparturient lipid metabolism.** L. Doepel<sup>1</sup>, H. Lapiere<sup>2</sup>, and J.J. Kennelly<sup>1</sup>, <sup>1</sup>University of Alberta, Edmonton, Canada, <sup>2</sup>Dairy and Swine R & D Centre, Lennoxville, Canada.

Parturition nutrient intake of dairy cows has been shown to affect hepatic lipid accumulation. This study was undertaken to determine the interaction of protein and energy intake in the close-up dry (CUD) period on periparturient lipid metabolism. Twenty-six multiparous Holstein cows were used. Two levels of energy, 1.61 Mcal/kg NE<sub>L</sub> (HE) and 1.27 Mcal/kg NE<sub>L</sub> (LE), and two levels of protein, 16.3% CP (HP) and 11.1% CP (LP), were tested according to a factorial arrangement in a randomized block design. Treatments began 21 days before expected calving date. After calving, a single diet (1.79 Mcal/kg NE<sub>L</sub>, 18.7% CP) was fed. Blood samples were collected by caudal venipuncture 3-5 h after feeding from -3 to +4 weeks relative to calving. Growth hormone (GH) and IGF-1 concentrations were not affected by treatment. Insulin concentrations decreased when energy and protein were uncoupled (energy by protein interaction, P = 0.02). β-hydroxybutyrate (BHBA) concentrations tended to be higher with the HP diets in the postcalving period (period by protein interaction, P = 0.10). Non-esterified fatty acid (NEFA) levels decreased (P < 0.01) with the HE diets. The HP treatment decreased NEFA in the HE diet but increased them in the LE diet (energy by protein interaction, P = 0.03). Liver triglyceride (TG) content on d1 and d21 postcalving tended to be lower (P = 0.08) with the HE than the LE diets. For all metabolites the effect of period was significant (P < 0.05). These data suggest that while CUD nutrient intake does have an effect on lipid metabolism, the physiological changes associated with parturition are far greater.

	Diet				(SEM)	Period	
	HEHP	HELP	LEHP	LELP		CUD	EL*
GH, ng/ml	4.59	4.32	4.12	4.87	0.63	2.03	6.34
Insulin, ng/ml	0.625	0.439	0.420	0.566	0.06	0.78	0.39
IGF-1, ng/ml	84.9	83.9	77.7	86.3	5.62	127.1	63.3
BHBA, mg/dl	12.17	10.17	12.02	11.01	0.98	9.39	11.08
NEFA, μM	355.3	444.1	653.9	531.7	44.2	215.8	423.5
Liver TG, %DM							
day 1	7.06	7.35	11.87	11.40	2.73		
day 21	13.65	11.19	16.03	16.11	2.73		

\*EL = early lactation

**Key Words:** Transition cow, Lipid metabolism

**1058 The effects of high inclusion grain mixes fed to transitioning cows on subsequent milk and milk component production.** C. M. Luhman\*, Land O'Lakes, Inc. and Cooperative Research Farms.

Fifty-seven multiparous Holstein cows that were 14 days prepartum were used in a completely randomized design to compare prepartum rations based on high inclusion grain mixes and forage base. Treatments were: 1) corn silage and grain mix (corn silage; F:C=58:42), 2) haylage + grain mix (haylage, F:C=40:60), and 3) control ration based on a traditional higher forage "steam up" ration (control; F:C=67:33). Rations were fed for 14 days prepartum and cows were then put on a common lactation ration for 28 days; milk production, milk components, and health were followed. Cows fed corn silage or haylage had higher prepartum dry matter intakes than did cows fed control at 1 week prepartum. The prepartum rations based on high inclusion grain mixes allowed for higher production, especially when corn silage is the forage base. Haylage treatment performed as well as or better than the control ration, a traditional "steam up" ration, and both are viable options for transition programs.

	Control	Corn Silage	Alfalfa Haylage	P=
DMI, kg/d	17.8	18.3	18.6	-
Milk, kg/d	37.4 <sup>b</sup>	41.4 <sup>a</sup>	38.6 <sup>b</sup>	0.03
FCM, kg/d	42.8 <sup>a</sup>	47.8 <sup>b</sup>	45.1 <sup>ab</sup>	0.04
Milk fat, %	4.47	4.39	4.46	-
Milk protein, %	3.25 <sup>ab</sup>	3.14 <sup>b</sup>	3.36 <sup>a</sup>	0.04

**1059 Effects of dietary protein prepartum and postpartum on nitrogen balance and milk production from dairy cows.** J. M. Moorby\*, R. T. Evans, and W. J. Fisher, Institute of Grassland and Environmental Research, Aberystwyth, UK.

Twelve Holstein-Friesian dairy cows were used to investigate the animals' ability to accrete and mobilize protein in the dry period and early lactation. Six dry animals were each offered one of two diets from 6 wk before predicted calving: DL, ad libitum mix of ryegrass silage and barley straw (60:40 DM ratio) with a low diet protein content (10.9 % CP, 2.17 Mcal metabolisable energy (ME)/kg DM), or DH, ad libitum grass silage and 0.5 kg/d high protein maize gluten meal, with a high diet protein content (19.2 % CP, 2.43 Mcal ME/kg DM). After calving, all animals received a standard grass silage based diet for the first 2 wk of lactation. At the start of week three of lactation, all animals received a low protein grass silage TMR diet (LL: 12.8 % CP, 2.42 Mcal ME/kg DM) for 3 wk, designed to force protein mobilization. At the start of week six of lactation, animals were switched to a high protein grass silage TMR diet (LH: 22.3 % CP, 2.62 Mcal ME/kg DM). Forage DM intake was not different among the two dry period diets (mean 8.8 kg DM/d; SE = 0.39), although N balance was significantly affected (6.5 and 69.2 g N/d for DL and DH respectively; SED = 6.67; P < 0.001). All cows were able to mobilize substantial amounts of N during early lactation when given the LL diet, but there was no residual effect of dry period diet (-44 and -53 g N/d for DL and DH; SED = 13.6). When subsequently offered diet LH, animals mobilized less body N (-3 and -29 g N/d for DL and DH; SED = 27.4), with no residual dry period effects, and produced more milk than from diet LL (means of 21.6 and 24.7 kg milk/d for LL and LH; SED = 1.13; P < 0.05). There were no residual effects of dry period treatment on milk production other than increases in protein concentrations from animals previously offered DH (means of 2.92 and 3.10 % for DL and DH; SED = 0.067; P < 0.05). It is concluded that dairy cows can mobilize substantial amounts of body N in early lactation even if dry period protein supply is too low to allow protein accretion.

**Key Words:** Dry Cows, N Balance, Milk Production

**1060 Chronic observation of gravid uterine blood flow around parturition in Holstein cows.** T. Nishida<sup>1</sup>, S. Ando<sup>1</sup>, M. R. Islam<sup>1</sup>, Y. Nagao<sup>2</sup>, and M. Ishida<sup>1</sup>, <sup>1</sup>National Grassland Research Institute, <sup>2</sup>Utsunomiya University Farm.

Blood flow to the gravid uterine horn of seven multiparous Holstein cows (BW = 625.5 pm 82.4 kg; age = 4.7 ± 1.7 years; parity = 2.86 ± 1.07 years) was measured from d 222 of gestation to d 30 postpartum using transit-time ultrasonic blood flow probes placed around the middle uterine artery. Surgery was done at d 215 of gestation. The cows were sedated with xylazine and local anesthesia (procaine hydrochloride) during surgery. The surgical operations were conducted at the flank of standing cows. A transit time ultrasonic flow probe ("S" series, diameter 12 or 14 mm, Transonic Systems Inc., Ithaca, NY, USA) was fitted surgically around the uterine artery of each cow. The animals recovered rapidly following surgery. Uterine blood flow (UBF, liters/min) was recorded at 10 s intervals for 1395 min; these values were averaged to determine UBF. Cows exhibited normal gestation lengths (279.1 ± 7.4 d), gave birth to normal healthy calves (birthweight = 40.6 ± 6.6 kg), and had no retained placentas. The UBF increased significantly (P < 0.01) from d 222 (6.67 ± 2.47) to d 249 (8.23 ± 2.89) of gestation, but the latter UBF was similar to that of d 266 (8.38 ± 2.70). In contrast, UBF declined dramatically after parturition (n = 3) from d 10 (0.29 ± 0.11) to d 20 (0.11 ± 0.026) as well as on d 30 (0.055 ± 0.053). The range of UBF varied widely from 2.93 at d 222 to 13.47 at d 266 of gestation, and from 0.41 at d 10 to 0.0063 at d 30 after parturition. The increased UBF indicates increased demand of nutrients of fetus with the progress of gestation. Our method is useful for chronic measurement of UBF in cows for nutritional or physiological studies and does not require sophisticated facilities or special surgical technique.

**Key Words:** Blood flow, Uterus, Dairy cows

**1061 Metabolic response during the periparturient period of Holstein cows fed varied amounts of dietary protein prepartum.** A.F. Park\*<sup>1</sup>, J.E. Shirley<sup>1</sup>, E.C. Titgemeyer<sup>1</sup>, M.J. Meyer<sup>1</sup>, M.J. VanBaale<sup>1</sup>, and M.J. VandeHaar<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Michigan State University, East Lansing.

Multiparous Holstein cows (75) were used in a block design to determine the level of dietary protein required prepartum to support metabolic functions and enhance body reserves during the periparturient period. Cows were blocked according to expected calving date and assigned to five diets: 9.7, 11.7, 13.7, 14.7 or 16.2/% CP. Treatments were initiated 28 d prior to expected calving and fed until parturition. Cows were fed a common diet postpartum. Plasma aspartate amino transferase (AST) tended to be higher (quadratic,  $P=.12$ ) prepartum in cows fed 13.7 and 14.7/% CP, but responded linearly ( $P=.15$ ) postpartum with 9.7/% CP leading to the highest activity. AST activity increased from d 1 prepartum to d 3 postpartum by 38%. Peak AST activity occurred on d 3 postpartum for 11.7 and 16.2/% CP, and d 15 in cows fed 9.7/% CP. Prepartum urinary creatinine was not influenced by diet, but postpartum increased linearly with prepartum dietary protein ( $P<.01$ ). Plasma IGF-1 declined by 50% in all cows from d 21 pre through d 3 postpartum and did not differ among diets. Diet effects on IGF-1 during the first 90 d postpartum were primarily due to differential responses to rbST injection. There were no treatment differences for IGF-1 at 60 d postpartum (before rbST), but IGF-1 on d 90 (after rbST) was higher ( $P<.01$ ) for 14.7/% CP than for other diets except 13.7/% CP. Cows fed 13.7/% CP exhibited a lesser IGF-1 response to rbST than 14.7/% CP ( $P<.05$ ) but a greater response than 9.7 and 11.7/% CP ( $P<.01$ ). Plasma glucose was similar among treatments prepartum but lowest postpartum for 16.2/% CP and highest for 14.7/% CP (cubic,  $P<.05$ ). Plasma total alpha-amino nitrogen exhibited a linear ( $P=.09$ ) and cubic ( $P<.05$ ) response prepartum with cows fed 14.7 and 16.2/% CP having highest concentrations. Prepartum plasma urea (PUN) increased linearly ( $P<.01$ ) with dietary protein. Conversely, postpartum PUN was highest in cows fed 9.7/% CP (linear,  $P<.01$ ). Protein level in prepartum diets affects nutrient reserves.

**Key Words:** Dairy, Aspartate Amino Transferase, IGF-1

**1062 Effect of wet corn gluten feed on intake and performance during the periparturient period.** A.F. Park, M.J. Meyer, J.M. DeFrain\*, J.E. Shirley, E.C. Titgemeyer, T.T. Marston, J.F. Gleghorn, and L.E. Wankel, Kansas State University, Manhattan.

Research was conducted to determine the effect of wet corn gluten feed (WCGF) inclusion during the last 21d of gestation on dry matter intake (DMI) and postpartum performance in eight primiparous (PP) and nine multiparous (MP) Holstein cows. Animals were blocked by parity and randomly assigned to 20/% WCGF (DM basis) or control diet. Treatments were initiated 21d prior to expected parturition and fed until calving with a common diet fed through 28d postpartum. Diet CP % and energy density (Mcal/kg NEL) were 14.3, 1.48 and 13.9, 1.50 for WCGF and control, respectively. Ultrasound techniques were used to determine depth of backfat (BF) and longissimus dorsi (LD). Significance was determined at ( $P<.05$ ) and tendencies at ( $P<.15$ ). Drop in DMI during the last 9d prepartum was 8 and 16/% for MP and 23.2 and 11/% for PP cows fed WCGF and control diets, respectively. DMI and DMI as a % of BW during the last 3d pre- and first 3d postpartum were numerically higher for MP cows fed WCGF. DMI and DMI as a % of BW were numerically lower for PP cows fed WCGF during the entire study. PP cows fed WCGF had higher BW prepartum ( $P<.15$ ) with the inverse being true postpartum. MP cows fed control had higher ( $P<.15$ ) calf birth weights (35.7 versus 47.0kg). Both MP and PP cows fed WCGF prior to calving showed greater ( $P<.15$ ) depth of LD. BF was lower ( $P<.15$ ) postpartum for WCGF fed MP cows. Milk and milk components were not different for MP or PP cows except SCC was higher ( $P<.01$ ) in cows fed WCGF. Plasma glucose, urea nitrogen (PUN), and total alpha amino nitrogen (TAAN) were not different for PP or MP cows. Graphically, PUN increased and TAAN decreased for both PP and MP cows on 1d postpartum, suggesting gluconeogenesis was occurring. These results suggest WCGF has the potential to improve DMI in MP but not PP cows during the last 21d prepartum.

**Key Words:** Dairy, Periparturient, Wet Corn Gluten Feed

**1063 Transition cow: administration of glucose precursors and probiotics.** V. Dell'Orto<sup>1</sup>, A. Agazzi<sup>1</sup>, G. Mancin<sup>1</sup>, and G. Savoini\*<sup>1</sup>, <sup>1</sup>University of Milan, Italy.

In early lactating cows energy intake is not sufficient to satisfy the requirements for maintenance and milk production. To reduce the negative energy balance in transition cows, the administration of glucose precursors such as propylene glycol, glycerol and probiotics could be useful. Twenty-four multiparous Friesian cows were divided into two groups (treatment=T and control=C) on the basis of parity. All cows received the same basal diet. Starting on 3d before and continuing until 5d after calving, T cows were administered daily 500 ml of a supplement containing: propylene glycol, glycerol, 1-6 diphosphate glucose dextrose and *Saccaromyces cerevisiae*. Blood samples were collected at 2d before and 4d, and 15d after calving and subsequently analyzed for glucose, NEFA, BHBA and plasma concentration. Milk production was recorded at 4d, 7d and 15d after calving. Body Condition Score (BCS) was evaluated at 60d, and 2d before and 4d, 7d and 15d after parturition. Data were analyzed by ANOVA using the GLM procedure. Plasma NEFA concentration picked at 4d after calving in C and T cows; however no significant difference was observed between groups. Treatment did not influence plasma glucose concentration, which decreased from 2d before to 4d after calving in all cows. Milk yield was significantly higher in T cows at 4d (38.44 kg vs 35.67 kg) ( $P\leq.01$ ) and 7d (39.78 kg vs 37.44 kg) ( $P\leq.04$ ). During the dry period the BCS did not differ between groups (average=3.7). At 15d of lactation BCS tended to be higher in T cows (3.43 vs 3.25) ( $P=0.1$ ). No clinical sign of ketosis was detected in C and T groups. The administration of glucose precursors and *Saccaromyces cerevisiae* to transition cow allowed an increase of milk yield without any negative effect on NEFA, BHBA, and glucose plasma concentration.

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**Key Words:** Transition cow, Propylene glycol, Probiotics

**1064 Metabolic effects of propylene glycol in transition diets of Jersey cows.** M. Birchen\*, B.A. Fadl-Alla, M.R. Murphy, G.C. McCoy, and M.F. Hutjens, University of Illinois, Urbana.

Twenty multiparous and twenty primiparous Jersey cows were assigned (based on age, calving date, and previous production) to either control or propylene glycol-treated groups. The propylene glycol treated group was drenched with 228 grams of propylene glycol daily from 7d prior to the projected calving date to 7d postpartum. Blood was sampled 8d prior to projected calving date, every 3 to 4d days until calving, the day of calving, 7d postpartum, and 14d postpartum. Blood plasma glucose and  $\beta$ -hydroxybutyrate concentrations were measured. Dry matter intake, milk production, body condition score, body weight, and milk composition were also determined. No differences between groups for dry matter intake, milk production, milk composition, or body condition score were observed. However, body weight loss was slowed in cows drenched with propylene glycol. Blood glucose concentrations for the propylene glycol-drenched group (80 mg/dl) were significantly higher ( $P<0.0001$ ) on the day of calving than the control group (65 mg/dl). Blood glucose concentrations were numerically higher in treated cows 7d after drenching was discontinued. The level of  $\beta$ -hydroxybutyrate levels remained lower in propylene glycol-drenched animals from calving until 14d postpartum. Drenching propylene glycol can alleviate subclinical ketosis in Jersey cattle.

**Key Words:** Ketosis, Propylene glycol, Transition diet

**1065 Blood, ruminal and fecal measures of steers fed different combinations of supplemental energy and DIP while grazing winter range.** T. N. Bodine\*, H. T. Purvis II, and D. A. Cox, Oklahoma Agricultural Experiment Station, Stillwater.

Fifty-two steers (286  $\bar{n}$  7 kg initial BW) and 8 ruminally cannulated steers (496  $\bar{n}$  14 kg) were individually fed 1 of 4 supplements 5 d/week while grazing dormant native tallgrass prairie for 98 d. Supplements were: 1) CORNSBM, corn and soybean meal, balanced for total diet DIP:TDN, 2) CORN, corn and soybean hulls, equal supplemental TDN to CORNSBM, 3) SBM, soybean meal, equal supplemental DIP to CORNSBM, or 4) CONT, cottonseed hull-based control. Supplements were fed at a rate of 13, 13, 4, or .6 g DM/(kg steer BW\*feeding), respectively. Weights, fecal grab samples and blood samples were taken monthly within one hour of feeding on the fifth of five consecutive days



of feeding. Fecal samples were analyzed for pH and concentrations of N and ADF. Serum from blood samples was analyzed for urea nitrogen and insulin. Steers fed CORNSBM, CORN and SBM vs CONT-fed cattle increased ( $P=.01$ ) ADG (.77, .29, .48, .05 kg), serum insulin (3, 2.5, 2.5, 2.3 ng/dl), fecal N (2.6, 2.4, 2.3, 2%) and ruminal  $\text{NH}_3\text{-N}$  (5.2, 6.7, 9, 1.3 mg/dl). Steers fed CORNSBM had greater ( $P<.01$ ) ADG, insulin and fecal N than those fed CORN or SBM. Steers fed supplements with corn (CORNSBM, CORN) had decreased ( $P=.01$ ) ruminal pH (6.1, 6.1, 6.4, 6.4), acetate:propionate (3.6, 3.8, 4.8, 5.2) and acetate (68, 68, 73, 76%) and increased ( $P<.01$ ) propionate (19, 18, 15, 15%) than those not fed supplemental corn (SBM, CONT). Corn-fed cattle had lesser ( $P<.01$ ) fecal pH (5.7, 5.8, 6.8, 6.8) and ADF (26, 27, 38, 40%) than those steers not consuming grain. Cattle fed supplements with soybean meal (CORNSBM and SBM) had greater ( $P<.01$ ) serum urea nitrogen (11.4, 16.5, 4.9, 5.6 mg/dl) than those without soybean meal (CORN, CONT). Stocker cattle grazing dormant native range had the greatest response in animal performance and physiological measures when supplements were balanced for ruminally degradable protein and energy.

**Key Words:** Grazing Beef Cattle, Physiological Measurements, Degradable Intake Protein

**1066 Effects of hay and(or) protein supplementation with pelleted soybean hulls on growth performance of growing steers.** J.A. Shiver\*<sup>1</sup>, D.L. Lalman<sup>1</sup>, D.R. Gill<sup>1</sup>, R.L. Ball<sup>1</sup>, J.N. Carter<sup>1</sup>, W.T. Choat<sup>1</sup>, S.D. Carter<sup>1</sup>, G.W. Horn<sup>1</sup>, and T.C. Stovall<sup>1</sup>, <sup>1</sup>Oklahoma State University, Stillwater.

Seventy-eight crossbred steers (190 kg initial BW) were allotted by weight block to three dietary treatments (5 pens/trt of five steers/pen) to evaluate the effects of hay and(or) protein supplementation to a pelleted soybean hull diet. Steers were housed in 4.6 x 9.1 meter dirt floor pens with the feeding area and concrete apron covered. Cattle were weighed prior to feeding every twenty eight days to determine average daily gain(ADG). Feed intake and feed refusals were recorded daily. Dietary treatments were: 1) ad libitum access to soybean hulls (CON), 2) CON plus .9 kg /hd/day supplement (TRT2), and 3) TRT2 plus .68 kg/hd/day long stem prairie hay (5.7% CP, 69.3% NDF and 40.9%ADF, DM basis)(TRT3). Soybean hulls contained 9.6% CP, 63.4%NDF and 48.7% ADF, DM basis. Protein requirement was estimated assuming 1.11 kg weight gain per day using 1996 National Research Council feed energy values. Protein supplement was formulated using a blend of soybean meal, cottonseed meal, wheat middlings, and vitamins and minerals, it contained 32% CP. Daily weight gain, feed DMI and G:F was .96, 1.11, 1.23 kg; 6.7, 7.25, 7.61 kg; and .165, .164, .144 for CON, TRT2 and TRT3, respectively. Daily gain was increased by addition of supplement and hay ( $P<.01$ ). Feed intake was similar when supplement was fed but increased ( $P=.02$ )when hay was fed. Total diet feed efficiency was not improved with supplement and decreased ( $P<.01$ ) when hay was fed. Protein content of soybean hulls fed in this study were not sufficient to meet the requirements of growing steers gaining over 1 kg per day. These results demonstrate the potential for increased growth performance when feeding ad libitum soybean hulls with the addition of a protein supplement and long stem prairie hay to growing steers.

**Key Words:** Soybean Hull, Ad Libitum, Growing Steers

**1067 Relative efficiency of 40 or 160 g of moderate or high undegradable intake protein supplements with low quality forage diets.** J. E. Sawyer\*, C. C. Rasor, R. C. Waterman, and M. K. Petersen, *New Mexico State University, Las Cruces, NM USA.*

A study comparing the relative efficiency of supplement utilization among different amounts of two protein sources, based on in situ forage DM disappearance, ruminal  $\text{NH}_3$  and serum urea nitrogen (SUN) accumulation, serum glucose, and nitrogen (N) concentration in duodenal contents, was conducted using a 4X4 Latin Square. Four dually cannulated steers were restricted to 6.8 kg/d sudan hay (3.7% CP) in addition to 56 g salt-mineral (CON), CON+40 g CP from cottonseed meal (LCS), CON+160 g CP from cottonseed meal (HCS) or CON+40 g CP from a blood and feather meal combination (BFM) during 14 d periods. In situ DM disappearance after 24 h was greater in supplemented animals ( $P<.1$ ), but was similar for BFM compared to HCS or LCS ( $P>.2$ ). Disappearance was 35.4, 39.5, 37.3 and  $37.2\pm 1.1\%$  for

CON, HCS, LCS, and BFM. Ruminal ammonia concentrations were influenced by supplementation ( $P<.05$ ). HCS induced greater ruminal ammonia accumulation than BFM ( $P<.01$ ) while BFM and LCS resulted in similar ammonia concentrations ( $P>.2$ ). Serum urea nitrogen concentrations followed a trend reflecting ruminal ammonia. SUN was influenced by supplementation ( $P<.01$ ), with HCS increasing SUN more than BFM ( $P<.02$ ) and LCS and BFM exerting similar effects ( $P>.4$ ). Serum glucose concentrations were increased with protein supplementation ( $P<.01$ ) but did not differ among supplemental treatments ( $P>.2$ ), indicating that more gluconeogenic precursors were available when additional protein was provided. Concentration of N in duodenal contents was increased by supplementation ( $P=.06$ ), with no statistical difference observed between supplements ( $P>.4$ ). Nitrogen concentrations in duodenal contents (mg N/g wet contents) were .69, .87, .79, and  $.86\pm .055$  for CON, HCS, LCS, and BFM. In conclusion, 40 g of protein supplement improved utilization of low quality forages. The marginal response to an additional 120 g of protein was diminished. These data suggest that due to improved efficiency, low levels of supplement may be as effective as higher amounts when fed with low quality forages.

**Key Words:** protein, supplementation, efficiency

**1068 Effects of supplementation of limit-fed growing diets with either soybean meal or non-enzymatically browned soybean meal on steer performance.** C. M. Coetzer\*, J. S. Drouillard, S. P. Montgomery, T. B. Farran, J. J. Sindt, A. M. Trater, H. J. LaBrune, R. D. Hunter, and T. A. Nutsch, *Kansas State University, Manhattan.*

Eighty individually fed Angus x Hereford steers (295 kg) were used to evaluate the effects of supplementing limit-fed, wheat middling or soybean hull-based diets with either soybean meal (SBM) or non-enzymatically browned soybean meal (NSBM) on growing steer performance. Steers were stratified by weight and randomly allotted, within strata, to one of ten treatments. The CP content of a wheat middling-based control diet (16.0% CP) was increased by 2.6 and 5.2 percentage units using SBM or NSBM to make up the first five treatments. The CP content of a soybean hull-based control diet (15.6% CP) was increased by 2.6 and 5.2 percentage units using SBM or NSBM to make up the remaining five treatments. Steers were fed once daily for 84 days at 1.8% of BW. Data were analyzed by regression using supplementation level as a continuous variable, nested within supplement source (SBM or NSBM). Average daily gain and efficiency did not change with increasing level of SBM among the wheat middling-based diets. However, gain and efficiency increased linearly ( $P<0.05$ ) with increasing level of NSBM ( $\text{ADG}=.992 - .00398(\text{increase in \% CP from SBM}) + .0197(\text{increase in \% CP from NSBM}); \text{gain:feed}=.166 - .000659(\text{increase in \% CP from SBM}) + .00325(\text{increase in \% CP from NSBM})$ ). Average daily gain and efficiency increased ( $P<0.05$ ) when the CP content of the soybean hull-based control diet was increased by 2.6 percentage units using SBM or NSBM. However, increasing the CP content by 5.2 percentage units did not further increase performance. Supplementation with NSBM, but not SBM, improved performance of growing steers fed restricted amounts of wheat middling-based diets. These data suggest that undegraded intake protein may be first limiting in high-concentrate, limit-fed growing diets composed of wheat middlings.

**Key Words:** Non-enzymatically Browned Soybean Meal, Limit-Feeding, Beef Cattle

**1069 Evaluation of performance in receiving heifers fed different sources of dietary lipids.** T.B. Farran, J.S. Drouillard, D.A. Blasi, H.J. LaBrune, S.P. Montgomery, J.J. Sindt, C.M. Coetzer, R.D. Hunter, T.A. Nutsch, and J.J. Higgins, *Kansas State University, Manhattan.*

High stress crossbred beef heifers (n=501, 201 kg) of Southeast origin were used in a 35-d receiving trial to evaluate average daily gain, feed intake, and efficiency when fed diets containing different sources of lipid. Cattle were provided grass hay and water on arrival and were processed within 24 h. Cattle were implanted, vaccinated against common viral and clostridial diseases, treated for internal and external parasites, and given a metaphylactic dose of tilmicosin (0.33 ml/kg BW) at processing. Heifers were individually weighed and randomly assigned to pens containing six to seven animals with twenty-six pens per treatment. Treatments consisted of diets containing different lipid sources by adding ground flaxseed (FLX), rolled full-fat soybeans (SOY), and

tallow (TAL) at 13, 20, and 4%, respectively (DM basis). Heifers were revaccinated, weighed, and rectal temperatures were recorded on d 7. ADG for the first seven days was greater ( $P < 0.01$ ) for FLX and TAL than for SOY (0.71, 0.58, 0.11 kg/d for FLX, TAL, and SOY, respectively). The reduction in mean rectal temperature by d 7 was greater for FLX ( $P < 0.05$ ) and SOY ( $P = 0.10$ ) compared to TAL, but SOY and FLX were not different ( $P > 0.50$ ). ADG for the 35-d receiving period were 1.24, 1.14, 0.88 kg/d and gain efficiencies were 0.257, 0.241, and 0.207 kg gain/kg DM for FLX, TAL, SOY, respectively. ADG and DM intake were greater ( $P < 0.01$ ) for FLX and TAL compared to SOY. Gain efficiency also was greater for FLX ( $P < 0.01$ ) and TAL ( $P = 0.07$ ) compared to SOY. Manipulating diets to contain different lipid sources may alter performance in highly stressed receiving cattle.

**Key Words:** Receiving cattle, Lipids

**1070 Bloodmeal increases performance of early-weaned calves late in the growing phase.** J. W. Lehmkuhler\*<sup>1</sup> and M. S. Kerley<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia.

Increasing the post-ruminal flow of amino acids was hypothesized to improve the performance and efficiency of early-weaned steer calves. Thirty-six crossbred steers were weaned at an average of 114 d (avg. wt. = 161 kg) and blocked by age. Steers were implanted with Revelor-S<sup>®</sup>, dewormed, and vaccinated with a four-way modified live vaccine on d 0 and reimplanted on d 113. Treatments were randomly assigned to 12 pens (3 steers/pen). Treatments tested were the replacement of corn with bloodmeal (BM) at 0, 5, 10, or 15% on a DM basis. The 0% diet consisted of 52.2% corn, 15% corn silage, 20% soybean hulls, 10% soybean meal, and 2.8% mineral/vitamin mix on a DM basis. Diets were sampled weekly and analyzed for DM, CP, ADF, and ash. Diets averaged 70% DM and 6% ash while CP for the treatments was 14.2%, 19.6%, 24.9%, and 31.1% for 0, 5, 10, and 15% BM, respectively. The study lasted 181 d and steers (474 kg) were shipped to a commercial slaughtering facility at an average age of 10 months. Steers yielded an average 293 kg hot carcass with 1.3 cm backfat, 76.1 cm<sup>2</sup> ribeye area, 3.3% kidney, pelvic, and heart fat, yield grade 2.8, and average to high select quality grade. The overall average DMI was lower ( $P < .05$ ) for 10% and 15% BM (8.6 and 8.2 kg) compared to 0% and 5% (9.3 and 9.2 kg). ADG was greater ( $P < .05$ ) for the 5% BM group at 1.9 kg than the other treatments (1.8 kg) for the entire study. Differences in ADG were found to be greater the last 67 d. Inclusion of 5% BM improved gain ( $P < .05$ ) compared to the control diet by 12.7% during the last 67 d. No differences in ADG were noted between treatments early in the study. Overall feed efficiencies were similar ranging from 4.6-5.3. Calculated efficiency of NEg utilization was improved 12% by the addition of 5% BM and 16% for 15% BM compared to the 0% diet. Increasing the amount of amino acids available at the small intestine via BM improved performance and efficiency of early-weaned calves late in the growing phase. We inferred that post-ruminal amino acid supply for finishing cattle is limiting on traditional diets.

**Key Words:** Undegradable intake protein, Cattle, Early-wean

**1071 Effects of feeding fat and normal vs. high oleic acid soybeans on feedlot steer performance and carcass characteristics.** E. E. D. Felton\*<sup>1</sup>, C. L. Lorenzen<sup>1</sup>, M. S. Kerley<sup>1</sup>, S. D. Soderlund<sup>2</sup>, and F. N. Owens<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Optimum Quality Grains, Des Moines, IA.

A 76d study was conducted to determine whether vegetable or animal fat would have an influence on improving feedlot steer performance. Whole raw soybeans, bin-run (NORM) or high oleic acid content (HO) were also compared for their effects on steer performance. Angus-crossbred steers ( $n = 72$ ) were randomly allotted to treatments (initial wt = 443.58 ± 1.00 kg) with 6 steers/pen. Dietary treatments were a control (T1), NORM replacing all soybean meal (SBM) (T2), HO replacing all SBM (T3), and the control diet plus addition of choice white grease equal to the EE of the soybean containing rations (T4). All diets were isonitrogenous and contained equal amounts of corn silage, soyhulls, limestone, NaCl, trace-mineral and vitamin premixes, Rumensin<sup>®</sup> and Tylan<sup>®</sup>. No differences ( $P > .05$ ) were observed in total weight gain (130 kg), ADG (1.7 kg/d) or hot carcass weight (347 kg). Likewise, no statistical differences ( $P > .05$ ) were detected in ribeye area (79.42 cm<sup>2</sup>), tenth rib backfat (13.2 mm), yield grade (3.3) or % boneless retail cuts (48.76). Linear contrasts revealed differences ( $P < .05$ ) in feed to gain (T1-8.02, T2-7.54, T3-7.41 & T4-7.23) and marbling (T1-slight<sup>66</sup>, T2-slight<sup>92</sup>, T3-slight<sup>91</sup>

& T4-slight<sup>90</sup>) with the addition of fat (8.02 vs. 7.39 and slight<sup>66</sup> vs. slight<sup>91</sup>, respectively for control vs. fat). Source of fat had no effect ( $P > .10$ ) on any parameters measured. We inferred that the addition of vegetable or animal fat to the diets of finishing steers can improve feed efficiency and marbling. These data further suggested that the performance of steers consuming diets containing genetically modified soybeans is unhindered.

**Key Words:** Soybeans, Fat, Cattle

**1072 Influence of dietary starch source on fatty acid synthesis and the expression of fat metabolism genes in bovine adipose tissue.** E. Okine\*<sup>1</sup>, D. R. Gimm<sup>2</sup>, G. R. Khorasani<sup>2</sup>, and J. J. Kennelly<sup>2</sup>, <sup>1</sup>Western Forage/Beef Group, Lacombe, AB, Canada, <sup>2</sup>University of Alberta, Edmonton, AB, Canada.

The hypothesis of this study was that different sources of dietary starch with different ruminal rates of degradation would influence parameters of fat metabolism and the fatty acid composition of bovine adipose tissue (BAT). We evaluated the expression of fatty acid synthase (FAS) and acetyl-CoA carboxylase (ACC) genes, the abundance of their respective proteins, and characterized the fatty acid composition of adipose tissue. Four barley grain varieties (Brier, Candle, Noble, and Oxbow) were compared to a corn grain. The ruminal rate of dry matter degradation for the Brier, Candle, Noble, and Oxbow barley varieties, and corn were 33.9, 29.0, 48.6, 47.9, and 6.5% per hour, respectively. Five Holstein heifers (456 ± 8.0 kg) were fed diets containing 35% barley silage and 65% concentrate in a 5 × 5 Latin square design experiment. The barley diets contained 59% barley grain and the corn-based diet contained 51% corn to achieve similar starch contents. Dry matter intake tended to be higher for heifers fed the corn diet (10.6 kg/d) compared to the Brier barley variety (7.7 kg/d, ( $P = 0.09$ ), but did not differ among the other dietary treatments. The concentration of C<sub>14:0</sub> fatty acid in BAT was 8% ( $P < 0.05$ ) higher for heifers fed the Brier variety of barley compared to the corn diet, but did not differ among the other dietary treatments. Dietary starch source had no effect on the abundance of ACC protein and mRNA in adipose tissue. However, the abundance of the FAS protein was about 3 times ( $P < 0.05$ ) higher in adipose tissue of heifers fed Brier compared to the Oxbow variety. The expression of FAS mRNA was ( $P < 0.05$ ) higher in adipose tissue of heifers fed diets with Candle and Noble barley varieties compared to the Oxbow variety. We conclude that different sources of dietary starch may affect fat metabolism in bovine adipose tissue through influences on gene expression and FAS enzyme kinetics.

**Key Words:** Starch Source, Adipose Tissue, Fatty Acid Synthesis

**1073 Effect of management strategy on average daily gain, carcass traits, and fatty acid composition in longissimus muscle of finishing steers.** L. F. Laborde, I. B. Mandell\*, J. J. Tosh, J. G. Buchanan-Smith, and J. W. Wilton, University of Guelph, Ontario, Canada.

The objective of this study was to evaluate the effect of management strategy on performance, carcass characteristics, and fatty acid composition of total lipids (TL) and phospholipids (PHL) from longissimus muscle in crossbred steers ( $n = 136$ ) sired from either Angus or Simmental bulls. Weaned cattle were finished under one of two management strategies: 1) high grain finishing with a 77% corn, 15% alfalfa silage diet fed ad libitum until slaughter (HG); and 2) backgrounding with a 100% alfalfa silage diet fed at 1.9% of BW for 112 d followed by feeding the HG diet ad libitum until slaughter (BKG). Data were adjusted to a 10-mm backfat (grade fat) endpoint in statistical analyses. Steers on the BKG regime spent 64 more ( $P < .001$ ) days on feed but had lower ( $P < .001$ ) average daily gain and smaller ( $P = .01$ ) longissimus muscle area as compared to steers on the HG strategy. Management strategy did not affect ( $P > .15$ ) weights at slaughter, intramuscular fat percentage, and subjective marbling score. For TL, backgrounding decreased ( $P < .05$ ) concentrations of myristic acid, stearic acid, and total saturated fatty acids (SFA), and increased ( $P < .05$ ) total monounsaturated fatty acids (MUFA) and conjugated linoleic acid (CLA) when compared to steers on the HG regime. For both TL and PHL, backgrounded cattle had lower ( $P < .05$ ) concentrations of linoleic acid, arachidonic acid, and total omega-6 ( $\omega 6$ ) polyunsaturated fatty acids (PUFA), higher ( $P < .001$ ) percentages of individual and total omega-3 ( $\omega 3$ ) PUFA, and lower ( $P < .001$ )  $\omega 6$ :  $\omega 3$  ratio, than steers directly placed on grain after weaning. Backgrounding increased deposition of MUFA,  $\omega 3$  PUFA and

CLA, desirable for promoting human health, while decreasing deposition of less desired SFA and  $\omega$ 6 PUFA.

**Key Words:** Beef Cattle, Backgrounding, Fatty Acids

**1074 Effect of method of diet adaptation on animal performance and carcass characteristics of beef steers.** W.T. Choat<sup>1</sup>, M.S. Brown<sup>2</sup>, C.R. Krehbiel<sup>\*1</sup>, G.C. Duff<sup>3</sup>, D.A. Walker<sup>3</sup>, K.J. Malcolm-Callis<sup>3</sup>, and M.W. Wiseman<sup>3</sup>, <sup>1</sup>Oklahoma State University, Stillwater, <sup>2</sup>West Texas A&M University, Canyon, <sup>3</sup>Clayton Livestock Research Center, Clayton, NM.

Seventy-three Angus x Hereford steers ( $415 \pm 64$  kg) were used in a completely random design to determine the effects of method of high-concentrate diet adaptation on animal performance and carcass characteristics during a 70-d feeding period. Conventional steers ( $n = 4$  pens; 9 or 10 steers/pen) were adapted to a 90% concentrate diet using five adaptation diets of 70, 75, 80, 85, and 90% concentrate. Steers were fed each diet for five d until adapted to the 90% concentrate diet. Initial level of intake was set at 2% of BW (as-fed basis) and increased .45 kg/steer when a slick bunk was evident. Restricted steers ( $n = 4$  pens; 9 steers/pen) were adapted using the 90% concentrate diet; initial level of intake was set at 0.5% of BW (as-fed basis), and increased 0.23 kg/steer when a slick bunk was evident. Steers were weighed (unshrunk) and period DMI was calculated on d 14, 28, 56, and 70. Overall ADG was calculated from BW on d 0 and 70 and reduced 4% for gastrointestinal fill. Overall ADG did not differ ( $P=.21$ ) due to starting method ( $1.81$  vs  $1.73 \pm .06$  kg/d, respectively), although DMI from d 0 through 70 was increased ( $P<.05$ ) for conventional steers compared with restricted steers. Overall, ADG:DMI was 5.1% greater ( $P=.09$ ) for restricted steers (.178) than for conventional steers (.169). Although final BW did not differ ( $564$  vs  $559 \pm 6$  kg), conventional steers had increased ( $P=.04$ ) hot carcass weights ( $343$  vs  $335 \pm 2$  kg) and greater ( $P=.04$ ) internal fat ( $2.26$  vs  $2.13 \pm .04\%$ ) than restricted steers. During adaptation to a high-concentrate diet, our data suggest more efficient conversion of feed to gain and less internal fat by restricting intake of a high-concentrate diet compared with the traditional altering of forage:concentrate.

**Key Words:** High Grain, Cattle, Diet Adaptation

**1075 Effects of previous grazing on feedlot cattle performance and carcass characteristics.** W.T. Choat<sup>\*1</sup>, C.R. Krehbiel<sup>1</sup>, G.C. Duff<sup>2</sup>, R.E. Kirksey<sup>3</sup>, D.A. Walker<sup>2</sup>, K.J. Malcolm-Callis<sup>2</sup>, M.W. Wiseman<sup>2</sup>, L.M. Lauriault<sup>3</sup>, and G.B. Donart<sup>4</sup>, <sup>1</sup>Oklahoma State University, Stillwater, <sup>2</sup>Clayton Livestock Research Center, Clayton, NM, <sup>3</sup>Agricultural Science Center, Tucumcari, NM, <sup>4</sup>New Mexico State University, Las Cruces.

The effects of winter grazing on gain, subsequent finishing performance, and carcass characteristics of 67 crossbred steers ( $231$  kg  $\pm$  21 kg) were evaluated in a completely random design. At weaning, steers were stratified by weight and allotted randomly to graze either winter wheat (WW; 43 steers) or dormant native range (NR; 24 steers). On May 10, 1999 steers were placed in a feedlot and assigned randomly (within previous treatment) to three (NR) or four (WW) pens. Steers were adapted to a 90% concentrate diet using 5 adaptation diets. Steers were fed each diet for 5 d until adapted to the 90% concentrate diet. Initial intake was set at 2% of BW (as-fed basis) and was increased .45 kg/steer when a slick bunk was evident. Steers which had grazed WW were fed for 70 d, whereas steers which grazed NR were fed for 126 d. Steers were weighed individually and period DMI was calculated for d 14, 28, 56, 70(wheat), 84, 112, and 126. During winter grazing, WW and NR grazed steers gained  $1.05$  and  $.32$  kg/d, respectively. During finishing, overall ADG ( $1.92$  vs  $1.81 \pm .064$  kg/d) and feed:gain ( $4.54$  vs  $6.36 \pm .21$ ) favored ( $P<.05$ ) steers which had grazed NR compared with steers which had grazed WW. Steers grazed on WW and NR yielded 88.4% and 87.5% U.S. choice carcasses, respectively. Hot carcass weight was not different ( $P>.10$ ), but steers grazed on WW had higher ( $P<.05$ ) marbling scores ( $480$  vs  $440$ ), less subcutaneous fat ( $1.3$  vs  $1.7$  cm), larger longissimus area ( $78$  vs  $74$  cm<sup>2</sup>), greater internal fat ( $2.26$  vs  $1.92\%$ ), and a lower numerical yield grade ( $3.25$  vs  $3.61$ ) than steers grazed on NR. Although compensatory growth occurs for steers wintered on NR, growing steers on WW prior to finishing results in more favorable carcass traits.

**Key Words:** Winter Wheat, Dormant Forage, Carcass Traits

**1076 Influence of previously grazed winter wheat or native range on nutrient digestion by growing bovine being adapted to a 90% concentrate diet.** W.T. Choat<sup>\*1</sup>, C.R. Krehbiel<sup>1</sup>, G.C. Duff<sup>2</sup>, J.D. Rivera<sup>2</sup>, D.A. Walker<sup>2</sup>, K.J. Malcolm-Callis<sup>2</sup>, M.W. Wiseman<sup>2</sup>, and B.J. Summers<sup>1</sup>, <sup>1</sup>Oklahoma State University, Stillwater, <sup>2</sup>Clayton Livestock Research Center, Clayton, NM.

Eight ruminally cannulated steers which had previously grazed winter wheat (WW;  $n = 4$ ; initial BW =  $407 \pm 12$  kg) or dormant native range (NR;  $n = 4$ ; initial BW =  $293 \pm 23$  kg) were used to determine intake, digesta kinetics, and total tract digestion while being adapted to a 90% concentrate diet. The adaptation included a series of 5 diets of 70, 75, 80, 85, and 90% concentrate. Steers were fed each diet for 5 d until adapted to the 90% concentrate diet. Chromic oxide (15g/d) was dosed ruminally (0730) via gelatin capsules as an indigestible marker of digesta flow throughout the 30-d experiment. Fecal grab samples were collected daily on d 7 through 10, 17 through 20, and 27 through 30. On d 5, 15, and 25, steers were dosed intraruminally at 0730 with 200 mL of Co-EDTA. Ruminal fluid samples were obtained at 0, 3, 6, 9, 12, 18, and 24 h after dosing. Ruminal contents were removed, weighed, subsampled, and returned to the rumen on d 17 and 27. Throughout the adaptation period, DMI (g/kg of BW) was greater ( $P<.05$ ) for steers that grazed NR compared with WW. In addition, total tract OM, starch, ADF, and N digestibilities were greater ( $P<.05$ ) for steers which had grazed NR compared with WW while consuming the 75% concentrate diet. No differences in total tract digestibilities were observed ( $P>.10$ ) when steers were consuming 85 or 90% concentrate. Ruminal liquid and DM fill (g/kg of BW) were numerically greater ( $P>.10$ ) when steers were consuming 80% concentrate, and were greater ( $P<.05$ ) when steers were consuming 90% concentrate for steers grazed on NR vs WW. Fluid passage rate generally did not differ among treatments. Improved total tract digestibility of nutrients early in the finishing period, partially attributable to greater ruminal volume, might result in a compensatory growth response by steers grazed previously on low-quality compared with high-quality forage.

**Key Words:** Cattle, High Grain Diets, Digestibility

**1077 Effect of animal grouping on feeding behavior and intake of dairy cattle.** R. J. Grant<sup>\*1</sup> and J. L. Albright<sup>2</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Purdue University, West Lafayette, IN.

Dry matter intake is the major factor influencing milk production and energy balance during lactation. Grouping strategy and subsequent group feeding behavior that influence dry matter intake have a potentially tremendous impact on cow productivity and farm profitability. The design of the feeding system, feeding management, and dietary formulations must recognize the dynamic nature of dairy cow psychology and physiology, nutrient requirements, and variability in feedstuff composition. Improperly grouping dairy cows perturbs the normal behavioral routines and time budgets. Grouping should not only minimize negative social interactions, but proper grouping strategy will also decrease within-group variation and increase across-group variation. A more homogeneous group of cows makes proper ration formulation easier. Feeding behavior has a substantial impact on dry matter intake, particularly for the transition cow. The transition cow is especially vulnerable to excessive competition for feed and other resources. Although feeding behavior is controlled by gut fill and chemostatic mechanisms, intake is modulated by management factors such as grouping strategy which interacts with feeding and housing facilities.

**Key Words:** Feeding behavior, Dry matter intake, Dairy cattle

**1078 Relationships of body weight and condition of Holstein cows with performance traits during the periparturient period.** A.F. Park<sup>\*</sup>, J.E. Shirley, M.J. Meyer, M.J. VanBaale, and E.C. Titgemeyer, Kansas State University, Manhattan.

This data was from a study evaluating amount of prepartum dietary protein on pre- and postpartum performance of dairy cows (75). Trial groups were balanced for bodyweight (BW), body condition score (BCS), and previous lactation milk yield (PMY). Initial BCS, BW, and PMY were not different among groups and averaged 2.91 (range 2.25 to 4.5), 670 kg (range of 520 to 875), and 10,843 kg (range 7,721 to 14,017), respectively. Measurements were initiated 28 d prior to expected calving date and a common diet fed postpartum. The relationships of BW

and BCS with individual cow data, irrespective of parturient diet, were evaluated due to their significant impact on cow data during this period. The mixed procedure of SAS was used for analyzing responses to dietary treatments with initial BCS, BW, and PMY included as covariates with significance at ( $P < .05$ ) required for covariates to be retained in the model. The BW of cows at the initiation of study (28 d pre-calving) was related positively to pre- and postpartum DMI ( $P < .01$ ). However, cows with the highest initial BW experienced the largest intake drop during the last 3 d prior to calving ( $P < .05$ ). Conversely, initial BCS was related negatively to pre- and postpartum DMI ( $P < .01$ ), but BCS was not related to the magnitude of the drop in DMI observed prepartum. Pre- and postpartum energy balances were related negatively to initial BCS ( $P < .01$ ). Initial BW was related positively ( $P < .01$ ) to milk yield, peak milk yield, kg milk/kg DMI, kg lactose, kg SNF, and kg milk fat during the first 90 d postpartum, but negatively ( $P < .01$ ) to kg milk protein. Initial BCS was related negatively ( $P < .05$ ) to milk yield, kg milk fat, kg milk protein, kg lactose, SNF percent and yield, peak milk yield, and days to peak milk. Initial BW and BCS significantly influenced the performance of Holstein cows. In general, BW was related positively, and BCS negatively, to production; these relationships appeared to be mediated primarily through their impacts on feed intake.

**Key Words:** Body Condition, Dairy, Periparturient Period

**1079 Liver metabolism and production of periparturient dairy cattle fed rumen-protected choline.** M. S. Piepenbrink\* and T. R. Overton, *Cornell University, Ithaca, NY.*

Forty-eight Holstein cows entering second or greater lactation were used to determine whether liver metabolism and production are affected by supplementation with choline during the periparturient period. Cows were fed common closeup dry and lactating TMR topdressed with either 0, 45, 60, or 75 g/d of rumen-protected choline (RPC; Reashure™ choline, Balchem Corporation, Slate Hill, NY) from 21 d before expected calving until 63 d after calving. Liver samples were obtained via biopsy before assignment to treatment, and 1 and 21 d after calving, and used for metabolic incubations and compositional analysis. Rates of conversion of [ $^{14}$ C]palmitate to  $CO_2$  were not affected by treatment (80, 76, 69, 75 nmoles/(hour x g wet weight);  $P > 0.15$ ). Rates of conversion of [ $^{14}$ C]palmitate to intracellular esterified products decreased linearly with RPC supplementation (343, 343, 300, 282 nmoles/(hour x g wet weight);  $P < 0.02$ ). Liver content of total lipid was not affected by RPC supplementation (9.9, 10.6, 8.3, 8.2 % of wet weight;  $P > 0.15$ ); however, liver glycogen content increased linearly as cows were fed increasing amounts of RPC (0.79, 0.81, 1.12, and 1.40 % of wet weight;  $P < 0.02$ ). Neither prepartum (12.8, 12.0, 12.9, 12.5 kg/d) nor postpartum (18.4, 18.9, 18.3, 18.7 kg/d) dry matter intake was affected by treatment. Yield of milk (39.4, 43.5, 40.2, 41.1 kg/d) and percentages of fat (4.04, 4.22, 3.97, 4.29 %) and protein (2.98, 3.02, 3.00, 3.07 %) were not affected by treatment; however, yield of 3.5% fat-corrected milk (42.4, 47.9, 42.7, 45.6 kg/d) tended ( $P < 0.12$ ) to be increased by RPC supplementation. These data suggest that hepatic fatty acid metabolism is sensitive to supply of choline during the periparturient period. Further research is required to determine whether choline supplementation during the periparturient period affects the rate of export of fatty acids from liver as lipoprotein triglycerides.

**Key Words:** Choline, Liver, Dairy Cow

**1080 Splanchnic metabolism in transition dairy cows.** C. K. Reynolds\*, P. C. Aikman, D. J. Humphries, and D. E. Beever, *University of Reading, Reading, UK.*

Splanchnic metabolism was measured in 4 multiparous, catheterized, rumen cannulated Holstein x Friesian cows in late gestation and early lactation. From at least 6 wk before expected calving date (CD) cows were fed a grass-silage based gestation TMR for BW (756 kg) stasis plus a maize-silage based lactation TMR at 2 kg DM/d beginning 10 d before expected CD. After calving lactation TMR incrementally replaced gestation TMR and was fed at ad libitum DMI. Cows were fed daily rations in equal meals provided at 8-h intervals. Hourly measurements (8) of splanchnic (portal-drained viscera [PDV] and liver [LIV]) blood flow (BF, L/h) and net nutrient flux (mmol/h) were obtained (on average) at 19 and 11 d before and 11, 22, 33 and 83 d after CD. For tabular data shown rates increased ( $P < 0.01$ ) after calving. After calving splanchnic BF and oxygen use more than doubled, with much of the increase within 11 d. Net PDV absorption of nutrients (e.g. lactate)

increased more gradually, reflecting increases in DMI. This suggests factors additional to intake contribute to the regulation of splanchnic BF and oxidative metabolism in postpartum dairy cows.

Day from CD...	-19	-11	11	22	33	83	SEM
DMI, kg/d	9.7	9.8	14.1	16.9	19.4	21.8	0.9
Milk yield, kg/d	-	-	36.3	41.9	44.0	41.0	1.3
PDV BF	944	1009	1675	1620	1667	2040	153
PDV oxygen	-1504	-1452	-2390	-2494	-2911	-3900	285
PDV lactate	99	93	133	177	200	205	24
PDV BHBA	143	131	171	191	251	289	31
LIV BF	1120	1140	2099	2139	2098	2408	125
LIV oxygen	-1473	-1619	-3159	-3336	-3454	-4092	230
LIV glucose	291	314	639	760	810	845	57
LIV lactate	-92	-128	-268	-238	-229	-143	35
LIV BHBA	142	157	398	309	429	247	68

**Key Words:** Splanchnic, Cows, Transition

**1081 Visceral tissue mass in transition dairy cows.** C. K. Reynolds\*, B. Durst, D. J. Humphries, B. Lupoli, A. K. Jones, R. H. Phipps, and D. E. Beever, *University of Reading, Reading, UK.*

Visceral tissue mass was measured in 36 Holstein x Friesian cows in late gestation and early lactation. For 6 wk before expected calving date (ECD) cows were fed a grass-silage based gestation TMR for BW (671 kg) stasis plus a maize-silage based lactation TMR (2 kg DM/d) beginning 7 d before ECD. Three groups (12 cows each) received no supplement, supplemental barley (800 g/d) or supplemental rumen-protected soybean meal (750 g/d) from 6 wk before ECD until calving. Three cows from each treatment group were slaughtered at 21 and 7 d before ECD and 10 and 22 d after calving and the wet weight of visceral tissues measured. In addition, cranial sac rumen papillae were excised from a 2.54 cm<sup>2</sup> ventral area and digitally analyzed. At d -21, -7, 10 and 22 DMI was 11.5, 12.3, 11.6 and 16.0 (SEM 0.7) kg/d, respectively. Milk yield at d 10 and 22 was 26.6 and 31.9 (SEM 1.3) kg/d, respectively. Supplements had no effect on visceral tissue mass ( $P > 0.14$ ). Most tabular data are mass (kg) before or after calving. There were no effects of transition on length, width or surface area of rumen papillae, but total tissue mass increased after calving. Weights of the reticulo-rumen, intestines and liver also increased, but largely on day 22 after DMI increased.

Day of study...	-21	-7	10	22	SEM	$P <$
Reticulo-rumen	12.2	11.8	12.3	14.2	0.5	0.02
Stomach	21.3	20.4	21.4	22.2	0.7	0.43
Small intestine	8.9	8.1	8.6	9.5	0.2	0.01
Large intestine	4.9	4.5	4.6	5.9	0.4	0.06
Liver	9.0	8.8	8.8	9.6	0.3	0.10
Spleen, g	1027	1050	940	836	65	0.10
Mesenteric fat	6.2	5.7	5.1	4.3	0.4	0.04
Omental fat	10.9	12.4	10.9	9.3	1.2	0.40
Papillae number/cm <sup>2</sup>	31	37	32	27	3	0.15
Papillae mass, g/cm <sup>2</sup>	2.5	2.8	3.4	3.9	0.3	0.02

**Key Words:** Viscera, Cows, Transition

**1082 Effects of high and low concentrations of UIP fed prepartum on postpartum production and health of Holstein cows during heat stress.** M. L. Scott\*<sup>1</sup> and W. B. Tucker<sup>1</sup>, <sup>1</sup>*Mississippi State University, Mississippi State.*

Our objective was to evaluate the effects of feeding high or low concentrations of UIP to thermally stressed dry cows on subsequent lactational performance and health. Forty-two Holsteins were assigned to two treatments based upon expected calving date and mature equivalent milk yield. Treatments were diets containing low or high UIP (32% or 40% of diet dry matter; Trt 1 and Trt 2, respectively). Diets were fed from 3 wk prior to expected parturition until parturition. Thereafter, all cows received the same total mixed ration for 90 days postpartum.

Feed intake was measured daily throughout the study. Blood samples were collected weekly from 3 wk prepartum until 90 d postpartum. Neither daily actual milk yield ( $30.7 \pm 3.25$  and  $30.9 \pm 3.1$  kg for Trt 1 and 2) nor daily dry matter intake ( $14.3 \pm 1.32$  and  $15.4 \pm 1.24$  kg for Trt 1 and 2) during lactation were affected by the UIP concentration of the diet fed prepartum. However, cows fed high UIP prepartum tended to produce more milk from wk 10 to wk 13 postpartum than did cows on Trt 1. Postpartum serum calcium and blood urea nitrogen concentrations were not affected by the diet fed prepartum, although blood urea nitrogen increased throughout the postpartum period for both treatments.

**Key Words:** Dairy cow, Heat stress, Bypass protein

**1083 Prepartum energy and protein intake of dairy cows. 1. Effect on pre- and post-parturient performance.** L. Doepel<sup>\*1</sup>, H. Lapierre<sup>2</sup>, and J.J. Kennelly<sup>1</sup>, <sup>1</sup>University of Alberta, Edmonton, Canada, <sup>2</sup>Dairy and Swine R & D Centre, Lennoxville, Canada.

Twenty-six multiparous Holstein cows were used to examine the effects of prepartum energy and protein intake on periparturient performance. Two levels of energy, 1.61 Mcal/kg NE<sub>L</sub> (HE) and 1.27 Mcal/kg NE<sub>L</sub> (LE), and two levels of protein, 16.3% CP (HP) and 11.1% CP (LP), were tested according to a factorial arrangement in a randomized block design. Treatments began 21 days before expected calving date. After calving, all cows were fed a single diet (1.79 Mcal/kg NE<sub>L</sub> and 18.7% CP). Cows on the LEHP treatment had a larger drop in intake at calving than cows on the other treatments (energy by protein by period interaction,  $P = 0.07$ ). Cows on the high energy treatments consumed less pre-calving but more post-calving than cows on the low energy diets (energy by period interaction,  $P = 0.02$ ). Milk and milk component yields were unaffected by treatment. There were no differences between treatments for milk lactose and protein content, but for milk fat content there was a trend for an energy by protein interaction ( $P = 0.09$ ). Body condition score during the close-up dry period increased for cows on the HEHP treatment but decreased for cows on the other treatments (energy by protein by period interaction,  $P = 0.06$ ). During lactation cows on the HELP diet lost more body condition than the other cows. The data from this study suggest that feeding diets higher in energy and protein than that recommended by NRC may not benefit production in early lactation dairy cows.

	HEHP	HELP	LEHP	LELP	(SEM)
DMI, close-up dry, kg/d	13.2	12.2	14.1	13.0	0.86
DMI, calving, kg/d	8.8	7.2	6.7	7.8	0.90
DMI, early lactation, kg/d	17.5	16.6	15.7	15.3	0.79
BCS, precalving	2.96	3.17	3.26	3.14	0.10
BCS, calving	3.05	3.16	3.18	3.06	0.10
BCS, early lactation	2.71	2.65	2.80	2.79	0.09
Milk yield, kg/d	37.4	34.9	34.8	34.3	1.85
4% FCM, kg/d	37.2	36.8	36.7	35.7	1.95
Milk fat, %	4.01	4.44	4.45	4.33	0.15
Milk fat, kg/d	1.48	1.52	1.52	1.47	0.08
Milk protein, %	3.25	3.23	3.26	3.30	0.13
Milk protein, kg/d	1.19	1.12	1.11	1.11	0.08
Milk lactose, %	4.46	4.43	4.40	4.45	0.07
Milk lactose, kg/d	1.68	1.55	1.54	1.52	0.08

**Key Words:** Transition cow, Energy, Protein

**1084 Effects of implanting and explanting on performance of finishing steers.** B.A. Berry<sup>\*1</sup>, D. R. Gill, F. N. Owens, B. Freking, and B.A. Gardner, <sup>1</sup>Oklahoma State University, Stillwater.

Previously nonimplanted Angus x Senepol crossbred steers ( $n=125$ ; BW  $332$  kg  $\pm$  34) were randomly assigned to one of five implant schemes for a 140-d finishing trial. All treatments, with the exception of the negative controls (treatment 1), received a combination estradiol (24 mg) and trenbolone acetate (120 mg) implant on d 0. On d 84, the treatments consisted of 1) no implant administered; 2) a second combination implant; 3) removal of the initial implant and administration of a second combination implant; 4) removal of the initial implant without reimplantation; 5) no reimplantation without removal of the initial implant. Overall ADG was 20% greater ( $P < .0001$ ) and dry matter

intake was increased ( $P < .001$ ) for implanted steers as compared to control steers. Steers on all treatments, with the exception of treatment 5, converted feed to gain more efficiently ( $P < .04$ ) than steers receiving no implants. Treatment 2 steers had higher ( $P < .03$ ) daily gains and lower ( $P < .0001$ ) feed to gain ratios than all other treatments. The two implant treatment groups carrying only one implant from d 84 to 140 (treatments 3 and 5) had similar daily gains but both treatments were significantly ( $P < .03$ ) greater than treatment 4. Treatment 3 steers converted more efficiently ( $P < .0005$ ) than both treatment groups that were not reimplanted (treatments 4 and 5) on d 84. These two groups of steers converted similarly ( $P > .25$ ). As compared to nonimplanted cattle, implanted cattle yielded 28.5 kg more carcass, had lower ( $P < .03$ ) percentages of KPH fat, and had more advanced ( $P < .004$ ) skeletal maturity. Fat thickness, ribeye area, yield grade, marbling score, and percentage of treatment cattle grading Choice were similar between treatment groups. Control cattle yielded significantly ( $P < .006$ ) more tender steaks, evaluated after both 7 d and 14 d aging periods, than twice implanted cattle, regardless of explant. After a 7 d aging period, treatments 2 and 3 had similar tenderness, however, treatment 2 was significantly ( $P < .05$ ) tougher than all remaining treatments. After a 14 d aging period, treatment 2 was tougher ( $P < .005$ ) than control and treatment 5.

**Key Words:** Implant, Performance, Carcass Traits

**1085 Dynamics of rehydration and dehydration of Wisconsin long haul bull calves.** T. E. Johnson<sup>\*</sup>, H. B. Perry, B. L. Miller, and M. A. Fowler, Land O'Lakes, Webster City, IA.

Weights, weight gains and fluid intake were examined in 812 bull calves purchased from Wisconsin sales barns (7 hour transit) over a 2 year period. Calves were weighed on arrival, fed CMR, electrolytes and water ad libitum. Calves were weighed 24 hours post arrival (initial trial weight) and 8 days post arrival (week 1 trial weight). Data were sorted by calf mortality and calf size. No differences ( $P > .05$ ) were observed in weight gain or fluid intake between calves that lived and those that eventually died. There was a linear effect ( $P < .0001$ ) in both calves that lived or died in 24 hour post arrival gain favoring heavier calves. There was a linear effect ( $P < .0001$ ) in calves that lived in week 1 trial gain favoring lighter calves. No differences ( $P > .05$ ) were seen in fluid consumption by calves of various sizes. These data suggest present fluid therapy on received calves is adequate and mortality can be attributed to factors other than trip dehydration. Also, heavier calves gain more weight 24 hours post arrival and lose more weight the first seven days on trial than lighter calves. Calves of all sizes are able to consume up to 20 pounds of fluid equally, within 24 hours post arrival.

**1086 Stair-step compensatory growth regimen in gestating beef heifers.** A. M. Encinias<sup>\*1</sup>, H. B. Encinias<sup>1</sup>, A. E. Radunz<sup>1</sup>, M. L. Bauer<sup>1</sup>, R. B. Danielson<sup>1</sup>, G. P. Lardy<sup>1</sup>, and C. S. Park<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo.

Our objectives were to evaluate performance of spring-calving beef heifers on a simplified stair-step compensatory growth (SSCG) regimen imposed at 90 d gestation. Twenty-four Angus and Angus-cross heifers (initial BW =  $409 \pm 1.9$  kg) were grouped by AI date into three groups of eight ( $n = 3$ ; 4 heifers pen<sup>-1</sup>). Treatments were imposed at 90 d of gestation. Two treatments were assigned randomly to each group of heifers. Control (CON) heifers were fed 20.4 Mcal ME·d<sup>-1</sup> from d 90 to d 180 of gestation and 24.2 Mcal ME·d<sup>-1</sup> from d 180 to d 270 to achieve .45 kg·d<sup>-1</sup> maternal (minus fetus) ADG. Stair-step compensatory growth heifers were fed 13.3 Mcal ME·d<sup>-1</sup> (65% CON) from d 90 to d 180 (restriction) and 30.3 Mcal ME·d<sup>-1</sup> (122% CON) from d 180 to d 270 (realimentation). Oil sunflower seeds (44.5% EE) were included during realimentation to achieve calculated ME in SSCG heifers. Four-day averages were used to measure initial and final BW. Initial and final body conditions were visually estimated using BCS and ultrasonic scans of back (BF) and rump fat (RF) taken. During restriction, ADG of CON was greater than SSCG (.46 vs .25  $\pm$  .09 kg;  $P = .08$ ), though BW was not affected ( $P = .44$ ). Mean BCS was not different ( $P = .15$ ) between CON (5.7) and SSCG (5.1). However, BF and RF thickness was decreased ( $P < .05$ ) in SSCG during restriction. Following realimentation, BW (571 vs 563  $\pm$  6.1 kg;  $P = .41$ ) and ADG (1.19 vs 1.11  $\pm$  .05;  $P = .33$ ) did not differ between CON and SSCG, respectively. Body condition score ( $P = .85$ ), BF ( $P = .73$ ), and RF ( $P = .53$ ) of SSCG were similar to CON. Energy efficiency (kg·Mcal ME) of CON and SSCG (.030 vs .035  $\pm$  .006) during feeding period was not influenced ( $P > .10$ ).

by treatment. A simplified stair-step compensatory growth regimen can be used to achieve similar final BW and performance of gestating beef heifers compared with conventional development methods.

**Key Words:** Beef Heifer, Stair-step Compensatory Growth, Gestation, Oil Seeds

**1087 Dose response effect of prenatal trenbolone acetate treatment on thyroid hormone concentrations and growth and reproductive performance of beef cows.** J. L. Stewart<sup>\*1</sup>, G. E. Carstens<sup>1</sup>, R. D. Randel<sup>2</sup>, and S. J. Falck<sup>1</sup>, <sup>1</sup>Texas A&M University, College Station, <sup>2</sup>Texas A&M University, Overton.

Trenbolone acetate (TBA) has been shown to reduce fasting metabolism of steers (Hunter & Vercoe, 1987), and increase maternal BW gain of pregnant cows without affecting fertility (Harting et al., 1997). Therefore, a dose-response study was conducted to determine the level of TBA needed to minimize feed inputs required to support BW gain during late gestation. Simmental cows were randomly assigned to one of four TBA treatments (n=14); 0, .4, .8, or 1.2 mg TBA/kg BW. Cows were implanted at 178±2 and again at 118±2 d prior to calving. A diet containing 65% whole corn, 20% chopped hay, 10% protein/mineral supplement and 5% molasses was limit fed individually using Calan gate feeders. Blood samples were collected at 14-day intervals and plasma analyzed for triiodothyronine (T3), thyroxine (T4) and blood urea nitrogen (BUN). Weekly analysis of plasma progesterone concentrations were used to determine ovarian cycling (> 1 ng/mL for 2 consecutive wk), and rectal palpation at 42 d postbreeding used to determine pregnancy rates. Feed intake (7.8±.06 kg/d), cow BW (563±6 kg) and BCS (4.7±.1) at calving were not affected by TBA treatment. Calf birth (43.8±.7 kg) and weaning weights (238±4 kg) were not affected by treatment, but calving difficulty scores increased (P<.01) as TBA dose increased (1.1, 1.0, 1.4 and 1.9 for 0, .4, .8 and 1.2 mg TBA/kg, respectively). Prenatal TBA treatment reduced (P<.05) the proportion of cows exhibiting estrus prior to breeding (77, 77, 38, and 57%, respectively) and reduced (P<.05) 42-d postbreeding pregnancy rates (92, 85, 69 and 36%, respectively). Plasma T3 and T4 concentrations throughout gestation were lower (P<.05) in cows implanted with 1.2 mg TBA/kg compared to controls, with cows implanted with .4 and .8 mg TBA/kg being intermediate. Plasma BUN concentrations were not affected by treatment. Prenatal TBA treatment did not alter cow or calf growth performance, but increased dystocia and reduced pregnancy rates in a dose-dependant manner.

**Key Words:** Trenbolone Acetate, Reproduction, Thyroid Hormones

**1088 Effect of the partial substitution of corn by shop suey beans (*Vigna radiata* L) on the apparent digestibility of growing diets for sheep.** R. Barajas<sup>\*</sup>, J.F. Obregon, A. Estrada, J.L. Velarde, and F. Caro, *Universidad Autonoma de Sinaloa*.

With the objective to determine the effect of the substitution of corn by shop suey beans (*Vigna radiata* L.) on total tract digestibility of growing diets for sheep. Four pelibuey sheep (16 kg) were used in a Cross Over experiment design, digestion trial. The diets in that consisted the treatments were: 1) Diet with 14.7% CP and 3.2 mcal DE/kg, containing (DM basis) 46% of cracked corn, 13.6% of canola meal, 24.3% of sudan grass hay, 13.4% of sugarcane molasses, 0.7% of urea and 2% of mineral premix (Control); and 2) Diet similar to Control diet but substituting 30% of cracked corn from the diet by row ground shop suey beans. The dry matter (DM) and organic matter (OM) intake were not affected (P>.06) by treatments. mean DM intake of experiment was 0.619 kg/day and represented the 3.8% of initial body weight of sheep. Fecal excretion of DM, OM, and CP were not affected (P>.10) by treatments. All tract dry matter digestion (72.2 vs 72.9%) was not affected (P>.10) by shop suey inclusion. Organic matter digestibility was similar (P>.10) between treatments (74.14 vs 74.67%). The substitution of corn by shop suey beans, increased (P=0.04) in 13% crude protein apparent digestibility (68.23 vs 77.09%). Taken 64% as true digestibility of crude protein of corn, the true digestibility value of crude protein of shop suey beans was 85%, and its value of digestible energy was close to corn DE value. It is concluded, that shop suey beans can be used a partial substitute of corn in growing diets for sheep.

**Key Words:** Chop suey beans, Digestibility, Sheep

**1089 Jerusalem artichoke (*Helianthus tuberosus*) flour as a partial starch replacement for growing beef steers.** T.C. Bramble<sup>\*1</sup>, G.V. Pollard<sup>1</sup>, K.F. Wilson<sup>1</sup>, B.S. Clyburn<sup>1</sup>, A. Gueye<sup>1</sup>, M.A. Johnson<sup>1</sup>, J.M. Abdelrahim<sup>1</sup>, C.R. Richardson<sup>1</sup>, and A.J. Mjolsness<sup>2</sup>, <sup>1</sup>Texas Tech University, Lubbock, <sup>2</sup>Premium Sweetner Products, Glyndon MN.

The primary objective of this study was to determine if Jerusalem artichoke (*Helianthus tuberosus*) flour high in fructooligosaccharides (FOS) could serve as a partial starch replacement in the diet of growing beef steers. Four black crossbred steers averaging 239 kg were utilized in a 4 x 4 Latin square design. The four dietary treatments were A) basal diet; B) 10% artichoke flour; C) 15% artichoke flour; and D) 20% artichoke flour. The basal diet, 90% concentrate, contained no artichoke flour and was formulated to meet or exceed (1996 NRC) beef cattle requirements for growing/ finishing steers. The artichoke flour was obtained from a local supplier and was incorporated into the basal diet at the expense of steam-flaked corn. Soy protein isolate was varied across the four dietary treatments to make the diets isonitrogenous. Steers were housed in individual metabolism crates equipped with feeders and an automatic water system in a temperature controlled environment (20°C). Steers were fed once daily (0900) to approximately 90% ad libitum intake. Each of the four collection periods consisted of a 10-d adjustment to the diet, followed by a 5-d collection of total urine and fecal excretion. Crude protein in the feed, urine and fecal material was determined via the Kjeldahl method. The inclusion of Jerusalem artichoke flour, high in FOS, into growing beef steer diets as a partial starch replacement for steam-flaked corn did not (P > .05) alter apparent crude protein digestibility, apparent dry matter digestibility, nitrogen retention, or fecal excretion. Furthermore, it appears that Jerusalem artichoke flour can be used to replace up to 20% of the steam-flaked corn in a growing steers diet as indicated by no health or metabolic disorders throughout the experiment. In this regard it appears that Jerusalem artichoke flour, high in FOS, could be a suitable alternative feed ingredient for feedlot cattle diets.

**Key Words:** Fructooligosaccharides, Artichoke flour, Steers

**1090 Ensiling of sludge from tuna processing plant as potential ingredient in ruminant diets: effects of different levels of sucrose.** A.E. Sanjuan<sup>1</sup>, A.A. Rodriguez<sup>\*2</sup>, J.M. Kubaryk<sup>1</sup>, and A. Sanchez<sup>3</sup>, <sup>1</sup>Department of Marine Sciences, <sup>2</sup>Department of Animal Science, <sup>3</sup>Department of Chemical Engineering, University of Puerto Rico, Mayaguez Campus.

Ensiling of by-products generated from fisheries operations have been utilized as a process for the reduction of industrial wastes and the production of animal feedstuffs. However, enhance the quality of the fermentation is essential for the utilization of waste silage as ingredient in animal diets. This experiment was designed to evaluate different levels of synthetic sucrose as carbohydrate source on the fermentation characteristics of sludge from tuna processing plant (STPP). Sludge was collected from the Star-Kist Caribe, Inc., a commercial tuna fish industry plant located at Mayaguez, Puerto Rico. The sludge was inoculated with a lactic acid-producing bacterial inoculant applied at 105.78cfu/g of fresh material. Inoculated STPP was mixed with four levels of sucrose (0, 5, 10 and 15% of fresh material), placed into 1 kg capacity silos fitted with valve for gas release, and maintained at room temperature (27±2°C). Three silos per treatment were opened after five fermentation periods (0, 2, 4, 7 and 9 d) and silage was analyzed to determine changes in acidity, chemical composition, and ammonia-N. Silage without sugar additive had higher (P<0.05) pH than STPP ensiled with the carbohydrate source. However, for all sucrose levels acidity of ensiled material was similar after 9 days of fermentation. In all treatments, for the entire fermentation process organic matter, inorganic matter, and crude fat content were similar regardless of sucrose levels, but residual soluble carbohydrates were greater (P<0.05) in silage containing higher amount of sucrose (5 and 10%). Sludge without sucrose had a greater (P<0.05) ammonia-N content than silage containing the sugar. In summary, it is possible to ferment STPP with the addition of synthetic sucrose as carbohydrate source, but levels of inclusion higher than 5% did not result in a better fermentation. Further studies with a more available and less expensive sugar source are necessary to ensure a practical application of STPP as ingredient in animal diets.

**Key Words:** Silage, Organic waste, Sucrose

**1091 Effect of feeding grapevine silage on apparent digestibility and performance of small ruminants.** F.T. Sleiman\*, N.I. Abi Aad, M.G. Uwayjan, and M.T. Farran, *American University of Beirut, Beirut, Lebanon.*

Twelve Awassi ram lambs averaging 45 kg BW were used in two trials of 4-wk each to evaluate the effect of feeding ensiled pruned grapevine branches on apparent digestibility and performance. Silage treatments consisted of 1) 100% corn silage (CS), 2) 100% ensiled pruned vine branches (EPVB), 3) 96%EPVB+4% ground yellow corn (GYC), and 4) 92% EPVB+8% GYC. In addition to ad libitum silage, each lamb received 0.7 kg concentrate (14% CP on DM basis) daily. Changes in silage temperature (average of 15.7 °C for all treatments) until 21d were not significantly different ( $P > 0.05$ ). pH of CS treatment at 21d was significantly lower than that of EPVB treatments (4.19 Vs 4.42,  $P < 0.05$ ). Silage DMI was not different among treatments although CS fed group had lower daily intakes (0.62 Vs 0.73 kg,  $P > 0.05$ ). Change in BW did not differ significantly between CS and EPVB treatments (228 Vs 157g/d,  $P > 0.05$ ). The apparent digestibility of DM, EE, CF, and CP of the CS group was significantly higher than other treatments (65.48, 66.43, 52.89, 57.59 Vs 59.85, 23.71, 44.78, 49.22%, respectively at  $P < 0.05$ ). It was concluded that EPVB was well accepted and digested by small ruminants, and that its digestibility improved when ensiled with GYC.

**Key Words:** Silage, Pruned Grapevine Branches, Digestibility

**1092 Lambs fed feed mixtures amended with extruded plate waste have inconsistent performance.** P.M. Walker<sup>1</sup>, T.R. Kelley<sup>1</sup>, S.B. Brown\*<sup>1</sup>, and A.T. Jensen<sup>1</sup>, *Illinois State University, Normal.*

Two feeding trials were conducted to evaluate the use of extruded plate waste (PW) as a feedstuff for sheep. In trial one (T1) 36 crossbred lambs were blocked by sex and randomly allotted within block to one of 18 pens. Each pen contained one ewe and one wether. Each pen of lambs was given ad libitum access for 105d to either an extruded mixture amended with PW (E1) or a traditional control diet (C1). In trial two (T2) 36 white faced wethers were randomly allotted to 18 pens and pair fed. Each pen of wethers was given ad libitum access for 64d to either a treatment diet (E2) amended with PW or a control diet (C2). The PW used in this study contained 35.3±7.1% DM, 33.3±6.7% CP, 15.9±2.6 ether extract, and 12.1±3.6% ADF. In T1, PW was mixed and extruded with soybean hulls and rolled shelled corn in a 40:55:5 ratio (wet wt. basis). The extruded mixture was supplemented with dicalcium phosphate, calcium carbonate and molasses to produce a diet containing CP (15.6±4.5), Ca (.91±.16) and P (.31±.11) percents similar to C1. On a DM basis E1 contained 23.9% PW. C1 consisted of corn, soybean meal, oats, ground hay, ground corn cobs, molasses, calcium carbonate, salt and Rumensin<sup>TM</sup> containing 15.6±4.4% CP, .87±.26% Ca and .38±.07% P. In T2 PW was mixed and extruded in a 40:60 ratio (wet wt. basis) with the extruded 40:55:5 mixture used in E1 and then blended with corn, molasses, dicalcium phosphate, calcium carbonate, salt and Rumensin to produce a diet similar in CP, Ca and P to a control diet (C2) containing corn, soybean meal, soybean hulls, molasses, calcium carbonate, salt and Rumensin. E2 contained 24.1% PW on a DM basis. Mean starting and ending wts. of the lambs in T1 and T2 were 27.7±5.9kg and 55.9±4.9kg and 40.7±3.9 and 56.1±5.4kg, respectively. During T1, C1 compared to E1 lambs had higher ( $P < .05$ ) ADG (299.6±36.3g vs. 259.0±54.5g), lower ( $P < .05$ ) ADFI (811.1±64.0g vs. 2113.6±748.6g) and higher ( $P < .05$ ) gain:feed (.37:1g vs. 12:1g). During T2, no significant differences between C2 and E2 lambs were observed in ADG (mean = 231.6±40.9g), ADFI (mean = 1766.1±168.0g) and gain:feed (mean = .13:1g). The data of this study suggest that plate waste can be utilized as a feedstuff but sheep fed processed food waste may have inconsistent performance compared to sheep fed traditional diets.

**Key Words:** Extruded, Plate Waste, Sheep

**1093 Dry field peas as a component in grain starter rations for preweaned and weaned dairy calves.** G.D. Marx\*, *University of Minnesota, Crookston, MN.*

Performance of 34 preweaned Holstein dairy calves during a 5 week period and 32 weaned calves during a 5 week period was evaluated when

dry field peas were included at 40% of the grain starter in the experimental ration. The control ration utilized barley at 40% of the grain with the balance of both rations containing similar amounts of corn, molasses, mineral, vitamins and balanced to 18% crude protein with soybean meal. This grain starter was fed free choice to preweaned calves and to weaned calves at 1.64 kg/animal/d along with free choice alfalfa haylage. New-born calves were fed colostrum for 3 days, subsequently given 4.4 kg whole milk/d, divided between two daily feedings, until weaned at 5 weeks. Calves were housed inside an insulated and ventilated warm barn in individual steel pens 1.2 m x 1.5 m. The temperature of the calf facility was maintained at 10 °C during the winter months. Water was available free choice with automatic waterers in every pen. Feed intakes and refusals, body weights and health data were collected. Data were analyzed by GLM procedure of SAS. Average daily weight gains for the preweaned and weaned calves fed the field peas were 0.35 and 0.69 kg, and control calves were 0.35 and 0.67 kg. Daily grain starter intakes for the preweaned and weaned calves fed field peas averaged 0.55 and 1.64 kg, and control calves were 0.53 and 1.64 kg. No differences ( $P > 0.05$ ) were noted between treatments for rate of gain or starter consumption. Forage intakes for the weaned calves and feed-to-gain ratios were similar for both treatment groups. No unusual health problems were observed. Feed intake and palatability was adequate and indicated that field peas were acceptable and a satisfactory component at 40% of grain starter rations for both preweaned and weaned dairy calves.

**Key Words:** Dairy calves, Calf starter, Field peas

**1094 Combinations of wet corn gluten feed and steam-flaked corn in finishing cattle diets: effects of E. coli, total coliforms, VFA profiles, and pH.** J. J. Sindt\*, J. S. Drouillard, H. Thippareddi, R. K. Phebus, D. L. Lambert, T. B. Farran, S. P. Montgomery, H. J. LaBrune, and J. J. Higgins, *Kansas State University, Manhattan.*

Crossbred beef steers (n=615; 291 kg BW) were fed diets containing varying proportions of wet corn gluten feed (CGF) and steam flaked corn (SFC) throughout a 152-d finishing experiment. Steers were blocked by previous treatment and allocated, within block, to each of three diets (four pens per diet, 48 to 53 steers per pen). Ratios of SFC to CGF were 80:0, 60:30, and 30:60 for 0CGF, 30CGF, and 60CGF treatments, respectively. Samples of rumen fluid and feces were collected from 180 steers (three animals per pen on each sampling day) on d 114 to 118 to evaluate effects of diet on total and acid resistant *Escherichia coli* (*E. coli*) and coliforms, VFA profiles, and pH. Samples of rumen fluid and feces were incubated for 1 h in citric acid/sodium phosphate buffer solutions at pH 2, 4, and 7 for determination of total and acid resistant *E. coli* and coliforms. Samples were serially diluted, plated onto Petrifilm<sup>TM</sup> plates, incubated at 37° C for 24 to 48 h, and enumerated. A linear increase was observed for ruminal pH (6.07, 6.15, 6.23;  $P < 0.01$ ) and fecal pH (6.78, 6.81, 6.94;  $P < 0.01$ ) for 0CGF, 30CGF, and 60CGF, respectively. Diet did not impact ( $P > 0.40$ ) *E. coli* or total coliform counts in ruminal fluid and fecal samples subjected to pH 2, 4, or 7 buffer treatments. Cattle fed 60CGF had higher molar proportions of fecal acetate (AC) and lower proportions of fecal propionate (PR) than cattle fed 0CGF ( $P < 0.05$ ), but AC:PR was not different ( $P > 0.17$ ) among treatments. The molar proportion of ruminal AC and AC:PR were greater ( $P < 0.05$ ) and molar proportion of ruminal PR was lower ( $P < 0.05$ ) for cattle fed CGF60 than for cattle fed CGF00. Addition of CGF to finishing diets altered VFA concentrations and increased pH; however, no differences were observed with respect to numbers of *E. coli*, total coliforms, acid resistant *E. coli*, or acid resistant coliforms.

**Key Words:** E. coli, Wet corn gluten feed, Finishing cattle

**1095 Relationship between dry matter intake, body weight, and milk yield in dairy cows: A summary of published data.** A. N. Hristov\*<sup>1</sup>, K. A. Hristova<sup>3</sup>, and W. J. Price<sup>2</sup>, <sup>1</sup>Department of Animal and Veterinary Sci. and, <sup>2</sup>Statistical Programs, College of Agriculture, University of Idaho, Moscow, ID 83844, <sup>3</sup>Moscow High School, Moscow, ID 83843.

An attempt was made to determine the relationship of dry matter intake (DMI) and body weight (BW) with milk yield (MY) in dairy cows using data from nutritional studies published in Journal of Dairy Science (volumes 1 through 82). Only articles containing feed intake and milk yield data were considered for this study. In cases where data were reported

as individual treatments within a trial, a separate observation was entered for each treatment. Where feed DM was not published, dietary DMI was determined based on tabular data (Nutrient Requirements of Dairy Cattle, NRC 1989). To remove extreme or unusual values the lower and upper 1% of the data was trimmed resulting in 5,814 and 2,752 observations for DMI/MY and BW, respectively. The bulk of the data (89%) were within the range of 14.1 to 26.6 kg/d, 15.9 to 40.5 kg/d, and 505 to 716 kg for DMI, MY, and BW, respectively. A plot of MY vs DMI indicated an approximately increasing linear relationship ( $r = 0.68$ ). Estimation of a simple linear regression model for this data, however, resulted in moderately strong fit:  $MY = -1.022 + 1.378 DMI$  ( $R^2=0.472$ ;  $P<0.001$ ). Attempts to account for differences in BW in this relationship through a multiple regression model did not provide a better alternative ( $R^2=0.475$ ). While these results suggest that DMI alone or in combination with BW cannot be used to predict MY, the data sets considered in this analysis may indicate some potential for defining a relationship. This could be accomplished by accounting for external sources of variability such as nutritional and genetic factors and differences in trial designs.

**Key Words:** Dairy Cows, Dry Matter Intake, Milk Yield

**1096 A dynamic mechanistic model of methanogenesis in the lactating dairy cow.** J.A.N. Mills\*<sup>1</sup>, J. Dijkstra<sup>2</sup>, and J. France<sup>1</sup>, <sup>1</sup>The University of Reading, Reading, United Kingdom, <sup>2</sup>Wageningen University, Wageningen, Netherlands.

Dietary intervention to reduce methane emissions from lactating dairy cattle is both environmentally and nutritionally desirable due to the importance of methane as a causative agent in global warming and as a significant loss of feed energy. This investigation involved the modification of a dynamic mechanistic model of whole rumen function (Dijkstra et al., 1992) and the incorporation of a post-ruminal digestive element. Regression analysis showed good agreement between observed and predicted results for experimental data taken from the literature ( $r^2$  0.76, root MSPE 15.4%). Evaluation of model predictions for experimental observations from five calorimetry studies with lactating dairy cows at CEDAR (Centre for Dairy Research, UK) showed an under-prediction (2.1MJ/d) of methane production ( $r^2$  0.46, root MSPE 12.4%). Model development to account for discontinuous feed inputs and a physical dietary description may further improve predictions of methanogenesis. Improvements to the representation of lipid metabolism in the rumen are needed to further enhance model predictions especially for diets with supplemental fat. Application of the model to develop diets to minimise methanogenesis indicates a need to limit the concentration of soluble sugars in the concentrate. The model simulated an increase in diet metabolisability (ME/GE) of 3.5% and a 1.1% reduction in the proportion of GE lost as methane as starch replaced soluble sugars in the concentrate. On a herd basis, the model predicts that increasing dietary energy intake per cow can minimise the annual loss of feed energy through methane production. Substitution of grass silage with maize silage or concentrates may significantly reduce the environmental impact of dairy farming through methane pollution whilst increasing the dietary energy available to the dairy cow.

Reference

Dijkstra, J., Neal, H.D.St.C., Beaver, D.E., France, J., 1992. Simulation of nutrient digestion, absorption and outflow in the rumen: model description. *J. Nutr.* 122, 2239-2256

**Key Words:** methane, model, dairy cow

**1097 Evaluation of two different equations for the prediction of the energy content of Canadian grown forages.** A. Fournier\*<sup>1</sup>, G. Allard<sup>1</sup>, J.F. Bernier<sup>1</sup>, H. Lapierre<sup>2</sup>, and D. Pellerin<sup>1</sup>, <sup>1</sup>Departement des sciences animales, Universite Laval, <sup>2</sup>Dairy and Swine R & D Center, Agriculture and Agri-Food Canada.

Climatic conditions vary from the East to the West coast of Canada. These various conditions have a strong influence on the digestibility of forages harvested in the different longitudes. In a data set including 139 observations of chemical composition of Canadian grown forages and their digestibility in cattle, we observed that, on average, the lignin content of legume and grass forages was about one point higher in forages grown in West (dry climate) compare to East (wet climate). We used this data set to derive a prediction equation including an area factor:  $DE = 3.56 - 0.029ADF\% + 0.004NDF\% - 0.067 AREA$  [West (1) or East (0)] ( $n = 139$ ;  $r^2 = 0.43$ ).

Twenty-two Canadian experiments done with dairy cows were used to compare this equation with the multicomponent Ohio state equation ( $TDN = .93 CP + 2.25 FA + .98 (100 - NDF_N - CP - ash - FA - 1) + .75 (NDF_N - lignin) [1 - (lignin/NDF_N)^{.667}] - 7$ ). Experiments selected for the comparison had to include adequate data on the composition of forages (CP, ADF and NDF), concentrate feed composition, milk production and composition, body weight and body weight change. Lignin, ash and FA content of forages in these experiments were estimated with equations produced with our initial data set (lignin =  $-3.82 + 0.36ADF - 0.09NDF + 0.015 (\% \text{ legume}) + 1.26AREA$  [ $r^2 = 0.85$ ]; ash =  $10.53 - 0.098NDF + 0.23PB$  [ $r^2 = 0.70$ ]; FA =  $6.089 - 0.11ADF + 0.04PB - 1$  [ $r^2 = 0.54$ ]) when this information was not reported. Energy values of forages were predicted using the respective equation while the NRC (1989) tables were used to evaluate energy values of concentrates. The regression of NEL values based on requirements (Y) against the NEL values based on feed composition (X) were: for the Canadian equation,  $Y = -0.12 + 1.02X$  ( $r^2 = 0.45$ ;  $p < 0.01$ ); for the Ohio state equation,  $Y = -0.08 + 1.01X$  ( $r^2 = 0.47$ ;  $P < 0.01$ ). The slopes were not different from 1 ( $P < 0.05$ ), and the intercepts were not different from 0 ( $P < 0.05$ ). The feed value for NEL were overestimated by 6 and 4 % by the Canadian and the Ohio state equation, respectively.

We conclude that both equations can be used to predict the energy value of Canadian grown forages based on their chemical composition. However, both model explained only 45 % of the variation of the energy requirements.

**Key Words:** Digestible Energy, Forage, Equation and Prediction

**1098 Growth and starch digestion by *Entodinium exiguum* as influenced by the source of starch and the presence of living rumen bacteria.** M. Fondevila\*<sup>1</sup> and B.A. Dehority<sup>2</sup>, <sup>1</sup>University of Zaragoza, Zaragoza, Spain, <sup>2</sup>Ohio State University, Wooster.

*In vitro* growth and amylolytic capability of the rumen protozoa *Entodinium exiguum* was studied using two different sources of starch, either in the presence or absence of rumen bacteria. *E. exiguum* was obtained from sheep rumen contents and maintained in basal medium M (Dehority, 1998. *J. Anim. Sci.*, 76:1189-1196). Tubes with basal medium plus (per 100 ml) 6 ml of a 1% phosphate buffer and 0.1 g trypticase, were added with 0.35 g of either corn (C) or rice (R) starch (average particle size of 13.5 and 5.2  $\mu\text{m}$ , respectively) just prior to inoculation. Treatments, for either C or R media, were: protozoa and bacteria (PB), protozoa plus 2000 U penicillin and 130 U streptomycin/ml medium (PA) and only bacteria (LB). Inoculum for PA was pre-incubated 4h with antibiotics and inoculum LB was filtered through a 5  $\mu\text{m}$  membrane filter. Protozoal concentrations and starch digestion were measured in samples taken from duplicate tubes at 6, 12, 24, 36 and 48h. Protozoal growth was higher in R with PB than PA at both 24 h ( $P<0.10$ ) and 48h ( $P<0.05$ ). Generation times after 24h were slower with PB than PA both in R (28.1 vs. 15.0h) and in C (22.0 vs. 17.6h). After 36 and 48h, generation times tended to be faster in C than in R ( $P<0.10$ ), probably because of substrate depletion in R. Starch digestion started earlier with R ( $P<0.05$  up to 24h), but was complete for both starches with PB after 24h. Digestion with PB was numerically higher than the sum of PA and LB up to 12h with R and up to 24h with C, indicating a synergism between protozoa and bacteria in coculture. Digestion of R with LB started later than with PA (0 vs. 10% at 6h); however, digestion by LB had reached 93% after 24h, compared to only 75% with PA at 48h. When C was the substrate, the digestion pattern was very similar with PA and LB (13 vs.8% at 24h). The total extent of starch digestion with protozoa was similar between the two starch sources; however, bacteria digest rice starch faster and to a greater extent than corn starch.

**Key Words:** rumen Protozoa, Starch digestion, In vitro culture

**1099 Effect of increasing levels of pure corn starch in the diet of lactating dairy cows on ruminal pH.** K. M. Krause\*<sup>1</sup>, D. K. Combs<sup>1</sup>, and K. A. Beauchemin<sup>2</sup>, <sup>1</sup>University of Wisconsin-Madison, Madison, WI, <sup>2</sup>Agriculture and Agri-Food Canada, Lethbridge, AB.

The objective of this study was to investigate the effects of a linear increase in the fraction of dietary starch provided as pure corn starch on ruminal pH at a constant level of dietary NDF. Eight ruminally cannulated, multiparous Holstein cows were used in two 4 x 4 Latin squares



with 23-d periods. The four dietary treatments consisted of increasing levels of pure corn starch. Dried, cracked corn grain was replaced with increasing levels of pure corn starch in a manner such that total corn starch provided was kept constant at 27% of dietary DM. Corn gluten feed was used to balance the diets for equal levels of NDF (28% of DM). Diets were fed as TMRs for ad libitum intake and consisted of 40% coarsely chopped alfalfa silage and 60% concentrate (DM basis). Treatments were: 0% (ST0), 6% (ST1), 12% (ST2) and 18% (ST3) pure corn starch in the TMR (DM basis). Cows averaged 53±16 DIM at the beginning of the experiment. Daily intake of pure corn starch was 0, 1.6, 3.2 and 4.8 kg for diets ST0, ST1, ST2 and ST3, respectively. None of the measured variables were affected significantly by diet. Milk yield was 38.90±4.87 kg/d and DMI 27.12±3.50 kg/d when averaged across diets. Milk contained 3.39±0.52% fat and 3.17±0.18% protein. Cows spent 447±51 min/d ruminating and 317±56 min/d eating. Ruminal pH was measured continuously each minute for 3 days using indwelling electrodes. Mean ruminal pH and area below pH 5.8 was not affected by diet and was 5.98, 5.97, 6.01 and 5.93 and 154, 151, 176, and 207 min × pH/d for ST0, ST1, ST2, and ST3, respectively. No relationship was found between increasing fractions of dietary starch provided as pure corn starch and ruminal pH in lactating cows fed TMRs containing adequate levels of fiber.

**Key Words:** Corn starch, Ruminal pH

**1100 Effect of subacute ruminal acidosis on the preference of cows for pellets containing sodium bicarbonate.** J. L. Cumber\*<sup>1</sup>, J. C. Plaizier<sup>1</sup>, I. Kyriazakis<sup>2</sup>, J.E. Keunen<sup>1</sup>, and B.W. McBride<sup>1</sup>, <sup>1</sup>Department of Animal and Poultry Science, University of Guelph, Ontario, Canada, <sup>2</sup>Animal Biology Division, Scottish Agricultural College, Edinburgh, U.K.

Using a previously developed nutritional model to induce sub-acute ruminal acidosis (SARA), it was determined if SARA affects the cows preference for pellets containing 4 % sodium bicarbonate compared to control pellets. Pellets also contained wheat shorts (38 %), alfalfa (38 %), beet pulp (10 %) and soy hulls (10 %) In the first experiment NaCl was added to the control pellets to balance for sodium. The control pellets of the second experiment did not contain NaCl. Four rumen cannulated Holstein dairy cows of second and third parity, in late lactation, were used. The first experiment lasted three weeks. Two SARA weeks were separated by a control week. The second experiment consisted of one SARA week followed by one control week. Ruminal pH was continuously monitored via indwelling pH probes. Cows could choose between two pellets, twice daily, for a 15 min. period (11-11:15 a.m., 3-3:15 p.m.) from Monday to Friday of each week. The pellets were offered in equal amounts (5 kg) and were offered to the animals in identical feed trays. Position of the feed was randomized per cow. Preference ratios (PR) for bicarbonate pellets were calculated after each choice period as: amount of bicarbonate pellets consumed/ (amount of bicarbonate pellets consumed + amount of control pellets consumed). In experiment 1 cows consumed predominantly bicarbonate pellets, but this was due to an aversion to the NaCl in the control pellets, as in the second experiment cows consumed predominantly control pellets. The SARA model reduced ruminal pH in experiment 1. In experiment 2, low ruminal pH was observed in the SARA week and in the control week. SARA did not affect the cows preference for the bicarbonate containing pellets in experiment 1.

Item	Exp. 1			Exp. 2		
	SARA Weeks	Control Week	P	SARA Week	Control Week	P
PR bicarbonate	0.83	0.85	n.s.	0.30	0.39	n.s.
Avg. pH	5.86	6.11	n.s.	5.85	5.93	n.s.
Time < pH 6 (min/d)	930	548	<0.05	796	830	n.s.
Area < pH 6 (min * pH/d)	337	184	<0.05	313	285	n.s.
Time < pH 5.6 (min/d)	348	194	<0.05	389	304	n.s.
Area < pH 5.6 (min * pH/d)	85	31	<0.05	78	59	n.s.

**Key Words:** acidosis, diet selection, dairy cows

**1101 Quantification of the effectiveness of whole linted cottonseed as a forage substitute when fed with corn differing in ruminal starch availability.** D.I. Harvatine\*, J.E. Winkler, J.L. Firkins, and M.L. Eastridge, *The Ohio State University, Columbus, OH.*

Six ruminally and duodenally cannulated primiparous Holstein cows (517 kg) in mid-lactation were used in a 6 x 6 Latin Square with 3-wk periods. Alfalfa silage in TMR was replaced with WCS on an NDF basis to achieve six treatments with ground (G) or steam-flaked (SF) corn: forage control with G [FCG] (21% forage NDF (fNDF)); low (5%) WCS with G [LG] or SF [LSF] (18% fNDF); medium (10%) WCS with G [MG] or SF [MSF] (15% fNDF); and high (15%) WCS with G [HG] (12% fNDF). Diets were balanced for equivalent nutrient concentrations. DMI increased quadratically (P<0.05) with increasing substitution of alfalfa silage NDF with NDF from WCS (17.8, 20.0, 20.5, 20.3 kg for FCG, LG, MG and HG, respectively). Milk production did not differ across treatments (P>0.10), although milk fat % was affected quadratically (P<0.05) and milk protein % increased linearly (P<0.01) with increasing substitution with WCS (26.5, 26.6, 27.9, 27.3 kg milk; 3.45, 3.70, 3.58, 3.41% fat; and 3.04, 3.16, 3.14, 3.26% protein for FCG, LG, MG and HG, respectively). Ruminal pH and acetate:propionate (A:P) decreased linearly (P<0.01) with increasing WCS level (pH = 6.28, 6.13, 6.12, 5.93 and A:P = 3.98, 3.59, 3.21, 3.01 for FCG, LG, MG and HG, respectively). Total chewing activity time did not differ across diets (P>0.10) (785, 799, 734, 805 min/d for FCG, LG, MG and HG, respectively). However, chewing efficiency increased quadratically (P<0.05) with increasing WCS addition (209, 227, 240, 324 min/kg fNDF for FCG, LG, MG and HG, respectively). Ruminal mat consistency did not differ across diets (P>0.10). No interactions between corn source and WCS were detected (P>0.10); WCS is equally effective in lactating dairy cattle diets that contain moderate or high ruminal starch digestibility. WCS is as effective as NDF from alfalfa silage in maintaining chewing activity, milk fat %, and ruminal mat consistency in diets with at least 12% fNDF.

**Key Words:** Effective NDF, Non-forage fiber, Whole cottonseed

**1102 Effects of speciality corn hybrids on the rumen fermentation and total tract digestion in dairy cows.** V. Akay\* and J. A. Jackson, *University of Kentucky, Lexington.*

Six cannulated primiparous Holstein cows were fed three diets in a 3 x 6 Latin rectangle design with 28 d periods to determine the effects of speciality corn hybrids on rumen fermentation and digestion. Diets were: 1) control (normal corn), 2) nutridense corn (high oil and protein), and 3) waxy corn (high amylopectin) diets. Diets contained 11% alfalfa silage, 33% corn silage (normal, nutridense and waxy corn silage), 28% cracked corn grain (normal, nutridense and waxy corn grain), and 28% other ingredients (DM basis). Cows were dosed with chromic oxide twice daily (20g/d) the last 11 d of each period. Fecal grab samples were collected every 12 h during the last 6 d of each period; collection times were postponed 2 h daily. Ruminal samples were collected every 6 h during the last 6 d of each period; the sampling time was adjusted ahead 1 h daily. Data were analyzed using GLM (for digestibility) and Proc Mixed Procedure (for ruminal parameters) of SAS. Differences were considered significant at P < 0.05. Ruminal pH (5.90, 5.83 and 5.84, respectively) was lower for nutridense and waxy corn diets than normal corn diet, and ruminal NH<sub>3</sub>-N concentration (9.62, 11.1 and 8.87 mg/dl, respectively) was higher for nutridense corn diet than normal and waxy corn diets. Ruminal acetate concentration (59.3, 58.2 and 57.2 mol/100 mol, respectively) was highest for normal corn diet and lowest for waxy corn diet. Ruminal propionate concentration (21.1, 22.2 and 23.3 mol/100 mol, respectively), however, was higher for waxy corn diet than normal corn diet. Total VFA concentration (150.8, 156.1 and 155.9 mM, respectively) tended to be higher for nutridense and waxy corn diets than normal corn diet. Apparent DM, OM, ADF, NDF and gross energy digestibilities were similar among diets. Apparent starch digestibility (83.4, 82.0 and 88.6%, respectively) was higher for waxy corn diet than nutridense corn diet; however, CP digestibility (58.5, 59.8 and 58.2%, respectively) tended to be higher for nutridense corn diet than waxy corn diet. The results suggest that animals consuming waxy corn hybrid as silage and grain could benefit from higher starch digestibility and more efficient rumen NH<sub>3</sub>-N utilization.

**Key Words:** Speciality corn hybrids, Ruminal fermentation, Apparent digestibility

**1103 Effects of dietary carbohydrate source, propionate, and fat on performance of lactating dairy cows during heat stress.** J. Jennings\*, A. Akinyode, M. Hall, and C. Staples, *University of Florida, Gainesville.*

The objective was to evaluate the effects of nonstructural carbohydrate (NSC) sources, fat and propionate on animal response to heat stress. Eight ruminally cannulated, multiparous cows in midlactation were assigned to one of eight dietary treatments arranged in a 2 by 2 by 2 factorial incomplete Latin square design with three 21-d periods. Samples were collected during the last 7 d of each period. Main effects were two sources of NSC (citrus pulp or hominy fed at 27 and 25% of dietary DM, respectively), calcium salts of long chain fatty acids (fat; Megalac<sup>®</sup>) fed at 0 or 0.73% of dietary DM, and propionate (Prop: Nutrocal<sup>®</sup>) fed at 0 or 0.6% of dietary DM. Ruminal pH was measured hourly for 7 h after feeding. Body temperature and respiration rates were measured on 3 d at 0500 and 1700 h. Values are least square means  $\pm$  standard error with significance declared at  $P < 0.05$ . Daily DM intake ( $18.1 \pm 0.9$  kg), milk yield ( $21.0 \pm 2.1$  kg) and milk fat % ( $3.58 \pm 0.24\%$ ) were similar across diets. Milk protein % was greater for cows fed hominy (3.13%) vs citrus (3.06%) or fat ( $3.17$  vs  $3.02\% \pm 0.04$ ). Yield of milk fat ( $0.78$  vs  $0.69$  kg/d) and protein ( $0.68$  vs  $0.60$  kg/d  $\pm 0.04$ ) were greater for cows fed fat. Prop increased yield of fat corrected milk when cows were fed citrus pulp ( $20.5$  vs  $17.1$  kg/d), but reduced production when fed hominy ( $18.3$  vs  $21.2$  kg/d  $\pm 1.1$ ); energy source by propionate interaction). Cows fed fat had a greater concentration of milk urea nitrogen when fed hominy ( $16.8$  vs  $13.7$  mg/dl), but a lower concentration when fed citrus pulp ( $17.1$  vs  $16.0$  mg/dl  $\pm 1.0$ ). Prop elevated mean ruminal pH of cows fed fat ( $6.16$  vs  $5.92$ ), whereas Prop decreased the mean pH in cows not fed fat ( $6.02$  vs  $6.09 \pm 0.09$ ). Feeding fat with citrus pulp reduced afternoon body temperature ( $39.3$  vs  $39.6^\circ$  C), whereas fat had no influence on body temperature of cows fed hominy ( $39.5$  vs  $39.5^\circ$  C  $\pm 0.01$ ). Dietary fat, propionate, and NSC sources interacted to affect animal responses during heat stress.

**Key Words:** heat stress, NSC, dairy cows

**1104 Creating a nutritional model to induce Subacute Ruminant Acidosis (SARA) in the dairy cow.** J.E. Keunen<sup>1</sup>, J.C. Plaizier<sup>\*1</sup>, I. Kyriazakis<sup>2</sup>, T. Duffield<sup>3</sup>, and B.W. McBride<sup>1</sup>, <sup>1</sup>*Department of Animal and Poultry Science, University of Guelph, Ontario, Canada*, <sup>2</sup>*Animal Biology Division, Scottish Agricultural College, Edinburgh, U.K.*, <sup>3</sup>*Department of Population Medicine, Ontario Veterinary College, University of Guelph, Canada.*

The effects of two nutritional models to reduce rumen pH in mid to late lactation dairy cows were investigated. The aim of these models was to enable studies on SARA with these cows. Rumen pH was measured continuously via in-dwelling probes. In the first model, using 4 cows in a Latin square design, high moisture corn (HMC) replaced 0, 20, 25, and 30% of the dry matter (DM) in a total mixed ration (TMR). Cows were fed for 5 consecutive days, 2kg TMR at 7 am, HMC at 9 am, and TMR was re-introduced at 1 pm, followed by a 9-day rest period. Average pH, time and area with pH below 6.0 and 5.6 were calculated daily for each cow. Time below pH 6 and 5.6 for the control (0%) was 169.95 and 36.55 min, respectively, across all periods. Average time below 6 and 5.6 for the 20, 25, and 30% levels was 361.65 and 73.48 min, as these treatments did not differ significantly from each other. In the second model, another 4 cows were used. 25% of the ad libitum DM intake of the TMR was replaced with grain pellets (50% wheat/50% barley). Pellets were fed at 9 am (15%) and 1 pm (10%) for a 5-day period, followed by a 9-day rest period, and was repeated twice. Restricted TMR was offered at 7am, 11-11:30 am, and 3-3:30 pm. Using this grain model, pH averaged 0.14 units lower during challenge weeks than during control weeks. Time below pH 6.0 averaged 318.49 and 640.78 min. for the control weeks and the challenge weeks, respectively. Times below pH 5.6 were on average 117.63 and 109.15 min. for control and challenge weeks, respectively. These data indicate that the cows in the first model did not experience a lengthy enough period of decreased rumen pH to induce SARA. In contrast, cows in the second model had a significant time period below pH 6 and 5.6, between 12 pm and 8 pm, indicating successful induction of SARA, similar to that observed in transition dairy cows during the first week post-calving.

**Key Words:** acidosis, dairy cow, model

**1105 Diet selection to attenuate decreased rumen pH in the dairy cow.** J.E. Keunen<sup>\*1</sup>, J.C. Plaizier<sup>1</sup>, I. Kyriazakis<sup>2</sup>, T.M. Widowski<sup>1</sup>, and B.W. McBride<sup>1</sup>, <sup>1</sup>*Department of Animal and Poultry Science, University of Guelph, Ontario, Canada*, <sup>2</sup>*Animal Biology Division, Scottish Agricultural College, Edinburgh, U.K.*

Using a previously developed nutritional model to induce prolonged periods of decreased rumen pH, it was addressed whether changes in rumen pH affected the feed preference for alfalfa hay compared to alfalfa pellets. Four multi-parous rumen cannulated Holstein dairy cows, mid-late lactation, were used in this trial. The trial took place over three weeks. Two grain challenge weeks, developed in a previous experiment, that lead to decreased rumen pH were separated by a control week. Rumen pH was continuously monitored via in-dwelling probes. Cows were given choice of 2 feeds, 2x daily, for a 30 min. period (11-11:30 am, 3-3:30 pm). The feeds offered, during the choice periods, alfalfa hay and alfalfa pellets, were similar in chemical composition but different in particle size. These feeds were offered in equal amounts (3 kg) to the animals in identical feed trays. Position of the feed was randomized per cow prior to the trial. Preference ratios (PR = Amount of Hay Consumed/ (Amount of Hay Consumed + Amount of Pellets Consumed) for alfalfa hay were calculated after each choice period. During the first day of each choice period, the PR for alfalfa hay was lower than during the last 4 days of those weeks due to sampling behaviour of the animals. During subsequent days of the grain challenge weeks, cows had a strong preference for alfalfa hay. There was no difference in diet selection between the two periods within a day. This preference was reduced during the control week. Time and area below pH 6 and 5.6 was significantly greater in the grain weeks than in the control week. Hence, the lower rumen pH observed during the grain weeks was associated with an increased preference for alfalfa hay compared to alfalfa pellets.

Item	Grain Weeks	Control Week	P
PR Hay	0.85	0.60	< 0.05
Avg. pH	5.93	6.19	< 0.05
Time < pH 6 (min/d)	831	273	< 0.001
Area < pH 6 (min*pH/d)	263	64	< 0.01
Time < pH 5.6 (min/d)	264	56	< 0.05
Area < pH 5.6 (min*pH/d)	49	10	n.s.

Days 2-5 of each week

**Key Words:** acidosis, dairy cow, diet choice

**1106 Effects of concentrate level and feeding management on feeding behavior and saliva production by lactating dairy cows.** M. Maekawa<sup>\*1</sup>, K.B. Beauchemin<sup>2</sup>, and D.A. Christensen<sup>1</sup>, <sup>1</sup>*University of Saskatchewan, Saskatoon, Canada*, <sup>2</sup>*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

The objectives of this study were to determine the effects of 1) proportion of concentrate "40, 50, 60%, DM basis" in the diet, and 2) feeding a TMR compared to separate ingredients "SI" for a diet containing 50% concentrate, on feeding behavior and saliva production. Eight ruminally cannulated lactating Holstein cows were used in a double 4 x 4 Latin square. Chewing time was measured visually, while saliva secretion during eating and resting was estimated by collecting swallowed saliva at the cardia. Cows were fed for ad libitum intake but DMI "18.2  $\pm$  0.6 kg/d" was similar for all diets. Level of concentrate in the TMR had no effect on eating time, but cows fed a TMR spent more time eating than cows fed SI "241 vs. 198 min/d;  $P < 0.05$ ". Rumination time decreased "P = 0.12" from 584, to 516, and 498 min/d as proportion of concentrate in the diet increased from 40, to 50, and 60%, respectively. Cows fed SI tended to ruminate more than cows fed a TMR "584 vs. 516 min/d; P = 0.12". Salivation rate during eating "115  $\pm$  8 ml/min" was not affected by proportion of concentrate in the TMR, but for cows fed SI, salivation rate was higher for concentrates than forage "201 vs. 94 ml/min;  $P < 0.05$ ". Estimates of the total amount of saliva secreted during eating tended to be lower for cows fed SI versus a TMR "23.5 vs. 28.6 L/d; P = 0.12", but there were no effects of proportion of concentrate in the TMR. Estimates of the total amount of saliva secreted during resting were similar for all diets "66.5  $\pm$  8 L/d". Results indicate that feeding a TMR rather than SI increases time spent eating and the amount of saliva secreted during eating, although this benefit may be negated by reduced rumination time. Feeding a TMR may be particularly beneficial when proportion of concentrate in the diet is high, as eating time and salivation rate were similar to that of a high forage diet.

**Key Words:** Dairy cow, Chewing activity, Saliva production

**1107 Effect of feeding corn meal or steam-rolled corn to lactating Holstein cows on total tract digestion, feeding behavior, milk yield and milk composition.** K. C. Uchida<sup>\*1</sup>, C. J. Sniffen<sup>2</sup>, C. S. Ballard<sup>2</sup>, P. Mandebvu<sup>2</sup>, and M. P. Carter<sup>2</sup>, <sup>1</sup>Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan., <sup>2</sup>W. H. Miner Agricultural Research Institute, Chazy, NY.

Sixty-six lactating multiparous Holstein cows (113546 days in milk) housed in a free-stall facility at Miner Institute in northeastern New York were blocked and randomly assigned to one of 3 dietary treatments containing on DM basis: 17% corn meal (CM); 17% CM and steam-rolled corn (SRC) mixed in a ratio of 1:1 (CMSRC); or 17% SRC. Diets were fed as total mixed rations (TMR) and were formulated using the CPM Dairy<sup>®</sup> model. The density (g/L) of CM and SRC respectively were: 635 and 553. The first 2 wk of the 8 wk-study were an adjustment period and data collected during this period were used as covariate in the statistical analysis of data collected in wk 6-8. Cows were fed test diets from wk 3-8. During wk 7 and 8, nutrient digestion by cows was determined using Cr<sub>2</sub>O<sub>3</sub> as an indigestible marker. The nutrient composition (%DM) of the CM, CMSRC, and SRC based TMRs, respectively were OM: 93.6, 92.4, 92.3; starch: 24.3, 23.9, 23.8; CP: 18.5, 18.6, 18.6; and NDF: 34.5, 34.5, 34.6. Apparent total tract digestibilities (%) of nutrients by cows fed CM, CMSRC, and SRC based TMRs, respectively were DM: 62.4, 63.5, 60.3 (SE=1.84); OM: 64.0, 64.7, 61.1 (SE=2.04); CP: 67.9, 68.4, 65.5 (SE=1.94); starch: 93.9, 96.5, 94.6 (SE=1.27); and NDF: 46.9, 46.8, 43.0 (SE=2.51). Data collected during wk 6-8 from cows fed CM, CMSRC, and SRC based TMR, respectively were time spent ruminating (min/d): 346, 438, 374 (SE=18.9); body condition score: 2.87, 2.95, 2.99 (SE=0.025); milk yield (kg/d): 39.5, 39.2, 39.6 (SE=0.35); 3.5% FCM yield (kg/d): 41.7, 40.9, 39.7 (SE=0.52); milk fat (%): 3.79, 3.81, 3.71 (SE=0.07); milk CP (%): 3.21, 3.23, 3.22 (SE=0.013); and milk lactose (%): 4.87, 4.90, 4.88 (SE=0.011). Cows fed TMRs containing SRC had better body condition ( $P=0.003$ ) and ruminated longer ( $P=0.032$ ). However feeding CM and SRC together did not significantly improve digestion of DM, OM, CP, starch or NDF, yield of milk and milk components. In conclusion feeding SRC mixed with CM improved the animal body condition and rumination when compared with CM. Partial or complete substitution of CM by SRC in diets for lactating dairy cows did not improve DM and nutrient digestion, milk yield, and milk composition.

**Key Words:** Key words: Dairy cow, Steam-rolled corn, Digestion, Milk yield, Feeding behavior

**1108 The effect of starch retrogradation on the nutritive value of corn hybrids.** K. F. Wilson<sup>\*1</sup>, C. R. Richardson<sup>1</sup>, and S. D. Soderlund<sup>2</sup>, <sup>1</sup>Texas Tech University, Lubbock, <sup>2</sup>Optimum Quality Grains, West Des Moines IA.

Ten commercially grown hybrids were used to determine the effects of starch retrogradation on the availability of crude protein, crude fat, fiber, total starch, enzyme susceptible starch (ESS); extent of dry matter disappearance; and presence of free moles of sulfhydryls (FMS). Each hybrid was evaluated in ground, steam-flaked (SF), and retrograded (RET) forms. Retrogradation was achieved by air drying each steam-flaked hybrid and then waiting 24 h before analysis. Pairs of samples of steamflaked and retrograded were compared to determine relative differences in the variables examined. Differences were ( $P<.05$ ) observed for individual hybrids across the treatments, and within hybrids across the ground, steam-flaked, and retrograded forms. Steam-flaking and retrogradation improved ( $P<.05$ ) crude protein, starch availability, and free moles of sulfhydryls. However, steam-flaking and retrogradation resulted in lower crude fat values across the hybrids. Differences ( $P<.05$ ) were also found for the dry matter disappearance. These data indicate a significant interaction of hybrid and processing treatment in all variables except ADF, 4 h dry matter disappearance, 8 h dry matter disappearance, and 24 h dry matter disappearance.

Form	Hyb ID									
	A	B	C	D	E	F	G	H	I	J
ESS										
SF	73.3	86.0	85.3	85.4	93.6	94.0	86.1	79.0	84.9	88.1
RET	86.8	79.2	83.1	74.7	85.1	81.3	75.0	78.2	79.6	80.0
FMS										
SF	.40	.35	.47	.31	.39	.43	.34	.37	.38	.41
RET	.29	.30	.32	.29	.35	.33	.30	.37	.31	.32

**Key Words:** Steamflaking, Corn hybrids, Nutrient composition

**1109 Comparing tempered and dry-rolled barley with and without the inclusion of yeast culture supplements in total mixed diets of early lactating dairy cows.** J.W. Schroeder, M.S. Laubach\*, D.B. Carlson, D.E. Schimek, W.L. Keller, and C.S. Park, North Dakota State University, Fargo, ND USA.

Objectives were to determine if tempered barley in combination with both a live yeast culture and a fungal extract preparation enhances the utilization of barley and alters the yield or composition of milk. Barley use promotes more rapid fermentation and lower ruminal pH. Tempering improves apparent dietary digestibility, while adding certain yeast cultures reduces lactic acid production and(or) improves nutrient utilization of forages in ruminants. Barley was tempered for 24 h at 20% moisture and rolled before adding to completely blended diets. Twenty-four primiparous and multiparous Holstein cows averaging 575 kg body weight and 46 d in lactation were stratified by age, days in milk, milk yield, and randomly assigned to one of four isonitrogenous, isocaloric barley-based diets: 1) tempered rolled barley (TRB-W); and 2) dry-rolled barley (DRB-W) with additives (a yeast culture and a source of fibrolytic enzyme, 9 and 15 g/d per cow, respectively); 3) tempered rolled barley (TRB-O); and 4) dry-rolled barley (DRB-O) without additives. Cows were fed the respective diets in Calan gates for nine wk. A univariate analysis was conducted for a fixed model blocked for variation due to feeding period. Substituting tempered for dry-rolled barley did not alter milk yield, dry matter intake (DMI), or body condition. Cows fed TRB-O had greater ( $P < 0.01$ ) concentrations of milk protein, lactose, solids-non-fat, and casein than DRB-O. Additives tended to diminish differences in milk components of cows fed tempered or dry-rolled barley, but did not affect fat-corrected milk yield or body condition. Milk urea nitrogen (MUN) levels were greatest ( $P < 0.01$ ) for cows on the DRB-O diet. Collectively, tempering and the addition of yeast and enzyme supplements lowered rumen ammonia ( $P < 0.001$ ) and subsequent MUN ( $P < 0.001$ ). Cows fed TRB-W had the lowest DMI, but no differences existed among treatments for corrected milk yield. Yeast and enzyme additives increased ( $P < 0.02$ ) both energy and protein efficiency, especially when used in combination with barley that was tempered versus dry-rolled prior to feeding.

**Key Words:** Barley, Dairy cattle, Tempered, Dry-rolled, Yeast supplements, Enzyme additives

**1110 Ruminal digestion of alfalfa hay and alfalfa hay:wheat straw mixtures by llamas (*Lama glama*).** M. S. Morales\*, R. Cabrera, A. Lopez, C. Navia, H. Salazar, and A. Fuentes, Universidad de Chile.

Ruminal utilization of alfalfa hay (AH) (100%, T1), AH : wheat straw (WS) (50:50, T2), and AH:WS (75:25, T3) was measured in 3 llamas with ruminal cannula in a 3x3 latin square; sampling was replicated on d 14 and 18 of each 21 d period. Feeds were ground to 2.5 cm particle size and llamas were limit fed once daily from 8 to 10 AM. AH and WS contained 43.5 and 70.5% NDF and 19.1 and 4.0% CP, resp. DM intakes by treatment were 0.78, 0.79 and 0.63 kg/d (<1% of BW). DM degradability (DMD) was measured in sacco at 0, 2, 4, 8, 12 and 24 hr. At the same times (except 24 hr) ruminal liquid was sampled for pH and VFA concentration. 24 hr DMD in sacco was 76.1±1.69 (mean±SD), 62.8±3.08 and 56.0±5.26% for T1, T2 and T3, resp. DMD was assessed by Orskov and MacDonald (J. Agric. Sci. Camb. 92:499, 1979), using a ruminal turnover rate for DM of 2.9% hr<sup>-1</sup>; a, b and c parameters of the DMD curve were 31.1, 48.6 and 0.14; 22.5, 46.3 and 0.09 and 19.1, 59.5 and 0.05 for T1, T2 and T3, resp. First order rate constants for DMD were (% hr<sup>-1</sup>) T1, 9.67; T2, 4.31; T3, 3.07. DMD of WS alone

was calculated by difference of DMD for 100% and 50% AH; by this estimate WS DMD was 2.23% hr<sup>-1</sup>, with little lag. Mean ruminal pH was: T1: 7.22±0.34, T2: 7.22±0.20, T3: 7.25±0.23 (P>0.05), and by time after feeding (hr): 0: 7.42a±0.29, 2: 7.11c±0.27, 4: 7.20b±0.22, 8: 7.20b±0.22 and 12: 7.23b±0.23 (P<0.05) with little change in relation with 0 time. Total VFA were not different by diet: T1: 74.5±19.5, T2: 77.8±14.5, T3: 74.3±16.0 mM (P>0.05). Acetic acid (C2) 59.8±11.3, propionic acid (C3) 16.0±3.3, butyric acid 12.5±3.4 and isovaleric acid 0.20±0.46 mM were different by time after feeding (P<0.05). C2:C3 molar ratios were different by diet: T1: 3.84b±0.56, T2: 4.10a±0.54 and T3: 3.98b±0.68, and by sampling time (P<0.05). DMD of different quality forages by llamas is similar to other ruminants.

**Key Words:** Llamas, Rumen Digestion

**1111 Effects of pH on microbial fermentation and nutrient flow in a dual flow continuous culture system.** P.W. Cardozo, S. Calsamiglia\*, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Eight 1325-mL dual flow continuous culture fermenters were used in two replicated periods (8 days) to study the effects of pH on microbial fermentation and nutrient flow. All fermenters were fed 95 g/d of a 60:40 forage to concentrate diet. Treatments were 8 different pH ranging from 4.9 to 7.0 (in .3 increases) and were randomly assigned to fermenters within period. Fermenters were maintained at 39°C, liquid and solid dilution rates were maintained at 10 and 5%/h respectively, and pH was controlled by infusion of 3N HCl or 5N NaOH. Results were analyzed for linear (L), quadratic (Q) and cubic (C) effects (P < .05). Cubic effects were observed for true digestion of OM (highest at pH 6.1, 54%; and lowest at 5.2, 35%), NDF (highest at pH 6.4, 37%; and lowest at pH 4.9, 12%) and ADF (highest at pH 6.1, 42%; and lowest at pH 5.2, 7%). Effects were Q for total VFA (highest at pH 7.0, 118 mM; and lowest at pH 4.9, 65 mM), L for acetate proportion (highest at pH 7.0, 71%; and lowest at pH 4.9, 51%), and C for propionate concentration (highest at pH 5.5, 35%; and lowest at pH 7.0, 15%), branched-chain VFA (highest at pH 7.0, 2.3%; and lowest at pH 5.5, .4%) and acetate to propionate ratio (highest at pH 7.0, 4.8; and lowest at pH 5.5, 1.5). Effects were C for ammonia N concentration (highest at pH 7.0, 14.1 mg N/dL; and lowest at pH 5.5, 3.2 mg N/dL), Q effects for bacterial N flow (highest at pH 6.4, 1.64 g/d; and lowest at pH 5.2, 1.0 g/d), L for dietary N flow (highest at pH 5.2, 2.03 g/d; and lowest at pH 6.7, 1.2 g/d). Crude protein degradation decreased linearly from 55% (pH 6.7) to 24% (pH 5.2). There were no pH effects on efficiency of microbial protein synthesis (mean of 36.7 g N/kg OM truly digested). Results indicated that microbial fermentation was optimal at pH between 6.1 and 6.7, and that most measurements followed a cubic response.

**Key Words:** Microbial fermentation, pH

**1112 Inhibition of fungal feed enzyme activities by silage extracts.** V.L. Nseroko\*, D.P. Morgavi<sup>1</sup>, K.A. Beauchemin<sup>1</sup>, L.M. Rode<sup>1</sup>, and A.F. Furtado<sup>1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada.*

Researchers have noted that feed enzymes are generally less efficacious when applied to silages as opposed to dry feeds. The reasons for this phenomenon are not clear. We investigated the presence, in silage, of soluble factor(s) that inhibit *Trichoderma* hydrolases. Samples of 14 different whole crop barley silages were homogenised in buffer at their original pH, and the liquid extracts clarified by centrifugation (10000 g; 20 min). An enzyme preparation (Pro-Mote; Biovance Tech., Omaha) was diluted in each extract or buffer alone (control) at the same pH. These solutions were assayed for cellulase (EC 3.2.1.4), xylanase (EC 3.2.1.8) and amylase (EC 3.2.1.1) activities using remazolbrilliant blue dyed (RBB) carboxymethyl cellulose, RBB-xylan and RBB-starch, respectively as substrates. The extracts inhibited xylanase and amylase activities by 23 to 51% (P<0.05). Three extracts showed some inhibition of cellulase activity (12 to 25%) but the rest had no effect (P>0.05). An 8-fold dilution of 1 extract retained an inhibitory activity, against xylanase, of 25%; only a dilution of 16-fold restored activities to those measured in buffer alone. The inhibitors were not proteases since autoclaved silage extracts retained inhibitory activity. Low M<sub>r</sub> filtrates of silage extracts (<10kDa) also retained inhibitory activity. Furthermore, inhibition was not related to levels of major organic acids or of total sugars present in the silages. With most available evidence suggesting that enzymic action is responsible for the beneficial effects of feed enzymes, the presence of hydrolase inhibitors may explain why these additives are

generally ineffective on silage diets. Additionally, since cellulase activity was relatively unaffected by silage extracts, these data may imply that exogenous cellulase activity is not a critical component of this particular feed enzyme preparation. We conclude that barley silages contain low M<sub>r</sub> thermostable factor(s) that inhibit *Trichoderma* xylanase and amylase activity but have little effect on cellulases.

**Key Words:** Feed enzymes, Silage, Inhibitors

**1113 Impact of a yeast culture, monensin or both on production of Holstein cows.** L.J. Erasmus\*<sup>1</sup>, P.H. Robinson<sup>2</sup>, R. Hinders<sup>3</sup>, and J.E. Garrett<sup>4</sup>, <sup>1</sup>*ARC - ANPI, Irene, RSA*, <sup>2</sup>*UCCE, Davis, CA*, <sup>3</sup>*Hinders Nutr. Cons., Acampo, CA*, <sup>4</sup>*Diamond V Mills Inc., Cedar Rapids, IA.*

Several studies report increased lactation performance of dairy cows fed yeast cultures (YC; XP, DVM) and monensin (M). Sixty mature Holstein cows were supplemented with YC, M, both (YCM) or neither (C), for approximately 21 d prepartum and 56 d postpartum. Rumen fluid was collected from all cows by rumenocentesis twice prepartum and thrice postpartum. There were no treatment differences in prepartum performance. Postpartum DM intake (DMI) was lower for M cows, and data suggested the extent of the suppression increased as the absolute DMI of individual cows increased (r=.52). In contrast, a numerical decrease in DMI for YC and YC/M cows was due to lower DMI for individual cows with lower absolute DMI, while cows with higher absolute DMI had higher DMI compared to C cows (r=.81). Crossover was 21 kg/d DMI. Milk, fat and lactose yields were higher for YC cows, while YC/M cows produced less milk and protein. Data suggested the suppression in protein yield for M cows increased as the absolute protein yield of individual cows increased (r=.56). In contrast, similar production of protein in YC vs. C cows masked a suppression in individual cows with lower protein yields, and an increase in those with higher yields (r=.74). Crossover was .95 kg/d. YC/M cows were similar to YC. NEL output, and calculated ration NEL concentration, was higher for YC cows. All treatments had some effects on rumen fermentation parameters. Results suggest that YC had a greater positive effect on performance as the absolute performance of individual cows increased while the effect of M was the opposite, with both potentially mediated by changes in rumen fermentation. The effect of YC/M was, in general, intermediate. Findings could be interpreted to suggest that YC is a better choice than M in cows with higher performance potentials, whereas M is a better choice in cows with lower performance potentials.

**Key Words:** Yeast culture, Monensin, Energy density

**1114 Ruminal fermentation and duodenal nutrient flow in sheep fed diets with different antibiotics.** H. Febel\*<sup>1</sup>, S. Fekete<sup>2</sup>, and Sz. Huszar<sup>1</sup>, <sup>1</sup>*Research Institute of Animal Breeding and Nutrition, Herceghalom, Hungary*, <sup>2</sup>*University of Veterinary Science, Budapest, Hungary.*

Even though many experimental investigations have been performed and published on the effects of antimicrobial agents on ruminal digestion, limited information is available detailing the connection between antibiotics and diet composition. The purpose of this study was to determine the ruminal effects of antibiotics dependent on diet. Nine wethers (62 kg) with cannulas in the rumen and proximal duodenum were used to study the effects of two different types of antimicrobial, salinomycin (S) and flavophospholipol (F) on characteristics of ruminal digestion. The influence of antibiotics was evaluated in animals fed three different amounts of rumen degradable protein (RDP) and nonstructural carbohydrate (NSC): high, 74% RDP-38% NSC (H), medium, 57% RDP-32% NSC (M), and low, 48% RDP-23% NSC (L). The treatments were applied in a 3x3 factorial arrangement of three levels of RDP and NSC (H, M, L) and three levels of antibiotic/animal/day supplementation (zero, 43 mg S, 22 mg F). Addition of S, independent of diet composition, decreased ruminal acetate:propionate ratio and ammonia concentration (P<.001). Ruminal ammonia content was lower (P<.01) in sheep fed on H diet with F. S supplementation, regardless of RDP and NSC contents of the diet, decreased (P<.05) the microbial N flow to the duodenum, the efficiency of microbial protein synthesis and ruminal degradation of dietary N, and these changes were associated with higher dietary N passage (P<.05). In contrast, F had no effect (P>.05) on the efficiency of microbial protein synthesis and improved N degradation in the rumen. The effect of F on the microbial breakdown of dietary protein was dependent on the feed composition. F increased (P<.05) the ruminal

degradation of protein in sheep fed M and L diets. This antimicrobial decreased ( $P < .05$ ) the bypass dietary N flow to the duodenum in sheep fed diet L. It seems that the effect of F was more dependent on dietary RDP and NSC contents than that of S.

**Key Words:** Salinomycin, Flavophospholipol, Sheep

**1115 Ruminal fermentation and flow of nutrients to the duodenum in goats fed ionophores and animal fat.** H.V. Janacua\*<sup>1</sup>, C.V. Villalobos<sup>1</sup>, C.S. Velez<sup>1</sup>, F.A. Rodriguez<sup>1</sup>, and A.D. Alarcon-Rojo<sup>1</sup>, <sup>1</sup>University of Chihuahua, Chihuahua, Mexico.

Five criollo goats (mean BW 35 kg) cannulated in rumen and duodenum were arranged in a 5 X 5 Latin square design to evaluate the influence of animal fat and ionophore on intake, digestion, and nutrients flow to the duodenum using Cr and purine bases as flow and microbial markers. Treatments were 1) control (no added fat or ionophore); 2) lasalocid (CL), lasalocid 33 ppm a/d; 3) monensin (CM), monensin 33 ppm a/d; 4) fat (CF), animal fat 3% DM; and 5) fat plus monensin (CFM). Supplements were offered at 0700 and 1900 h daily. Ruminal pH were not different ( $P > .05$ ) among diets (average 6.4). Ruminal ammonia concentrations were 16.5 to 20.4 mg/L, and did not differ between treatments ( $P > .05$ ). Ruminal VFA concentration were not different ( $P > .05$ ) among treatment; initial, peak, and average values were 85 to 110, 104 to 146, and 100 to 117 mm/L, respectively. Ruminal digestion of OM averaged 52% and was lower ( $P < .05$ ) when goats were fed CM diet. There were no differences ( $P > .05$ ) between CL and CFM in ruminal degradability of feed N. However, microbial N synthesis was greater ( $P < .05$ ) for the CM treatment. The flow of microbial N to the duodenum was higher ( $P < .05$ ) when goats were fed CFM and CF diets than when they were fed other diets. These data indicate that supplementation with animal fat and ionophore in diets for goats had minimal effects on digestion characteristics.

**Key Words:** Animal Fat, Digestion, Protein Synthesis

**1116 Effect of Monensin on protein fermentation of some feed sources.** L. T. Cunha, R. P. Lana\*, A. C. Borges, and J. S. Oliveira, Universidade Federal de Vicosa, Vicosa-MG, Brazil.

This research evaluated the effect of Monensin on protein degradation of soybean meal, wheat meal and corn meal. Ruminal fluid was taken from a fistulated steer on a 40% concentrate diet and centrifuged at 500g for 15 minutes to remove feed particles and protozoa. The incubations were performed in an anaerobic environment at 39°C using 100 mg of feed, 14.7 mL of ruminal fluid and 0.3 mL of ethanol with or without dissolved Monensin (5 µM as final concentration). The soybean meal resulted in ( $P < 0.05$ ) higher amounts of ammonia production, microbial protein and final pH compared with wheat meal and corn meal. The greater ammonia production was due to higher protein content and high degradability of the soybean meal and with higher media pH that stimulates deamination. Wheat meal had greater final pH than corn meal ( $P < 0.05$ ). Monensin decreased the protein degradability ( $P < 0.05$ ), although it was more effective in reducing protein degradation at higher pH values. Monensin increased efficiency of protein utilization by ruminants in diets with high protein and carbohydrate rates of fermentation and high ruminal pH, as would be true of pastures with young grasses and forage legumes.

**Key Words:** Ammonia, Monensin, pH

**1117 Effect of thymol on ruminal microorganisms.** J. D. Evans\* and S. A. Martin, University of Georgia, Athens.

Thymol is a phenolic compound that is used to inhibit oral bacteria. Because little is known regarding the effects of this compound on ruminal microorganisms, the objective of this study was to determine the effect of thymol on growth and lactate production by the ruminal bacteria *Streptococcus bovis* JB1 and *Selenomonas ruminantium* HD4. In addition, the effect of thymol on the in vitro fermentation of glucose by mixed ruminal microorganisms was investigated. Neither 45 or 90 µg/ml of thymol had any effect on growth or lactate production by *S. bovis* JB1, but 180 µg/ml of thymol completely inhibited growth and lactate production. Increasing concentrations of thymol decreased ( $P < 0.05$ ) glucose uptake by whole cells of *S. bovis* JB1 in a dose response manner. In the case of *S. ruminantium* HD4, 45 µg/ml of thymol had little effect on growth and lactate production. However,

90 µg/ml of thymol completely inhibited growth of *S. ruminantium* HD4. When mixed ruminal microorganisms were incubated in medium that contained glucose, 400 µg/ml of thymol increased ( $P < 0.05$ ) final pH and the acetate:propionate ratio and decreased ( $P < 0.05$ ) concentrations of methane, acetate, propionate, and lactate. In conclusion, thymol was a potent inhibitor of glucose fermentation by *S. bovis* JB1 and *S. ruminantium* HD4. Even though thymol treatment decreased methane and lactate concentrations and increased final pH in mixed ruminal microorganism fermentations of glucose, concentrations of acetate and propionate were also reduced.

**Key Words:** thymol, ruminal microorganisms, in vitro

**1118 Extruded-expelled cottonseed meal with lint as a source of rumen undegradable protein for lactating dairy cows.** M.J. Meyer\*, J.E. Shirley, A.F. Park, M.J. VanBaale, and E.C. Titgemeyer, Kansas State University, Manhattan.

Twenty-four multiparous Holstein cows (121 ± 23 DIM) averaging 40.8 kg/d energy corrected milk (ECM) were used in six 4x4 Latin squares with 21-d periods to evaluate extruded-expelled cottonseed meal (EC) as a source of rumen undegradable protein (RUP). Cows were blocked according to pretreatment milk yield and bodyweight and fed similarly prior to assignment to the following diets: 16% crude protein (CP), 35% RUP (SBM16); 18% CP, 35% RUP (SBM18); 16% CP, 40% RUP using EC (EC16); 16% CP, 40% RUP using a fish meal-blood meal blend (FB16). Diets with 35% RUP contained solvent soybean meal as the primary protein source. Alfalfa hay and corn silage were included in the diets at 25 and 20% of DM, respectively. Ground corn grain was the primary cereal grain. EC16 contained 8.4% EC and FB16 contained 3.2% fish meal and 0.8% blood meal (DM basis). Milk production by cows fed SBM16, SBM18, EC16, and FB16 was 36.7, 37.6, 37.2, and 37.2 kg/d, respectively, with no diet effect ( $P > .05$ ). DM intakes for cows fed SBM16, SBM18, EC16, and FB16 were 29.7, 29.6, 29.3, and 28.0 kg/d, respectively, with cows fed FB16 consuming less than ( $P < .05$ ) cows fed the other diets. Cows fed FB16 were the most efficient producers of milk ( $P < .05$ ), with others being equal. Somatic cells and percent milk fat, protein, casein, and SNF were not affected by diet, but percent lactose in milk was lowest ( $P < .05$ ) for cows fed EC16. MUN was similar between EC16 and FB16, but both were lower ( $P < .05$ ) than SBM18. MUN for cows fed SBM16 was lower than SBM18 ( $P < .05$ ), higher than EC16 ( $P < .05$ ), and similar to FB16. Bodyweight, BCS, and plasma NEFA, glucose, and total alpha-amino N were not influenced by diets. Plasma urea N was higher ( $P < .05$ ) for SBM18 than other diets. Results of this study suggest that extruded-expelled cottonseed meal with lint can be substituted for soybean meal or a fish meal-blood meal blend without affecting performance.

**Key Words:** Dairy, Extruded-Expelled Cottonseed, Rumen-Undegradable Protein

**1119 Determination of the amount of wet corn gluten feed to include in diets for lactating dairy cows.** M.J. VanBaale\*<sup>1</sup>, J.E. Shirley<sup>1</sup>, E.C. Titgemeyer<sup>1</sup>, M.J. Meyer<sup>1</sup>, A.F. Park<sup>1</sup>, R.U. Lindquist<sup>2</sup>, and R.T. Ethington<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Minnesota Corn Processors, Inc.

Twenty-four multiparous Holstein cows were blocked according to pretreatment milk yield, DIM, and bodyweight and used in six 4 x 4 Latin squares with 28-d periods to determine inclusion rates for wet corn gluten feed (WCGF) in diets for lactating dairy cows. Cows were housed in a tie stall barn and fed diets to meet or exceed NRC (1989) nutrient requirements. Diets were formulated to be isonitrogenous and isocaloric and fed twice daily as a total mixed ration. Treatments were 0, 20, 27.5, and 35% WCGF (DM Basis). WCGF was substituted in the diets for a portion of the alfalfa hay, corn silage, corn grain, and soybean meal. Milk yield (kg/d) and DMI (kg/d) for cows fed 0, 20, 27.5, and 35% WCGF were 37.8, 26.8; 41.6, 27.7; 41.6, 27.9; and 41.6, 26.5; respectively. Cows fed WCGF produced more ( $P < .01$ ) milk, ECM, and 4% FCM than cows fed the control diet, but these parameters did not differ among cows fed 20, 27.5, and 35% WCGF. Cows fed 0 and 35% WCGF had similar DMI as did those fed 20 and 27.5%. However, cows fed 20 and 27.5% WCGF consumed more DM ( $P < .01$ ) than those fed either 0 or 35% WCGF. Cows fed 20 and 27.5% WCGF produced ECM more efficiently ( $P < .01$ ) than those fed the control diet, and those fed 35% WCGF were more efficient ( $P < .01$ ) than all others. Fat percent in milk was less ( $P < .01$ ) from cows fed WCGF, but feeding WCGF did not

effect percent protein, lactose, and SNF, however total protein (kg/d) increased ( $P < .01$ ) relative to control. Plasma glucose, total alpha-amino N, and total triglycerides were similar among diets, but PUN increased ( $P < .01$ ) when cows consumed WCGF. Bodyweight, condition, and SCC were not affected by treatment. WCGF stimulated milk yield and improved efficiency of production when substituted in the diet for a portion of the forage, grain and protein supplement.

**Key Words:** Dairy, Wet Corn Gluten Feed

**1120 Portal-drained visceral (PDVF) flux and mammary uptake (MU) of free (FAA) and peptide-bound amino acids (PBAA) in lactating cows fed diets containing steam flaked corn (SF) at 360 or 490 g/l.** H. Tagari\*<sup>1</sup>, K. Webb<sup>2</sup>, B. Therer<sup>3</sup>, T. Huber<sup>3</sup>, P. Cuneo<sup>3</sup>, D. Deyoung<sup>3</sup>, A. Delgado-Elorduy<sup>3</sup>, M. Sadik<sup>3</sup>, A. Alio<sup>3</sup>, O. Lozano<sup>3</sup>, J. Simas<sup>3</sup>, C. Nussio<sup>3</sup>, P. Pu<sup>3</sup>, F. Santos<sup>3</sup>, and J. Santos<sup>3</sup>, <sup>1</sup>Hebrew University of Jerusalem, <sup>2</sup>Virginia Tech, Blacksburg, <sup>3</sup>University of Arizona, Tucson.

PDVF and MU of FAA and PBAA were quantified in six lactating Holstein cows fed TMR with 40% SF360 or SF490 at 12-h intervals in a crossover design. Blood was sampled via indwelling catheters in portal and milk veins and in costabdominal or mesenteric arteries every 2 h. DMI, NI, PDV and mammary plasma flows were similar for both diets and averaged 18.3 kg/d, 0.48 kg/d, 1392 l/h, and 399 l/h, respectively. Milk (28.3 vs. 26.9 kg/d;  $P < 0.05$ ) and milk CP (0.86 vs. 0.785 kg/d;  $P < 0.069$ ) yields differed for SF360 and SF490. PDVF of FAA and PBAA was greater in SF360 but the PDVF of PBAA as a proportion of FAA was greater in SF490 (14.2%) than for SF360 (11%). Amino acids with the greatest percentage PDVF occurring as PBAA, included HIS (27-59%), THR (26-55%), LYS (18-20%) and VAL (10-27%). MU of FAA and PBAA was greater for cows fed SF360, thus reflecting differences in milk and milk CP yields. LYS seems to be the first limiting AA as reflected by the greatest proportional uptake from the PBAA fraction, being 20 to 31% of free LYS uptake. The large MU of PBMET in excess of needs for milk production may be explained by its need for other metabolic purposes. PBAA appearing in the mammary vein may be the result of mammary degradation of plasma proteins.

Item, Diet, Pool	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL
PDVF, SF360, FAA	60.8	19.0	58.2	94.1	60.2	32.8	60.7	40.2	26.3	65.2
PDVF, SF360, PBAA	-4.7	<b>11.2</b>	5.6*	9.4	10.5*	-2.1	-3.9	10.6*		17.6*
PDVF, SF490, FAA	42.1	13.3	37.0	59.8	41.4	19.1	44.3	28.3	9.3	37.5
PDVF, SF490, PBAA	<b>-9.3</b>	3.6	7.0*	6.9	8.3*	-0.5	1.2	<b>15.7</b>		3.7
Milk, SF360	14.0	11.0	22.2	39.0	32.7	10.8	20.8	17.3		25.2
Milk, SF490	12.4	9.7	19.7	34.5	28.1	9.5	18.4	15.4		22.4
MU, SF360, FAA	27.8	10.5	29.5	48.3	24.4	9.3	20.2	14.9	4.9	34.9
MU, SF360, PBAA	<b>3.8</b>	-0.5	0.6	<b>2.8</b>	<b>7.6</b>	<b>6.2</b>	0.8	<b>3.3</b>		0.8
MU, SF490, FAA	24.7	8.4	25.7	43.3	21.3	9.3	17.6	14.4	6.0	28.8
MU, SF490, PBAA	<b>3.0</b>	0.4	-2.4	-0.1	<b>4.3</b>	<b>2.9</b>	-1.1	-0.9		1.2

Units = g/12h. **Bold** or with \*, values differ from zero at  $P < .05$  or  $P < .09$ , respectively.

**Key Words:** Mammary Gland, Absorption

**1121 Portal-drained visceral flux (PDVF) and mammary uptake (MU) of free (FAA) and peptide-bound amino acids (PBAA) in lactating cows fed diets containing steam flaked (SFS) or dry rolled (RDS) sorghum.** H. Tagari\*<sup>1</sup>, K. Webb<sup>2</sup>, B. Theurer<sup>3</sup>, T. Huber<sup>3</sup>, P. Cuneo<sup>3</sup>, D. Deyoung<sup>3</sup>, A. Delgado-Elorduy<sup>3</sup>, M. Sadik<sup>3</sup>, A. Alio<sup>3</sup>, O. Lozano<sup>3</sup>, J. Simas<sup>3</sup>, C. Nussio<sup>3</sup>, P. Pu<sup>3</sup>, F. Santos<sup>3</sup>, and J. Santos<sup>3</sup>, <sup>1</sup>Hebrew University of Jerusalem, <sup>2</sup>Virginia Tech, Blacksburg, <sup>3</sup>University of Arizona, Tucson.

PDVF and MU of FAA and PBAA were quantified in eight lactating Holstein cows fed TMR with 40% SFS or DRS at 12-h intervals in a crossover design. Blood was sampled via indwelling catheters in portal and milk veins and in costabdominal or mesenteric arteries every 2 h. DMI, NI, were: 16 and 18 and .45 and .51 kg/24h on SFS and DRS diets and milk yield and milk CP yields were 27.7 vs. 26.5 and 0.85 vs. 0.792 kg/d. PDVF and mammary plasma flows were similar for both diets at 1,287±183 and 399±62 l/h. PDVF of FAA was similar for both diets but that of PBAA was 18.6% of PDVF of FAA in SFS compared with 9.3% in DRS (about half the SFS diet). The highest proportion of PDVF of PBAA was HIS, averaging 68% for both diets. Proportions of LYS and VAL differed for both diets. LYS was higher for SFS than DRS (55% vs 29%) and the opposite was true for VAL with DRS having the higher value (DRS, 12% vs SFS, -10%). The effect ( $P < .05$ ) of SFS diet on PDVF of PBARG and PBLEU may indicate that these PBAA are a result of the effect of the diet and are not residues from metabolism. Extensive MU of PBLYS was observed in both treatments to furnish the shortage of this FAA in the plasma. PBAA appearing in the mammary vein may be the result of mammary degradation of plasma proteins.

Diet, Tissue, Pool	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL
DRS, PDVF, FAA	38.4	11.7	43.3	74.5	35.4	18.7	44.8	29.8	11.8	48.9
DRS, PDVF, PBAA	3.5	<b>7.9</b>	-1.9	4.4	<b>10.1</b>	6.0	3.0	3.2		-4.7
DRS, Milk	12.8	9.8	20.1	35.1	30.5	9.8	18.5	15.7		22.8
DRS, MU, FAA	24.5	8.6	26.5	46.7	22.7	11.4	18.0	13.5	6.0	29.4
DRS, MU, PBAA	1.3	1.5	-0.8	-0.7	<b>5.4</b>	0.7	1.0	0.6		0.1
SFS, PDVF, FAA	33.1	13.9	39.7	65.1	27.3	14.6	38.8	24.7	13.7	56.5
SFS, PDVF, PBAA	<b>4.2</b>	<b>9.5</b>	10.4	<b>8.4</b>	<b>14.9</b>	1.2	-1.6	7.5		6.4
SFS, Milk	14.1	10.9	21.8	37.9	33.0	10.6	20.2	16.8		24.7
SFS, MU, FAA	24.1	9.3	28.8	44.0	21.7	12.6	19.2	14.8	8.0	26.4
SFS, MU, PBAA	-1.1	-2.5	1.2	0.8	2.3	1.6	0.3	-0.2		-0.9

Units = g/12h. **Bold** values differ from zero at  $P < .05$ .

**Key Words:** Mammary Gland, Absorption

**1122 Effects of duodenal infusion of graded amounts of Phe on mammary uptake and metabolism in dairy cows.** H. Rulquin\*<sup>1</sup> and P.M. Pisulewski<sup>2</sup>, <sup>1</sup>UMRPL INRA, St Gilles, France, <sup>2</sup>Agricultural Univ., Cracow, Poland.

Phe is one of the proposed limiting amino acids for dairy cow. However, its requirement and the dynamic of its metabolism in the mammary gland are poorly documented. A 4x4 Latin square was realized to study effects of duodenal infusion of graded amounts of Phe (0, 6, 21, and 37 g/d) during 4 days on mammary uptake and milk secretion in Holstein cows. Diet covered 100 and 75% of energy and protein requirements. An extra duodenal infusion of 430 g/d of free Phe mixture of Met, Lys, Thr, Leu, Trp, Val, Ile, His, Arg, Tyr and Glu was used to meet 110% of protein requirements. Supply of Phe provided 75, 100, 125, and 150% of the expected requirements for the 4 treatments respectively. Cows

equipped with a duodenal cannula and an ultrasonic blood flow probe fitted around a pudic artery were sampled for arterial (carotid) and venous blood (subcutaneous) 6 times during 12 hours. Milk yield was unaffected by infusions. True protein concentration of milk increased significantly to a plateau at the second dose infused (3.22, 3.35, 3.40, and 3.35 %). Arterial concentrations of Phe and Tyr in plasma increased linearly for Phe and quadratically for Tyr (0.65, 0.74, 0.86, and 0.87 mg/100 ml for Phe; 0.65, 0.74, 0.86 and 0.87 mg/100ml for Tyr). Mammary extraction rate linearly decreased (62, 53, 38, and 35% for Phe; 47, 43, 38, and 33% for Tyr), whereas mammary uptakes were not significantly affected. Ratio of plasma uptake of Phe and Tyr to milk output were always close to 1 (0.99, 1.01, 0.78, and 1.07 for Phe; 1.04, 1.03, .84, and 0.90 for Tyr). It is concluded that 1) mammary uptakes of Phe and Tyr are independent from their arterial levels, 2) optimum of dietary Phe concentration is located between 4.6 and 5.8% of Phe truly digested in the small intestine (PheDI) in proteins truly digested in the small intestine (PDI).

**Key Words:** Phe, Mammary metabolim, Dairy cow

**1123 A blood procedure to determine bioavailability of rumen-protected Met for ruminants.** H. Rulquin<sup>\*1</sup> and J. Kowalczyk<sup>2</sup>, <sup>1</sup>UMRPL INRA, St Gilles, France, <sup>2</sup>IFZZ, Jablonna, Poland.

In vitro or in sacco methods used to test the efficiency of process of protection of amino acids against ruminal degradations are not satisfactory because liquid or pulverulent products can not be tested, and differences in intestinal absorption are not evaluated. An in vivo method based on blood responses was tested on six commercial products. The principle of the method is to predict the bioavailability of Met provided by a rumen-protected product from a blood response-curve calibrated with duodenal infusions of graded doses of crystalline Met. Animal response calibration, and tests of commercial products were performed on three dried-off cows fitted with rumen and duodenum cannula by infusing water, 3, 15, 20 and 30g of D-L Met, or by introducing protected products in the rumen twice a day, 15 min after meals. Code of products, process of protection, Met content and amounts supplied were respectively: A (pH-sensitive coating, 78%, 30g/d), B (pH-sensitive coating, 17%, 76g/d), C (fat coating, 26%, 50g/d), D (fat and ethyl-cellulose encapsulation, 85%, 24 g/d), E (fat coating, 54%, 50g/d), and F (Zn-chelating and fat coating, 30%, 66g/d). Each supplement was given during four days, and the last day blood samples were withdrawn every six hours during 12 h through a catheter inserted in the jugular. Met was dosed on a pooled sample of deproteinized plasma by ion exchange chromatography. Results were tested by variance and covariance analysis. Calibration curve was linear and not significantly different between cows (Met supplied =  $0.287 \pm 0.05 + (0.039 \pm 0.003) \times \text{Met mg/100ml plasma}$ ;  $R^2 = 0.96$ ,  $SE = 0.12$ ). Met bioavailability of the products is A=75, B=65, C=-1, D=16, E=0 and F=30%. With a standard error of mean of 11%, differences are significant ( $P < 0.05$ ) for products A and B vs. the others, and C vs. F. The calibration used in this procedure permits the measurement of the absolute value of bioavailability of Met of rumen-protected products. Using four cows will allow detecting differences in bioavailability between products of 20%.

**Key Words:** Rumen-protected Met, Bioavailability, Dairy cow

**1124 The effect of rumen protected methionine on milk production and milk composition in first lactation Holstein cows fed high protein diets.** J. D. Ferguson<sup>\*1</sup>, B. Veccharelli<sup>1</sup>, J. Beach<sup>1</sup>, and S. Takenaka<sup>2</sup>, <sup>1</sup>University of Pennsylvania, Kennett Square, <sup>2</sup>Nisso America, Inc. New York, NY.

Forty seven first lactation animals were randomly assigned to one of two precalving diets and postcalving diets to examine the effects of rumen protected methionine (RPMET) on production and reproduction. Precalving diets contained 15.3% CP and 1.56 mcg/kg of net energy. At calving, cows were randomly assigned to diets containing 17.5% CP with 38% of the protein as RUP and a net energy of 1.72 mcg/kg. Ration ingredients were mixed together in a TMR and offered once a day to 10% feed refusal. Both precalving and postcalving, one group of animals received a top dress of .45 kg of ground corn containing 20 g of RPMET (Met-PlusR) and the other group received a top dress of .45 kg of ground corn alone. Animals were fed the precalving diets for 21 to 60 days prior to calving. Lactating cows were fed the RPMET through 100 days post calving. Feed intake was measured daily for each group of 12

animals. Milk production was measured twice a day. Body weight and body condition score was measured weekly. Once a week, milk samples from a.m. and p.m. milking were composited, preserved with bronopol, and analyzed for fat, crude protein, true protein, milk urea nitrogen, and solids not fat by the PA DHIA milk testing laboratory, University Park, PA. Results were as follows: Values (sem) with different superscripts in same column differ by  $p < .10$ .

Dietary Treatments	Milk, kg	Fat, %	CP,%	TrProt,%
MET-MET	28.5a	3.85	3.25a	3.13ac
No-No	28.8a	3.58	3.18b	3.06a
MET-No	27.6a	3.81	3.26a	3.17bc
No-MET	25.8b	3.70	3.34a	3.24b

**Key Words:** Methionine, Rumen protected, Production

**1125 Effect of source of bypass protein and supplemental Alimet<sup>®</sup> and Lysine-HCL on lactation performance.** J. H. Harrison<sup>\*1</sup>, D. Davidson<sup>1</sup>, L. Johnson<sup>1</sup>, M. L. Swift<sup>2</sup>, M. von Keyserlingk<sup>2</sup>, M. Vazquez-Anon<sup>3</sup>, and W. Chalupa<sup>4</sup>, <sup>1</sup>Washington State University, Puyallup, <sup>2</sup>Agro Pacific Ind., Ltd., Chilliwack, B.C., Canada, <sup>3</sup>Novus, Int., St. Louis, MO, <sup>4</sup>University of Pennsylvania, Kennett Square.

Two commercially available bypass protein sources (Prolak<sup>TM</sup>- animal based, H J Baker and Ami Pro<sup>TM</sup> vegetable based, Pro Form Feeds) were compared with and without added lysine HCL and Alimet<sup>®</sup> feed supplement. Diets were formulated with CPM Dairy to meet 100 % of required Met and Lys (diets Ami Pro<sup>TM</sup> and Prolak<sup>TM</sup>) or 116 % of Met and 106 % of Lys (diets Ami+ and Pro+). Respective diets were fed from 3 wk prepartum through wk 17 postpartum to 98 Holstein cows in a continuous trial design. Cows were fed individually via Calan headgates. Detailed data are summarized below. No statistical differences were observed between bypass protein sources with or without supplemental Lys and Met. However, trends were for increased Milk, FCM, and yield of components when either protein source was supplemented with Lys and Met. Cows yielded the greatest (numerically) amount of Milk, FCM, and components when fed Prolak<sup>TM</sup> plus supplemental Lys and Met.

Item	Amipro <sup>TM</sup>	Ami+	Prolak <sup>TM</sup>	Pro+	SE	P <
DMI, kg	21.95	21.83	22.16	21.69	.6	NS
Milk, kg	38.78	38.87	39.57	39.75	1.32	NS
3.5% FCM, kg	39.51	39.8	40.59	41.4	1.31	NS
Milk fat, kg	1.4	1.42	1.45	1.49	.05	.11
Milk protein, kg	1.19	1.19	1.22	1.3	.06	NS

<sup>®</sup> Registered trademark of Novus Int., St. Louis, MO.

**Key Words:** Protein, Milk, Amino acids

**1126 Metabolism of 2-hydroxy-4-methylthio butanoic acid (HMB) in growing lambs.** T.J. Wester<sup>1</sup>, M. Vazquez-Anon<sup>2</sup>, D. Parker<sup>2</sup>, J. Dibner<sup>2</sup>, A.G. Calder<sup>1</sup>, and G.E. Lobley<sup>\*1</sup>, <sup>1</sup>Rowett Institute, Aberdeen, UK, <sup>2</sup>Novus International, St. Louis, MO.

HMB is an effective source of methionine (Met) in non-ruminant diets although the sites of its metabolism remain unclear. The objective of the current study was to examine the extraction of HMB by the liver and the consequences on Met metabolism in ruminants. Four sheep (initial body weight 50 kg) were prepared with catheters in the aorta, mesenteric, portal, hepatic and jugular veins plus the abomasum. To ensure metabolic steady state sheep were fed hourly at 1.5 x maintenance on a grass hay, barley, fishmeal, molasses/premix (5:3:1:1) diet. Animals were infused for 12 h with [1-13C]Met in a jugular vein and, from 3 h onwards, successive 3 h infusions of saline (control), 0.55 mg/min and 4.4 mg/min HMB into the mesenteric vein. Plasma samples, collected continuously, were taken every 20 min during the last 80 min of each infusion. All infused HMB was recovered at the portal vein but 25% was extracted subsequently by the liver. Portal appearance of Met and cystine (Cys) was unaltered by HMB infusion. Net splanchnic output of Met, however, decreased (0.14, -0.01, -0.21 mmol/h, SED 0.07,  $P = 0.02$ ) while that of Cys increased (0.04, 0.08, 0.23 mmol/h, SED 0.07,  $P = 0.07$ ) with increasing rates of HMB infusion. Despite the lack of release of dietary Met into the peripheral circulation arterial concentrations of Met increased (27.0, 30.7, 51.5 uM, SED 3.0,  $P < 0.001$ ) as did Met irreversible loss rate (1.78, 1.84, 2.53 mmol/h SED 0.15,  $P <$

0.001). The increase in Met irreversible loss rate was the equivalent of 40% of the HMB delivered beyond the liver entering the plasma Met pool following metabolism by peripheral tissues. These data indicate that the liver does not secrete into circulation the Met derived from the extracted HMB although it may contribute to increase Cys output. The results also suggest that HMB is being extensively metabolised by extra-hepatic tissues.

**Key Words:** HMB, Methionine, Absorption

**1127 Synthesis of methionine (Met) from 2-hydroxy-4-methylthio butanoic acid (HMB) in growing lambs.** T.J. Wester<sup>1</sup>, M. Vazquez-Anon<sup>2</sup>, D. Parker<sup>2</sup>, J. Dibner<sup>2</sup>, A.G. Calder<sup>1</sup>, and G.E. Lobley<sup>\*1</sup>, <sup>1</sup>Rowett Institute, Aberdeen, UK, <sup>2</sup>Novus International, St. Louis, MO.

Previous data have suggested that HMB is converted to Met by peripheral tissues in sheep. This was examined by following the metabolism of [1-<sup>13</sup>C]HMB. Four sheep (initial body weight 50 kg) were prepared with catheters in the aorta, mesenteric, portal, hepatic and jugular veins plus the abomasum and fed at 2.5 × maintenance on a grass hay, barley, fishmeal, molasses/premix (5:3:1:1) diet. To ensure metabolic steady state the diet was fed as hourly meals. Sheep were infused with unlabelled HMB (1.1 mg/min) into the abomasum for 24 h followed by [1-<sup>13</sup>C]HMB for 6h, during which time [2H<sup>3</sup>]methionine was infused into the mesenteric vein. During the last 2 h of infusion continuously withdrawn plasma samples were collected at 30 min intervals from the aorta, portal and hepatic veins. Recovery of infused HMB was 75% at the portal vein, with 36% of this extracted by the liver. HMB contributed 10% to overall Met irreversible loss rate (2.8 mmol/h) which was equivalent to 40% of absorbed Met (0.67 mmol/h) and similar to the amount of HMB that appeared beyond the liver (0.21 mmol/h). Enrichment of [1-<sup>13</sup>C]Met was greater in arterial than in either portal or hepatic plasma (8.94, 7.37, 7.61 molar % excess, SED 0.17, P < 0.001). The ratio of <sup>13</sup>C:2H<sup>3</sup> Met enrichments was also greater in arterial than portal or hepatic plasma (2.19, 1.75, 1.54, SED 0.094, P = 0.001). These data suggest the involvement of post-splanchnic tissues in the synthesis of Met from HMB. This was confirmed from analysis of the <sup>13</sup>C:2H<sup>3</sup> free Met enrichments from visceral tissues where Met synthesised from HMB represented from 22 to 26% (P < 0.001) of Met present within the cells (kidney > liver > rumen > jejunum > duodenum > ileum). Other peripheral tissues (lung, brain, muscle, skin) also synthesised Met from HMB but this represented a smaller proportion (<5% of intracellular Met). These results indicate that HMB is being converted to Met and used directly to meet tissue requirements.

**Key Words:** HMB, Methionine, Amino acid metabolism

**1128 Dipeptides or their amino acids administered to a perfused area of the skin in Angora goats.** R. Puchala<sup>1</sup>, S.G. Pierzynowski<sup>2</sup>, T. Wuliji<sup>1</sup>, A.L. Goetsch<sup>1</sup>, S.A. Soto-Navarro<sup>1</sup>, T. Sahlui<sup>1</sup>, and M. Lachica<sup>3</sup>, <sup>1</sup>E (Kika) de la Garza Institute for Goat Research, Langston, OK, <sup>2</sup>Dept. Of Zoophysiology, Lund University, Lund, Sweden, <sup>3</sup>Animal Nutrition Department, Estación Experimental del Zaidín (CSIC), Armilla, Spain.

Effects of infusion of dipeptides or their amino acids on mohair growth of Angora goats were investigated using a skin perfusion technique. Six Angora wethers (average BW 30 ± 3 kg) were implanted bilaterally with silicon catheters into the superficial branches of the deep circumflex iliac artery and into the deep circumflex iliac vein. For the first 14 d of the experiment, animals were infused into the deep circumflex iliac arteries with a mixture of Met-Leu and Lys-Leu on one side and similar amounts of free amino acids on the other side. The infusion rate of dipeptides were .85 mg Met-Leu and .85 mg Lys-Leu/h in 2.4 ml saline. Infusion rates of amino acids were .474 mg Lys, .483 mg Met and .743 mg Leu/h in 2.4 ml saline. The area of skin supplied by the deep circumflex iliac artery was approximately 300 cm<sup>2</sup>. An area of 100 cm<sup>2</sup> within the perfused region was used to determine mohair growth. Two weeks after the cessation of infusions, perfused areas were shorn. Greasy mohair production from the perfused region was similar for dipeptide infusion compared with free amino acids (5.56 vs 5.69 g/100 cm<sup>2</sup> for the 28 d period, respectively, P > .1). However, mohair production was relatively higher than that observed when only saline was infused for 28 d preceding the experiment (4.71 g/100 cm<sup>2</sup>). No significant changes were observed in concentrations of amino acids, glucose or hormones in blood from the deep circumflex iliac vein (P > .1). In conclusion, the effects of

supplementing mohair-producing skin with limiting amino acids given in the free form and as small peptides, had similar effect on mohair growth.

**Key Words:** Peptide and Amino Acids, Skin Perfusion, Mohair

**1129 Action of hydroxy methyl butanoic acid (HMB) on microbial growth and metabolism.** B. K. Sloan<sup>\*1</sup>, W. H. Hoover<sup>2</sup>, T. K. Miller Webster<sup>2</sup>, C. G. Schwab<sup>3</sup>, and N. L. Whitehouse<sup>3</sup>, <sup>1</sup>Aventis Animal Nutrition, Alpharetta, GA, <sup>2</sup>West Virginia University, Morgantown, <sup>3</sup>University of New Hampshire, Durham.

The effect on ruminal fermentation parameters of three HMB concentrations (0, 0.11, and 0.22 % of DM) were tested on two diets in a continuous culture system (Stern and Hoover, 1990). Diets 1 (CORN) and 2 (BARLEY) contained respectively (% of DM) : corn silage (31.3, 31.3), haycrop silage (14, 14), soyhulls (6.0, 0), ground corn (25.3, 5.5), barley (0, 26.7), whole cottonseed (0, 7.4), soybean meal (11.5, 4.4), SoyPass<sup>TM</sup> (5.7, 2.2), bloodmeal (0, 2.1), Alifet<sup>TM</sup> (2.8, 0.5), tallow (0, 0.7), mineral vitamin premix (3.6, 3.4) and were designed to satisfy the energy and protein requirements of a dairy cow producing 45 kg of milk. Diets were as fed during an accompanying dairy trial (Johnson et al 1999). The six rations were fermented in continuous culture operated with a 12% liquid and 4.2% solids dilution rate. There were 4 replicates per treatment. Main effects were analysed as a 3\*2 factorial. CORN diets were more completely digested (P<0.01) than BARLEY diets (DM; 69.8 vs 63.6, OM; 49.6 vs 44.2, ADF; 41.7 vs 30.1, NDF; 47.3 vs 42.4, CP; 65.5 vs 58.5). The following HMB results are all presented in order of increasing dietary concentration of HMB. The intermediate HMB concentration resulted in elevated digestibility (quadratic effect) of CP (59.1 vs 69.5 vs 57.4 ; P<0.01), increased non ammonia nitrogen flow (2.69 vs 2.76 vs 2.64 g/d ; P<0.07), increased microbial-N production (1.44 vs 1.83 vs 1.35 g/d ; P<0.01) and a reduction in fermenter ammonia levels (10.3 vs 8.3 vs 11.5 mg/dl ; P<0.01), resulting in an increase in microbial protein efficiency (33.1 vs 40.4 vs 32.4 g N/kg OM digested ; P<0.01). Volatile fatty acid concentrations and proportions were unaffected by level of HMB. Irrespective of diet type, the results indicate there is an optimum concentration of dietary HMB ( 0.11%) that facilitates an improvement in protein digestion and assimilation of N into microbial protein.

**Key Words:** HMB, Microbial protein efficiency, Continuous culture

**1130 Deoxyribonuclease activity in the ruminal bacteria *Selenomonas ruminantium* and *Streptococcus bovis*.** S. F. Al-Khaldi, L. L. Durocher, and S. A. Martin<sup>\*</sup>, University of Georgia, Athens.

Six *Selenomonas ruminantium* strains (132c, JW13, SRK1, 179f, 5521c1, and 5934e) and *Streptococcus bovis* JB1 were examined for nuclease activity as well as the ability to utilize nucleic acids, ribose, and 2-deoxyribose. Nuclease activity was detected in sonicated cells and culture supernatants for all bacteria except *S. ruminantium* JW13 and 179f sonicated cells. *S. ruminantium* strains were able to utilize several deoxyribonucleosides, while *S. bovis* JB1 showed little or no growth on all deoxyribonucleosides. When *S. ruminantium* strains 5934e, 132c, JW13, and SRK1 were incubated in medium that contained 15 mM ribose, acetate, propionate, and lactate were the major end products. *S. ruminantium* 5521c1 and *S. bovis* JB1 did not grow on ribose, and none of the *S. ruminantium* strains or *S. bovis* JB1 grew on 15 mM 2-deoxyribose. In conclusion, all *S. ruminantium* strains and *S. bovis* JB1 had nuclease activity. However, not all bacteria were able to utilize deoxyribonucleosides, ribose, or 2-deoxyribose. More research is needed to characterize the proteins involved in DNA degradation as well as the metabolism of deoxyribonucleosides and ribose in these bacteria. In particular, understanding how DNA is degraded and metabolized by *S. ruminantium* may lead to the construction of a transformable mutant.

**Key Words:** ruminal bacteria, nuclease, deoxyribonucleosides

**1131 The effects of cutting height on nutritive value of corn silage.** A. Garcia<sup>\*</sup>, C. Velázquez, P. Marinho, K. Cresci, I. Garmendia, and J. Piaggio, Facultad de Veterinaria, Montevideo, Uruguay.

The purpose of this study was to determine if the increase in corn silage nutritive value resulting from a higher length of cut offsets the decrease in total dry matter (DM) and thus digestible nutrient yields. Corn at



half milk stage was hand harvested and chopped with a one-row forage harvester leaving stubbles in the field of 15 (LC) and 90 (HC) cm. Total DM yield was determined by cutting and weighing representative areas from both treatments. Treatments were then ensiled in microsilos and allowed to ferment for 41 days. No differences in pH between treatments were found. Treatment LC yielded 28% more DM per hectare, had more NDF (46.5 vs 42.3%) and ADF (25.2 vs 19.5%) than HC ( $P < .05$ ). The latter had more DM (44.2 vs 38.7%), CP (5.9 vs 5.1%), and organic matter (39.7 vs 34.0%) than LC ( $P < .05$ ). There was a trend (61.9 vs 58.9%) for HC to have higher *in vitro* DM digestibility ( $P < .07$ ). In this trial the increase in nutritive value as a result of a higher cutting height did not offset the decrease in total digestible nutrients harvested. Possible reasons could be the variety and stage of maturity at harvesting. Nevertheless adjusting cutting height could be a useful strategy when energy dense rations have to be formulated in the presence of high grain prices.

**Key Words:** Corn silage, Harvesting height

**1132 Yield, chemical composition and ruminal degradability of *Brachiaria humidicola* (Rendle) Schweick at seven clipping stages under dry tropical conditions.** J. Vergara-Lopez\* and O. Araujo-Febres, *La Universidad del Zulia, Facultad de Agronomía, Maracaibo, ZU 4005. Venezuela. jvergara.luz.ve.*

Plots of *Brachiaria humidicola* were clipped at 14, 28, 42, 56, 70, 84 and 98 days to assess yield, chemical composition and ruminal degradability during dry (DS) and rainy season (RS). Dry matter (DM), organic matter (OM), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) and lignin (Lig) were determined on field samples. Degradability of DM and CP were evaluated utilizing two steers with permanent rumen canulae. Three mathematical models were evaluated: first order kinetics (FOK), FOK with discrete lag phase (FOL) and sigmoidal (SIG). Yield increased ( $P < .05$ ) from 1099.3 kg ha<sup>-1</sup> clipping<sup>-1</sup> (14d) to 2654.0 kg ha<sup>-1</sup> clipping<sup>-1</sup> (98d) and from 1547.1 kg ha<sup>-1</sup> clipping<sup>-1</sup> (14d) to 3092.7 kg ha<sup>-1</sup> clipping<sup>-1</sup> (98d) on DS and RS respectively. DM increased ( $P < .05$ ) from 41.1% (14d) to 47.7% (98d) during DS and from 35.7% (14d) to 43.0% (98d) during RS. OM remains constant along ages during DS (89.0%), while during RS it increased ( $P < .05$ ) from 84.7% (14d) to 90.3% (98d). CP decreased ( $P < .05$ ) from 6.6% (14d) to 4.8% (98d) and from 8.5 (14d) to 4.3% (98d) during DS and RS respectively. NDF remains constant along ages (70.6% and 76.0% for DS and RS, respectively). ADF during RS (37.9%) was higher ( $P < .05$ ) than DS (40.5%). Lig remains constant along DS (4.38%), while in RS it increased from 5.0% (14d) to 6.3% (98d). DM degradability was affected by season and mathematical models estimation: 77.6% and 80.4% for FOK, 44.7% and 42.0% for FOL and 75.2% and 78.1% for SIG during DS and RS, respectively but not by ages. CP degradability had a similar performance: 63.8% and 65.5% for FOK, 51.0% and 63.9% for FOL and 61.9% and 63.7% for SIG during DS and RS, respectively. Season affected yield, OM, CP, FDA, Lig and DM and CP degradability. We recommend to use SIG to evaluate ruminal degradability.

**Key Words:** *Brachiaria humidicola*, dry matter yield, rumen degradability

**1133 Effects of corn silage or high moisture corn supplementation on performance of beef heifers grazing high quality pastures.** L. O. Abdelhadi\*<sup>1,2</sup>, F. J. Santini<sup>1</sup>, G. A. Gagliostro<sup>1</sup>, and C. A. Cangiano, <sup>1</sup>Fac. Cs. Agrarias. UNMdP-INTA EEA Balcarce, <sup>2</sup>CONICET.

The objective of the experiment was to evaluate if replacing high quality fresh pasture with corn silage (CS) or high moisture corn (HMC) could affect liveweight gain (LWG) and fat deposition rate (FDR). Forty-eight British heifers averaging 10 months of age and 196 kg of liveweight (LW) at the start of the experiment were assigned to three treatments in a randomized design. In T0 fresh pasture was the sole component of the diet; in T1 CS was included at 40% of the diet and in T2 HMC was included at 31% of the diet (on a DM basis). All heifers grazed in a one-day strips throughout 81 days from August to October, a mixed pasture containing 80% grass and 20% legume. Herbage mass averaged 3416±838 kg DM/ha and parameters of pasture quality were: DM 30±1.6%; CP 12.6±2.4%, NDF 46.6±3.8%; IVOMD 69.9±3.3% and a soluble carbohydrate content of 18.1±3.4%. Supplements contained 6.9 and 10% CP; 45.7 and 9.8% NDF; 21.5 and 64.5% starch; 61.7 and 87.2% IVOMD and were consumed at a rate of 2.9±0.4 (1.06% of LW) and 2.7 (1% of

LW) kg DM/animal/day, for CS and HMC respectively. Total DM intake (DMI) was estimated in eight heifers per treatment using Cr<sub>2</sub>O<sub>3</sub> as a fecal marker. FDR was estimated measuring fat cover (FC) between 11-12<sup>th</sup> rib using an ultrasonic ecograph. Jugular blood samples were obtained to measure glucose and urea concentrations. Supplementation of high quality pasture with CS or HMC, allowed to increase stocking rates from 4.2 in T0 up to 7 (T1) and 6.2 (T2) heifers/ha and beef production from 320 in T0 up to 499 (T1) and 467 (T2) kg/ha, without decreasing LWG and FDR of the animals.

Item	T0	T1	T2	SEM
DMI, kg/d	7.24 <sup>b</sup>	6.68 <sup>b</sup>	8.54 <sup>a</sup>	0.25
Initial LW, kg	198.6	198.9	188.7	3.85
Final LW, kg	277.2	268.7	264.1	4.05
LWG, kg/d	0.94	0.88	0.93	0.03
Initial FC, mm	2.52	2.22	2.23	0.12
Final FC, mm	4.05	4.23	3.67	0.25
FDR, mm/30d	0.75	1.05	0.60	0.30
Glucose, mg/dl	51.9 <sup>c</sup>	77.2 <sup>a</sup>	62.1 <sup>b</sup>	0.02
Urea, mg/dl	29.7	23.9	17.1	0.04

<sup>abc</sup>Means within a row with unlike superscripts differ ( $P < 0.01$ )

**Key Words:** Grazing Beef Heifers, Corn Silage, High Moisture Corn

**1134 Effects of corn silage or high moisture corn supplementation on ruminal pH and pasture digestion in beef heifers grazing high quality pastures.** L. O. Abdelhadi\*<sup>1,2</sup>, F. J. Santini<sup>1</sup>, C. A. Cangiano<sup>1</sup>, and G. A. Gagliostro<sup>1</sup>, <sup>1</sup>Fac. Cs. Agrarias. UNMdP-INTA EEA Balcarce, <sup>2</sup>CONICET.

Six British heifers ruminally cannulated, averaging 284±25 kg of live weight (LW), were used in a replicated 3 x 3 Latin square with 15 day-periods to study the effect of corn silage (CS) or high moisture corn (HMC) supplementation on ruminal pH and *in situ* pasture digestion characteristics. Heifers were fed diets consisting of fresh pasture as the sole component (T0); CS was included at 40% of the diet in T1 and HMC was included at 31% of the diet in T2 (on a DM basis). All heifers grazed in a one-day strips from August to October, a mixed pasture containing 80% grass and 20% legume. Herbage mass averaged 3416±838 kg DM/ha and parameters of pasture quality were: DM 30±1.6%; CP 12.6±2.4% NDF 46.6±3.8%; IVOMD 69.9±3.3% and a soluble carbohydrate content of 18.1±3.4%. Supplements contained 6.9 and 10% CP; 45.7 and 9.8% NDF; 21.5 and 64.5% starch; 61.7 and 87.2% IVOMD and were fed once (7h) or twice daily (7 and 16h) before heifers returned to pasture, for CS and HMC respectively. Heifers consuming diets containing CS had higher ruminal pH ( $P < 0.05$ ). Pasture degradation characteristics were estimated using the model of Orskov and Mc Donald (1979). CS increased potentially digestible fractions (PD) of pasture DM and NDF ( $P < 0.05$ ); while HMC decreased degradation rate, PD and effective degradability (ED) of pasture NDF ( $P < 0.05$ ). Neither degradation rate nor ED of pasture DM was different among treatments ( $P > 0.05$ ). These results suggest that CS supplementation had a positive associative effect on high quality pasture digestion, being a more appropriate supplement than HMC to be used in grazing beef heifers.

Item	T0	T1	T2	SEM	P <
pH	5.9 <sup>b</sup>	6.3 <sup>a</sup>	5.8 <sup>b</sup>	0.08	0.01
DM					
PD, %	79.1 <sup>b</sup>	84.4 <sup>a</sup>	79.3 <sup>b</sup>	1.39	0.05
Rate, %/h	8.1	7.0	8.8	0.89	0.39
NDF					
PD, %	79.5 <sup>b</sup>	84.8 <sup>a</sup>	70.9 <sup>c</sup>	0.91	0.01
Rate, %/h	3.9 <sup>a</sup>	4.4 <sup>a</sup>	2.8 <sup>b</sup>	0.28	0.01
ED (kp <sup>1</sup> =5%/h)					
DM	64.7	67.6	66.7	1.04	0.19
NDF	53.1 <sup>b</sup>	59.1 <sup>a</sup>	46.2 <sup>c</sup>	1.41	0.01

<sup>1</sup>rate of passage assumed

**Key Words:** Grazing Beef Heifers, Corn Silage, High Moisture Corn

**1135 Rumen fermentation patterns of a range of forage diets.** V. E. Brown\* and R. E. Agnew, *Agricultural Research Institute of Northern Ireland, Hillsborough, Co. Down.*

9 rumen fistulated steers, averaging 750 kg, were used to evaluate the rumen fermentation characteristics of 24 forage treatments, consisting of sole forages and forage mixtures. Treatments were formulated on two basic parameters (1) to reflect diets in commercial use and (2) to give a large range of rumen fermentation patterns. 12 forages were used as the basis for the 24 treatments: grass, high dry matter silage, low dry matter silage, high digestibility silage, low digestibility silage, maize silage, whole crop wheat, hay, straw, lucerne, fodder beet and potatoes. Each treatment was fed to maintenance energy level, in a changeover design to allow 3 replications of each treatment. Periods were 16 days in length, days 1-14 for dietary acclimatisation and rumen sampling on days 15-16. The animals were fed twice daily, with equal portions given at each feed (9am and 4pm). Samples of rumen fluid were obtained through a rumen cannula, using an aspiration method, at 1, 2, 4 and 6 hours after the morning feed, and 1, 2, 4, 7, 11, 14 and 16 hours after the evening feed. The data were analysed using Genstat REML procedure for the analysis of variance of unbalanced data. The model removed animal and period effects, and compared treatment means using the between animal variation. The time means were compared using within animal variation. There were significant effects of treatment on rumen ammonia, propionate, butyrate, valerate, ethanol, proportion of acetate, proportion of butyrate, proportion of valerate and acetate: propionate ratio. Time had a highly significant ( $p < 0.01$ ) effect on all rumen parameters measured, and treatment by time interactions were also highly significant with all treatments. A model to predict rumen fermentation parameters from feed characteristics has been developed.

**Key Words:** Rumen Fermentation, Forage diets

**1136 Ruminal parameters and digestibility in sheep fed with basal oat straw diet.** H. G. González\*<sup>1</sup>, O. B. Ruiz<sup>1</sup>, M. L. De la Vega<sup>1</sup>, A. Correa<sup>2</sup>, F. J. Verdugo<sup>2</sup>, H. C. Hernández<sup>3</sup>, L. E. Gerlach<sup>4</sup>, A. E. Orozco<sup>1</sup>, and E. E. Perez<sup>5</sup>, <sup>1</sup>Universidad Autónoma de Chihuahua, <sup>2</sup>Universidad Autónoma de Baja California, <sup>3</sup>Universidad Autónoma de Baja California Sur, <sup>4</sup>Universidad de Sonora, <sup>5</sup>Universidad Autónoma de Ciudad Juárez, Mexico.

Eight crossbred sheep with permanent ruminal cannulated were used in a fed trial. The objective was to evaluate the effect of two size ground length: 2.5 cm (T1) and 10 cm (T2) of forage on ruminal parameters and digestibility. The animals were fed by using a basal oat straw diet and providing them an alfalfa hay supplement (20 %), all diets were isonitrogenous. Rumen fluid samples were collected at 0h, 1.5h, 3h, 6h, 9h, 12h, 16h and 24 hours after first meal and analyzed for pH, ammonia-nitrogen (NH<sub>3</sub>-N) and volatile fatty acids (VFA) concentration. The digestibility (DM, ADF and NDF) was estimated through the total collection of feces and measurement of feed intake. The ruminal degradation of straw was estimated by using the nylon bag technique under a non linear model. The statistical analysis of data was made by using a crossover design. The feed intake was *ad libitum*. It was observed a bigger dry matter intake ( $P < .07$ ) of T1 than T2 (56.8 vs 50.4 g kg<sup>-1</sup> W<sup>.75</sup>). There was not found significant differences ( $P > .05$ ) to pH (7 vs 6.9), NH<sub>3</sub>-N (12.5 vs 12.8 mg 100 ml<sup>-1</sup>) and isobutyric acid (.8 vs .6 mM). However there were detected significant differences ( $P < .01$ ) between T1 and T2 in concentration of acetic (78.6 vs 83.7 mM), propionic (15.5 vs 11.5 mM) and butyric ( $P < .05$ ; 5.1 vs 4.2 mM), respectively. There was detected significant differences ( $P < .07$ ) in DM digestibility (55.9 vs 58.7 %), ADF (54.8 vs 55.5 %) and NDF (56.3 vs 58.2 %) of diets T1 and T2, respectively. It was detected significant difference ( $P < .06$ ) into the potential degradation of constant b (42.7 vs 44.6 %), but no differences ( $P > .05$ ) were detected into degradation rate (2.6 vs 2.4 % h<sup>-1</sup>) between T1 and T2. These results suggest that size of the forage affects the consumption and diet digestibility; there is an apparent effect into the ruminal conditions.

**Key Words:** Sheep, Particle size, Straw

**1137 Ruminal parameters and digestibility in steers fed with basal oat straw diet.** H. G. González\*<sup>1</sup>, O. B. Ruiz<sup>1</sup>, M. L. De la Vega<sup>1</sup>, A. E. Orozco<sup>1</sup>, A. Correa<sup>2</sup>, A. P. Márquez<sup>2</sup>, L. E. Gerlach<sup>3</sup>, E. E. Perez<sup>4</sup>, and H. C. Hernandez<sup>5</sup>, <sup>1</sup>Universidad Autónoma de Chihuahua, <sup>2</sup>Universidad Autónoma de Baja California, <sup>3</sup>Universidad de Sonora, <sup>4</sup>Universidad Autónoma de Ciudad Juárez, <sup>5</sup>Universidad Autónoma de Baja California Sur, Mexico.

Four Hereford steers with permanent ruminal cannulated were used in a fed trial. The objective was to evaluate the effect of two size ground length: 2.5 cm (T1) and 10 cm (T2) of forage on ruminal parameters and digestibility. The animals were fed by using a basal oat straw diet and providing them an alfalfa hay supplement (20 %), all diets were isonitrogenous. Rumen fluid samples were collected at 0h, 1.5h, 3h, 6h, 9h, 12h, 16h and 24 hours after first meal and analyzed for pH, ammonia-nitrogen (NH<sub>3</sub>-N) and volatile fatty acids (VFA) concentration. The digestibility (DM, ADF and NDF) was estimated through the total collection of feces and measurement of feed intake. The ruminal degradation of straw was estimated by using the nylon bag technique under a non linear model. The statistical analysis of data was made by using a switch back design. The feed intake was *ad libitum*. It was observed a bigger dry matter intake ( $P < .05$ ) of T1 than T2 (79.7 vs 70.8 g kg<sup>-1</sup> W<sup>.75</sup>). The findings were not statistically different ( $P > .05$ ) nor to pH (7 vs 7), NH<sub>3</sub>-N (8.5 vs 8.7 mg 100 ml<sup>-1</sup>) neither for VFA (acetic; 80.7 vs 80.9 mM), (propionic; 13.2 vs 13.3 mM), (butyric; 5.4 vs 5.2 mM), (isobutyric; .75 vs .65 mM) for T1 and T2 treatments, respectively. Nevertheless were detected significant differences ( $P < .01$ ) in digestibility of DM (68.8 vs 71.5 %), ADF (66.9 vs 69.6 %) and NDF (68.2 vs 71.1 %) to diets T1 and T2, in that order. Additionally was detected significant difference ( $P < .05$ ) into potential degradability of b constant (31 vs 33.3 %), the degradability rate (2.6 vs 2.6 % h<sup>-1</sup>) was not statistically different ( $P > .05$ ) for T1 and T2, respectively. The size of forage particle affected the consumption and the digestibility of the diet, apparently the rumen conditions did not.

**Key Words:** Steers, Particle size, Straw

**1138 Digestibility in steers fed with a basal oat straw diet and supplemented with alfalfa.** H. C. Hernandez\*<sup>1</sup>, M. L. De la Vega<sup>2</sup>, M. G. Ferreira<sup>2</sup>, A. P. Márquez<sup>3</sup>, A. Correa<sup>3</sup>, H. G. González<sup>3</sup>, and E. E. Perez<sup>4</sup>, <sup>1</sup>Universidad Autónoma de Baja California Sur, <sup>2</sup>Universidad Autónoma de Chihuahua, <sup>3</sup>Universidad Autónoma de Baja California, <sup>4</sup>Universidad Autónoma de Ciudad Juárez, Mexico.

To evaluate the digestion performance, four Hereford steers 230 kg and permanent ruminal cannulated were fed to a basal oat straw diet and supplemented with alfalfa hay to levels (0, 10, 20 and 30 %) of dry matter intake and .5 kg rolled milo per animal d<sup>-1</sup>, all diets were isonitrogenous. The digestibility (DM, ADF, NDF and cellulose) was estimated through the total collection of feces and measurement of feed intake. The data were analyzed by using a 4 x 4 latin square design. The voluntary intake of total diet (64.6, 69.8, 80.7 and 81.1 g kg<sup>-1</sup> W<sup>.75</sup>) was improved ( $P < .01$ ) proportional to an increase of supplements levels. There were detected significant linear trends ( $P < .01$ ) to increase the digestibility proportional to an increase of supplement of alfalfa. Additionally, was detected significant differences ( $P < .01$ ) into digestibility of DM (61.4, 61.2, 68 and 68 %), NDF (57, 65.7, 65.3 and 64.6 %), ADF (54.4, 57.3, 62.3 and 62.4 %) and cellulose (62.4, 63.3, 66.8 and 65.4 %) to supplemented alfalfa diets (0, 10, 20 and 30 %), in that order, best results were observed by using levels of 20 and 30 % of supplemented alfalfa. These findings suggest that the supplementation of a basal straw diet with alfalfa increase the total consumption and digestibility of fiber components of the total diet.

**Key Words:** Steers, Digestibility, Straw

**1139 *In vivo* and *in vitro* digestibility and chemical composition of maize silage from a crop in three stages of maturity.** M. Nomdedeu\*<sup>1,2</sup> and O. N. Di Marco<sup>1</sup>, <sup>1</sup>Fac. Cs. Agrarias UNMDP-INTA EEA Balcarce, <sup>2</sup>CIC, Mexico.

The objective of this experiment was to investigate the effect of a maize crop maturity on silage *in vivo* digestibility of dry matter (IDMD) and neutral detergent fiber (INDFD) and the relationship of these parameters with their corresponding *in vitro* determinations (IVDMD) and (IVNDFD). The crop was harvested at the following maturity stages:

a) stage-blister (20.5% DM), b) stage-milk (26.0% DM) and c) stage-dough (32.5% DM). *In vivo* digestibility was measured using 9 lambs (30 kg BW) in a triplicate 3x3 latin squared design with 17 days-periods. The silages were characterized in terms of their contents of NDF, ADF, starch (STA), soluble non structural carbohydrate (SNSC) and lignin (L). As the maturity of the crop progressed the content of STA in the silage increased from 2.0% to 27.5% and the NDF decreased from 60.4% to 42.0% ( $P < 0.05$ ), but L remained constant ( $P > 0.05$ ). The IDMD was not affected ( $P > 0.05$ ) by the stage of growth of the crop (average: 52.4%), the starch was completely digested *in vivo*, although INDFD decreased from 52.5% to 29.0% ( $P < 0.05$ ). The IVDMD (average: 60.7%) was 8 points higher than IDMD and increased ( $P < 0.05$ ) at 62.5% in the latest stage of growth. The IVNDFD was lower than INDFD but both were correlated ( $r: 0.99$ ). It was concluded that the changes provoked by crop maturity affected silage INDFD without affecting IDMD, which was over predicted by 15% by the *in vitro* digestibility.

Parameters (%)	Stage-blister	Stage-milk	Stage-dough	SEM
STA	2.0 <sup>a</sup>	13.4 <sup>b</sup>	27.5 <sup>c</sup>	0.242
ADF	35.6 <sup>a</sup>	31.4 <sup>b</sup>	26.2 <sup>c</sup>	0.506
NDF	60.4 <sup>a</sup>	55.6 <sup>b</sup>	42.0 <sup>c</sup>	0.264
L	3.3 <sup>a</sup>	3.2 <sup>a</sup>	2.6 <sup>a</sup>	0.165
SNSC	2.3 <sup>a</sup>	9.7 <sup>b</sup>	9.0 <sup>c</sup>	0.020
IDMD	52.2 <sup>a</sup>	52.3 <sup>a</sup>	52.6 <sup>a</sup>	0.010
INDFD	52.5 <sup>a</sup>	45.6 <sup>b</sup>	29 <sup>c</sup>	0.928
IVDMD	59.2 <sup>a</sup>	60.0 <sup>a</sup>	62.5 <sup>b</sup>	0.377
IVNDFD	43.9 <sup>a</sup>	34.3 <sup>b</sup>	19.2 <sup>c</sup>	0.667

<sup>abc</sup>Means within a row with the same letter are not different (Tukey,  $P > 0.05$ )

**Key Words:** Whole-plant Corn Silage, Digestibility, Maturity Stage

**1140 Corn silage supplementation of different chop length to dairy cows grazing temperate pasture.** G.A. Pieroni\*, D.H. Rearte, F.J. Santini, M. San Martín, and G. Eyherabide, *Fac. Cs. Agrarias, UNMdP - EEA INTA Balcarce, Bs. As., Argentina.*

The objective of the trial was to evaluate the effects of corn silage supplementation of different particle length on total intake, milk yield and composition, BW and BCS of grazing dairy cows. Whole-plant corn (2/3 milkline) was harvested and chopped at 6mm (CS6) or 24mm (CS24) without rolling. Forty Holstein cows (48 DIM, 581 kg BW and 2.15 BCS) were randomly assigned to two treatments: 1) 6 kg DM/d CS6 (CS6), and 2) 6 kg CS24 (CS24). Corn silage (plus 0.06 kg/cow/d urea) was fed twice daily after milking. CS6 and CS24 had 32.4 and 30.3% DM; 7.6 and 8.3% CP; 36.5 and 42.9% NDF; 65.0 and 63.4% *in vitro* DM digestibility (IVDMD), respectively. Cows grazed a winter oats (*Avena sativa* L.) pasture offered at 27.3 kg DM/cow/d with in average 1690 kg DM/ha herbage mass, 17.6% DM; 18.4% CP; 34.8% NDF; and 77.2% IVDMD. Cows were allotted to a new paddock twice daily, after corn silage feeding. Both groups of cows were fed with 5.5 kg DM/d of a 65% ground corn-35% sunflower meal concentrate with 89.3% DM; 20.2% CP; 23.3% NDF; and 75.4% IVDMD. Intake of total DM (estimated on six cows per treatment using Cr<sub>2</sub>O<sub>3</sub> as a fecal marker), corn silage, concentrate, and pasture were similar between treatments ( $P > 0.10$ ) (average 20.96; 5.45; 5.23 and 10.28 kg/d, respectively). Milk yield and composition were analyzed by repeated measurement (10 weeks). Not interaction between treatments and weeks were detected ( $P > 0.10$ ). Milk yield and composition were not affected by treatments ( $P > 0.10$ ). Neither BW nor BCS change were different between treatments ( $P > 0.10$ ). Chopped length (6 or 24 mm) of corn silage supplemented to dairy cows grazing high quality pasture did not affect performance.

	CS6	CS24	SEM	$P >$
Milk yield, kg/d	23.41	23.55	0.54	0.86
FCM 4%, kg/d	22.01	22.10	0.60	0.91
Protein, %	3.49	3.45	0.03	0.36
Protein yield, kg/d	0.813	0.802	0.02	0.71
Fat, %	3.57	3.66	0.07	0.39
Fat yield, kg/d	0.838	0.848	0.03	0.77

**Key Words:** Corn Silage, Chop Length, Grazing Dairy Cows

**1141 Effect of particle size, quality and quantity of alfalfa hay, and cow on selective consumption by dairy cattle.** C. Leonardi\* and L. E. Armentano, *University of Wisconsin, Madison.*

Twenty-four lactating Holsteins (half primiparous) were used in 4 6x6 Latin Squares. The experimental periods were 7 d each. Cows were in tie-stalls; diets were fed at libitum twice a day at 1100 and 1600. Diets contained 60% concentrate and 40% alfalfa, with either 20% hay and 20% haylage or 40% hay (DM basis). Treatments were: 20% of low quality chopped hay (20LQC) or high quality chopped hay (20HQC), 20% low or high quality long alfalfa hay (20LQL or 20HQL), or 40% low or high quality chopped alfalfa hay (40LQC or 40HQC). Particle distribution of TMR and refused feed were determined using square hole screens with diagonals: 26.9, 18, 8.98, 5.61 and 1.65 mm (Y1 to Y5 respectively). The intake of each fraction was expressed as % of the theoretical intake, where theoretical intake of Y<sub>n</sub> = as fed intake × fraction of Y<sub>n</sub> in TMR. No differences were observed in sorting behavior between day 1 and the end of the periods, data presented are from the end of the periods. Across treatments, animals consistently sort against long particles (Y1 and Y2 <100%). Increasing the proportion of dry hay dramatically enhanced sorting. Surprisingly there was significantly less sorting for the lower quality hay. A primary goal of this trial was to measure variation among cows. Intake of Y1 (averaged across the 6 treatments for each cow) was between 60 and 70% for 4 cows, 70-80% for 11 cows, 80-90% for 5 cows, 90-100% for 2 cows and 100-110% for 2 cows. Sorting by a single cow can be quite extreme as exhibited by one cow fed 40LQC who consumed no Y1 particles.

	20 HQL (A)	20 LQL (B)	20 HQC (C)	20 LQC (D)	40 HQC (E)	40 LQC (F)	C,D vs E,F	A,C,E vs B,D,F	A,B vs C,D
DMI, kg/d	23.9	23.7	24.2	24.4	25.8	25.7	$P < .01$	$P = .92$	$P = .14$
Y1, %	86.7	86	86.7	96.3	56.4	63.8	$P < .01$	$P < .05$	$P = .06$
Y2, %	94.3	93.1	95.3	90.4	82.8	79.9	$P < .01$	$P < .05$	$P = .05$
Y3, %	96.7	96.2	96.9	95.5	84.2	84.8	$P < .01$	$P = .8$	$P = .65$
Y4, %	99.9	99.2	99.5	99.9	99.5	101.9	$P < .05$	$P = .07$	$P = .82$
Y5, %	103.7	103.6	102.3	101.8	107.6	107.2	$P < .01$	$P = .42$	$P < .01$
PAN, %	105.8	106.4	104.1	104.3	111.2	110.2	$P < .01$	$P = .94$	$P < .05$

**Key Words:** Particle size, Alfalfa hay, Sorting

**1142 The effect of processing corn silage prior to ensiling on particle size and production and digestibility characteristics of growing beef heifers.** D.R. ZoBell\*<sup>1</sup>, K.C. Olson<sup>1</sup>, R.D. Wiedmeier<sup>1</sup>, D. Sass<sup>2</sup>, K.J. Shinnors<sup>3</sup>, and T.A. McAllister<sup>4</sup>, <sup>1</sup>Utah State University, <sup>2</sup>Pioneer Hi-Bred, <sup>3</sup>University of Wisconsin, Madison, <sup>4</sup>Agriculture and Agri-Food Canada.

A study was conducted to determine the effect of processing corn silage, prior to ensiling, on particle size, feedlot production, and *in vivo* digestibility characteristics of growing beef heifers. Corn was planted in the spring and in the fall, chopped, and ensiled. Two identical six-row self-propelled choppers were utilized, one of which was adapted with a roller-processing unit. The chopped corn was taken from the same field and ensiled in a silage bag. Over the 56 day feedlot study, heifers (293 kg initial weight) were randomly assigned one of two treatments: unprocessed (UP) or processed (P). The growing ration consisted of 55.4% UP or P corn silage, 22.3% alfalfa hay, 19.6% wheat mill run, and 2.7% supplement (DMB). There were 15 head per pen with three replications per treatment. The *in vivo* digestibility study consisted of four cannulated beef heifers in a double cross-over design with a three week adaptation and six day collection period using the same grower ration as the feedlot study. Whole-plant particle size was quantified from three separate sub-samples per treatment using standard procedures. Results showed that whole cob fraction as a percent of total mass were 0 and 6.5 ( $P < .05$ ) for the P and UP respectively. Undamaged kernels and broken kernels as a percent of total kernel mass were 1.8% and 93.9% for P and 17.3% and 64.5% for UP ( $P < .05$ ). Average daily gain (kg-ADG), dry matter intake (kg-DMI), and feed efficiency (FE) for the 0-56 day period were .96, 7.55, and 7.87 for UP and 1.00, 7.59, and 7.56 for the P heifers with no differences for any of these traits ( $P > .05$ ). *In vivo* digestibility measurements showed that pH, volatile fatty acids, dry matter, acid detergent fiber, and neutral detergent fiber digestibilities were not affected by treatment. ( $P > .05$ ). This study shows that corn silage kernels are affected by processing and there is a numerical trend for improved ADG and FE.

**Key Words:** Corn silage, Processing silage, Heifers

**1143 Effect of feeding a corn hybrid selected for leafiness as silage or grain to lactating dairy cattle.** P.W. Clark\*<sup>1</sup>, S.C. Kelm<sup>1</sup>, and M.I. Endres<sup>2</sup>, <sup>1</sup>University of Wisconsin, River Falls, <sup>2</sup>Mycogen Seeds.

Sixteen multiparous Holstein cows were used in a feeding trial based on 4 x 4 Latin squares with 21 d periods to evaluate a leafy corn hybrid as both a silage and grain crop for lactating cows. Four diets containing (dry basis) 8% chopped hay, 42% corn silage, 11% high moisture corn grain, 10% whole, fuzzy cottonseed, and 29% concentrate varied only in the variety of corn (leafy = L or control, grain-type hybrid = C) used for grain (G) or silage (S). Cows on the L silage diets (LGLS and CGLS) produced more (P<.05) milk (43.2 vs. 41.8 kg/d), 4% FCM (38.5 vs. 37.2 kg) and protein (1.38 vs. 1.33 kg/d) and ate more DM (23.3 vs. 22.4 kg/d) than cows on the C silage diets (LGCS and CGCS). There was no difference (P>.05) in milk protein or fat concentration. Grain variety (LGLS and LGCS vs. CGLS and CGCS) did not influence (P>.05) milk yield or composition. Dry matter intake was greater (P<.05) for the "all leafy" diet (LGLS) compared to the "all control" diet (CGCS) at 23.5 vs. 21.9 k/d. In this study, cows fed leafy corn silage consumed more DM and produced more milk and protein than cows fed the control, grain-type corn silage.

**Key Words:** Corn Silage, Dry Matter Intake

**1144 Effect of feeding Roundup Ready<sup>®</sup> corn silage and grain on feed intake, milk production and milk composition in lactating dairy cattle.** S. S. Donkin\*<sup>1</sup>, J.C. Velez<sup>1</sup>, E. P. Stanisiewski<sup>2</sup>, and G. F. Hartnell<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Monsanto Company, St Louis, MO.

Dairy cows were used to determine the effects of feeding corn, genetically modified to tolerate glyphosate, on feed intake, milk production and milk composition. Alternating plots of a 20.25 ha field were planted at equal densities with either Roundup Ready<sup>®</sup> (RR) corn (DK626RR) or its isogenic (ISO) counterpart (DK626). Perimeter rows were removed and half of each strip was harvested for whole plant corn silage. The remainder was allowed to mature and was harvested as grain. Sixteen multiparous Holsteins (71 to 107 DIM) were assigned to two groups and fed diets containing 62% corn silage and 17% corn grain (DM basis) from either RR or ISO lines; the balance of the diet was protein supplements, vitamins and minerals. Diets were formulated to contain 1.64 Mcal/kg NEL, 16.7% CP, 16% ADF, 27% NDF, 0.65% Ca and 0.43% P. Treatments were applied as switchback design consisting of 3 contiguous 28-d periods with each period containing 14-d of adaptation followed by 14 days of data collection. Cows were fed for ad libitum intake and milked twice daily. There were no significant differences for dry matter intake, 21.5 vs. 21.9 ± 0.4; milk production, 29.4 vs. 29.5 ± 0.4; milk protein yield, 0.96 vs. 0.96 ± 0.01; milkfat yield, 1.04 vs. 1.06 ± 0.02; or lactose yield, 1.39 vs. 1.40 ± 0.22 (kg/d) between RR and ISO diets, respectively. There were no differences in percentages of milkfat, 3.55 vs. 3.61 ± 0.04; protein, 3.25 vs. 3.25 ± 0.02; lactose, 4.70 vs. 4.72 ± 0.01; solids not fat, 8.74 vs. 8.75 ± 0.02; SSC (1000/ml), 100 vs. 98 ± 10; or MUN (mg/dl), 10.9 vs. 10.8 ± 0.2 between RR and ISO diets. There were no differences in 4% FCM yield to DM intake (kg/kg), 1.29 vs. 1.30 ± 0.02 between RR and ISO diets, respectively. The data demonstrate lactating cows fed RR corn and the ISO counterpart perform similarly.

**Key Words:** Genetically modified crops, Milk production, Roundup Ready<sup>®</sup>

**1145 Effects of corn silage hybrid and level of forage NDF on nutrient digestibility and duodenal fatty acid content of lactating cows.** X. Qiu\*, M.L. Eastridge, and Z. Wang, The Ohio State University, Columbus.

Four ruminally and duodenally cannulated primiparous cows were fed four diets in a 4 x 4 Latin square design: 1) 17% forage NDF (FNDF) with brown midrib (BMR) corn silage (CS), 2) 21% FNDF with BMR CS, 3) 17% FNDF with conventional CS (CCS), and 4) 21% FNDF with CCS. Diets contained 17.3% CP and 38.5% NDF. Each period consisted of 2 wk with the later weeks devoted to data collection. Duodenal, fecal, and ruminal bacteria samples were collected from day 11 through 13 to determine nutrient digestibility, efficiency of bacterial N synthesis, and duodenal content of fatty acids (FA). Ruminal fermentation characteristics and production responses have been previously reported (J. Dairy Sci. 82 (Suppl.1):88). Intakes of DM, OM, NDF, protein, starch,

and FA were higher or tended to be higher for BMR CS than CCS and for 17% FNDF than 21% FNDF. The total tract digestibilities of these components and efficiency of bacterial N synthesis were similar among treatments, except that BMR CS resulted in lower intestinal FA digestibility (74.1 vs. 78.8% of duodenal flow) than CCS, and 17% FNDF tended to be higher in total tract FA digestibility (79.7 vs. 76.5%) than 21% FNDF. Ruminal NDF digestibility was similar among dietary treatments (54.7, 54.8, 52.6, and 46.5%). Compared with CCS, BMR CS tended to be higher in duodenal content and flow of oleic acid (4.64 vs. 4.48 mg/g DM; 50.3 vs. 44.6 g/d), linoleic acid (2.22 vs. 1.97 mg/g DM; 24.6 vs. 19.8 g/d), and conjugated linoleic acid (CLA; 0.17 vs. 0.15 mg/g DM; 1775.8 vs. 1490.3 mg/d). There tended to be an interaction between CS and FNDF on biohydrogenation (71.5, 74.7, 77.0, and 74.2%, respectively). Based on the data from this study, the increased milk production observed from feeding BMR CS in some studies may be explained by higher DM intake rather than an increased total tract digestibility of the diets. Feeding the BMR CS tended to increase duodenal flow of CLA, which should translate to increased availability of CLA for transfer into milk fat.

**Key Words:** Brown Midrib, Corn Silage, Conjugated Linoleic Acid

**1146 Feeding value of whole plant silage and crop residues from Bt or normal corns.** K.S. Hendrix\*, A.T. Petty, and D.L. Lofgren, Purdue University, West Lafayette, IN.

During the 1998 (yr 1) and 1999 (yr 2) cropping seasons, 6.8 ha fields were planted to either a Bt or the isogenetic normal (N) corn hybrid. Objectives were to determine the influence of corn type on: 1) performance of steer calves fed whole plant silage (WPS), 2) performance of beef cows grazing corn residue and 3) grazing pattern of beef cows when given a choice of either Bt or N residue. Each yr, 56 Angus and Simmental sired steer calves (299 kg) were randomly allotted by weight and breed type into eight pens of seven steers. Four pens were fed diets containing WPS from either corn type for 89 d (yr 1) and 85 d (yr 2). Dry, pregnant beef cows (40 in yr 1, 36 in yr 2) were randomly allotted by weight and body condition score into four groups. Replicate groups grazed either Bt or N corn residue (6.8 ha/group) for 34 d (yr 1) and 42 d (yr 2). In yr 1, 20 additional cows were given access to adjacent fields from which the division fence was removed. One field contained residue from Bt corn and the other residue from N corn. Three times daily, the number of cows within each field was observed. For steer calves, the interactions among corn type, breed type and year were not significant (P>.10) for ADG, daily DMI or feed/gain. ADG (1.30 vs 1.34 kg/d) and DMI (8.88 vs 8.67 kg/d) for steers fed Bt vs N silage, respectively, were not different (P>.10). However, feed/gain was greater (6.86 vs 6.48, P<.05) for steers fed Bt vs N WPS. For cows grazing residue, the interaction of year and corn type was not significant (P>.10). Average weight change was -2.29 vs -2.34 kg/cow for Bt vs N residue (P>.10), respectively. When given a choice of grazing Bt or N corn residue, cows tended to graze as a group and grazing pattern varied greatly. Over the entire observation period, 46% of cows were observed in the Bt field vs 54% in the N field (P<.01). These results do not indicate major differences in the feeding value of WPS or residue between Bt and N corns. A slight reduction in energy level of Bt WPS is indicated based on steer calf performance.

**Key Words:** Beef, Bt Corn

**1147 Effects of activated carbon on performance and apparent total tract nutrient digestibility of dairy cows fed poorly fermented corn silage.** P.S. Erickson\*<sup>1</sup>, N.L. Whitehouse<sup>1</sup>, O.A. Ayangbile<sup>2</sup>, D.A. Spangler<sup>2</sup>, A. Gotlieb<sup>3</sup>, and C.G. Schwab<sup>1</sup>, <sup>1</sup>University of New Hampshire, Durham, <sup>2</sup>Agri-King Inc., Fulton, IL, <sup>3</sup>University of Vermont, Burlington.

Activated carbon (AC) is a widely used toxin binder in non-agricultural industries. The primary objective of this study was to determine the effects of adding AC to a diet containing mycotoxin-laden corn silage on DMI and total tract nutrient digestibility. Six multiparous late lactation Holstein cows (738 kg BW) were assigned to a replicated 3 X 3 Latin square design; period length was 21d with the last 10 d for data collection. Diets contained 60 % corn silage, 30 % dry ground corn, 6.0 % soybean meal, and 4.1 % minerals and vitamins (DM basis). Treatments were 0 g/d, 20 g/d or 40 g/d AC and were topdressed onto the TMR once daily and hand mixed. Cows were dosed with 10 g Cr<sub>2</sub>O<sub>3</sub> twice daily during the collection period. Deoxynivalenol was measured in the

corn silage and varied from 0.8 ppm to 1.5 ppm over the experiment. Milk samples (AM and PM) were taken on d 16 and d 21. A trend ( $P < .10$ ) for linear increases in DMI (0 g, 17.5 kg; 20 g, 18.7 kg; 40 g, 19.8 kg) and apparent N digestibility (0 g, 58.4 %; 20 g, 61.0 %; 40 g, 62.1 %) occurred in cows fed AC. Apparent NDF digestibility, apparent hemicellulose digestibility (NDF % - ADF %) and body condition score were improved linearly ( $P < .05$ ) by AC supplementation (0 g, 47.7 %, 57.2 %, 3.6; 20 g, 47.5 %, 57.2 %, 3.8; 40 g 51.9 %, 64.0 %, 4.0). There were no effects of AC on milk production or composition. Activated carbon improved DMI and apparent total tract fiber digestibility when cows were fed poorly fermented corn silage.

**Key Words:** Activated Carbon, Deoxynivalenol, Digestibility

**1148 Effects of replacing concentrate with soyhulls in diets of lactating cows.** I. R. Ipharraguerre<sup>\*1</sup>, R. R. Ipharraguerre<sup>2</sup>, and J. H. Clark<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>University of Buenos Aires, Argentina.

Soyhulls (SH), a by-product of soybean processing, can be used as a replacement of either grain or forage in dairy cattle diets because of their high content of fermentable fiber. This study was conducted to evaluate the substitution of SH for concentrate in the diet of mid-lactation Holstein cows. Fifteen multiparous cows averaging 112 DIM were used in a triplicated 5x5 Latin square with 21 day periods. Diets were isonitrogenous and consisted of 23% alfalfa silage, 23% corn silage, and 54% concentrate on DM basis. The pelleted SH replaced the concentrate to supply 0, 10, 20, 30, or 40% of the dietary DM. The five diets were fed twice daily as TMR to ad libitum intake. Dietary DM intake (DMI), milk yield, and milk composition were measured during the last week of each experimental period. DMI tended ( $P < .06$ ) to linearly decrease and NDF intake linearly increased ( $P < .0001$ ) as SH increased from 0 to 40% of dietary DM. Milk yield, protein content, protein yield, MUN, and total solids (TS) yield were not affected by treatments. However, increasing the dietary DM percentage of SH linearly increased milk fat content ( $P < .004$ ), fat yield ( $P < .001$ ) and TS concentration ( $P < .007$ ). Therefore, SH represent an alternative feed for replacing a portion of the concentrate in the diet of mid-lactation cows without depressing the production of milk and milk components. Furthermore, feeding SH may help to reduce feed cost.

Item	SH, % of dietary DM					SEM	P
	0	10	20	30	40		
DMI, kg/d	23.8	24.8	24.4	22.9	22.7	.63	.06
NDF intake, kg/d	6.9	8.5	9.7	10.2	11.2	.30	.0001
CP intake, kg/d	3.7	3.9	3.8	3.6	3.7	.11	.57
Milk yield, kg/d	29.5	29.3	29.9	29.3	28.3	.48	.12
Fat, %	3.60	3.61	3.67	3.93	3.91	.09	.004
Fat, kg/d	0.99	1.00	1.06	1.11	1.08	.03	.001
Protein, %	3.36	3.28	3.33	3.30	3.31	.19	.36
Protein, kg/d	1.05	0.92	0.97	0.94	0.92	.07	.28
TS, %	12.36	12.41	12.56	12.76	12.67	1.30	.007
TS, kg/d	3.63	3.62	3.73	3.72	3.57	.11	.99
MUN, kg/d	14.0	14.4	14.4	14.5	14.4	.39	.41

**Key Words:** soyhulls, milk production, dairy cow

**1149 Effect of urea molasses block storage time on intake and digestion of prairie hay by sheep.** O. Araujo-Febres<sup>\*</sup>, J. A. Vergara, M. B. Lachmann, and A. E. Ortega, La Universidad del Zulia. Facultad de Agronomía. Maracaibo, Venezuela.

A work was designed to measure the effect of storage time of supplemented urea molasses block (UMB) on intake, digestion and nitrogen balance in sheep fed with a low quality grass. Twelve male African hair sheep (aged 4 months; initial weight of 15 kg) were brought to metabolism crates for a 12-day adjustment period and 6-day experimental period. Animals were randomly assigned to one of the following treatments: (T1) Control, this group was offered a diet of 100% humidicola hay (*Brachiaria humidicola*) ad libitum; (T2) 15-days storage time UMB and hay; and (T3) 45-days storage time UMB and hay. Sheep received the supplements at 0900 and its had free access to water. All were drenched with an anthelmintic. During a 6 days trial period, animals were attached with harnesses for faecal collection, also refusals and urine outputs were collected. DM, OM and total nitrogen contents of

feed, feed refusals and faeces were determined. Urine samples were analysed for N. Digestibility and nitrogen balance were calculated for each group. All comparisons between treatments were analysed for a completely randomized design with 4 replications, using ANOVA of SAS. Nitrogen content of forage and supplements were .72 and 3.2%, respectively. Sheep supplemented any of UMB consumed more ( $P < .05$ ) forage DM and OM than control. Forage DM and OM, and UMB intakes were similar among sheep fed different UMB. Increase in forage DM intake was 17% and 10% for T2 and T3, respectively. Supplementation with UMB increased ( $P < .05$ ) digestible forage DM by 40%; digestible OM by 22%; and digestible N by 20%. Nitrogen apparently retained were 39.9%, 68.4% and 62.7% ( $P < .01$ ) for T1, T2, and T3, respectively. The increase of both, intake and digestibility, indicate that UMB must have increase digestion more than enough to compensate for the increased passage rate. UMB increase intake and digestion of low-quality tropical forage.

**Key Words:** molasse urea block, digestion, intake

**1150 Effect of substitution of alfalfa hay with clitoria hay (*Clitoria ternatea*) on apparent digestibility in sheep.** A. Estrada<sup>\*</sup>, R. Barajas, J.F. Obregon, and E. Sanchez, Universidad Autonoma de Sinaloa.

A cross over design experiment was conducted to determine the effect of substituting alfalfa hay with clitoria hay on total tract digestibility in sheep. Four Pelibuey male sheep (19.6 kg) allocated in metabolic cages (0.6 X 1.2 m), were assigned dietary treatments that consisted of: 1) Control: Alfalfa hay (CP, 18%; OM, 88.8%; and ADF, 41%); and 2) Diet similar to control, but substituting 50% of alfalfa hay with clitoria hay (CP, 18.5%; OM, 91%; and ADF, 43.5%). After a 10-day adaptation period, the total of produced feces were collected four four days. Food and fecal samples were oven dried (110 C; 24 h) and lab determinations for DM, OM, CP and ADF were performed. The substitution of 50% of alfalfa hay by clitoria hay, had no effect ( $P > .10$ ) on daily intake of DM, OM, CP, or ADF. The treatments had no effect ( $P > 0.10$ ) on total tract digestibility of DM (62.2 vs 63.3%), OM (63.4 vs 63.9%), CP (73.3 vs 74.3%), or ADF (53.3 vs 54.8%). Nutritional value of clitoria hay is similar to that of alfalfa hay.

**Key Words:** Alfalfa, Digestibility, Sheep

**1151 Influence of feed intake and forage level on nutrient utilization in the rumen of sheep.** I. Varhegyi, H. Febel<sup>\*</sup>, and Sz. Huszar, Research Institute of Animal Breeding and Nutrition, Herceghalom, Hungary.

Ruminal fermentation and flow of microbial and dietary protein to the small intestine are affected by feed intake (FI) and the amount and source of energy and protein in the diet. Reports in which both FI and forage level (FL) were varied, are scarce. The goal of this study was to evaluate the effects of FI and different forage to concentrate ratios on rumen fermentation, microbial protein synthesis and degree of nutrient digestion in sheep. Four cannulated wethers were used in a 4x4 Latin square design experiment. Treatments consisted of HI-HF: high FI (65 g DM/kg BW<sup>.75</sup>/day) – high FL (70%), HI-LF: high FI – low FL (30%), LI-HF: low FI (40 g DM/kg BW<sup>.75</sup>/day) – high FL and LI-LF: low FI – low FL. The forage portion and concentrate components in the diets were altered by keeping the nonstructural carbohydrate:rumen degradable protein ratio constant (3.3). The pH of ruminal fluid was decreased and total VFA concentration was increased by higher FI and lower FL ( $P < .05$ ). Regardless of FI, molar percentage of acetate was higher as forage proportion increased ( $P < .05$ ). Molar percentage of propionate was the highest for wethers of HI-LF ( $P < .05$ ). Ruminal ammonia and urea concentrations were decreased by higher FL ( $P < .05$ ). Ruminal degradations of DM and OM were lower in the groups HI-HF and LI-HF ( $P < .05$ ). At higher FI and with rations of higher FL, wethers had higher ( $P < .05$ ) duodenal flows of total N and nonammonia N (NAN). This increase was due to an increase ( $P < .05$ ) in both the quantity of microbial N and that of dietary N. Duodenal flows of microbial N and dietary N expressed as a percentage of NAN flow were similar ( $P > .05$ ) regardless of the diet used. Efficiency of microbial protein synthesis was significantly higher ( $P < .05$ ) when FL increased from 30% to 70% in the ration. This result suggests that, under the conditions of the recent study, diets with higher forage level (independent of feed intake), through more stabilized fermentation, caused degraded proteins to be transformed into microbial protein quite efficiently.

**Key Words:** Feed Intake, Forage Level, Sheep

**1152 Effect of a fibrolytic enzyme supplement (Fibrozyme) on intake and apparent digestibility of alfalfa and ryegrass fed to lambs.** R.J. Pinos<sup>1</sup>, S. González<sup>1</sup>, G. Mendoza<sup>1</sup>, M. Cobo<sup>1</sup>, R. Bárcena<sup>1</sup>, A. Hernández<sup>1</sup>, A. Martínez<sup>1</sup>, M. Ortega<sup>1</sup>, G. Hoyos<sup>2</sup>, and K. Jacques\*<sup>3</sup>, <sup>1</sup>*Colegio de Postgraduados, Montecillo, México*, <sup>2</sup>*Alltech Mexico, Mexico City*, <sup>3</sup>*Alltech Inc., Nicholasville*.

This study was conducted to evaluate effects of addition of a fibrolytic enzyme supplement (Fibrozyme, Alltech Inc.) to diets fed to lambs on feed intake and apparent digestion of dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) of alfalfa and ryegrass. Four ruminally cannulated lambs were randomly assigned to one of four dietary treatments in a 4 x 4 Latin square design, repeated in time, with a 2 x 2 factorial arrangement of treatments: two forages, alfalfa and ryegrass, and two levels of enzyme, 0 and 5 g/hd/day. Intake of alfalfa DM was higher than ryegrass DM intake ( $P < 0.01$ ), while intake of alfalfa NDF was lower ( $P < 0.01$ ). Intake of DM and NDF were increased ( $P < 0.05$ ) by Fibrozyme for both the alfalfa and ryegrass diets ( $P < 0.05$ ), however ADF intake was increased only in the ryegrass diet. Apparent digestibility of DM, OM, CP and NDF was higher ( $P < 0.01$ ) for alfalfa than for ryegrass; but the enzyme did not affect digestibility of these fractions. Fibrozyme increased alfalfa NDF digestibility ( $P < 0.10$ ). It was concluded that supplementation with Fibrozyme may affect intake and digestibility of forages with the presence or magnitude of the effect depending on forage type.

**Key Words:** Enzymes, Digestibility, Intake

**1153 In vitro effects of common fatty acids on fermentation and protozoal numbers and activity in rumen fluid from cattle fed a barley-based diet.** A. N. Hristov\*<sup>1</sup>, M. Ivan<sup>2</sup>, and T.A. McAllister<sup>2</sup>, <sup>1</sup>*Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330, U.S.A.*, <sup>2</sup>*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1, Canada*.

Reducing protozoal density and activity in the rumen may be beneficial to the ruminant by reducing nitrogen recycling and increasing microbial nitrogen flow to the intestine. The objective of this experiment was to evaluate the effect of Na salts of fatty acids, commonly found in ruminant feeds on protozoal numbers and fermentation in vitro. Two 4-h incubations were carried out with rumen inoculum obtained from two heifers fed a diet consisting of (DM basis): 90% rolled barley grain; 4% barley silage; 5% soybean meal and 1% mineralized salt. The following FA were included individually in the incubation medium at three concentrations: C6:0, C8:0 and C10:0 (0.0625, 0.12, 0.25%); C12:0, C16:0, C18:1, C18:2 and C18:3 (0.25, 0.5, 1.0%); and C14:0 and C18:0 (0.125, 0.25, 0.5%). <sup>15</sup>N-casein was added to the media as N tracer. With the exception of C6:0, C16:0, and C18:0 all FA reduced ( $P < 0.05$ ) protozoal numbers to: 55% (C8:0), ND (not detected) (C10:0), ND (C12:0), 36% (C14:0), 6% (C18:3), 22% (C18:2), and 49% (C18:1) of the Blank (no FA addition,  $1.78 \times 10^6$  protozoa per cm<sup>3</sup>, 99.6% *Entodinium* spp.). Compared to Blank, C8:0, C14:0, C18:3, C18:2 and C18:1 FA reduced ( $P < 0.05$ ) protozoal activity (estimated as <sup>15</sup>N-protozoa ÷ <sup>15</sup>N-bacteria) by 81, 78, 54, 58 and 68%, respectively and C10:0 and C12:0 reduced ( $P < 0.05$ ) total VFA concentration (by 29 and 22%, respectively). Compared to the Blank, C6:0, C8:0, C14:0, C18:3, C18:2 and C18:1 FA increased ( $P < 0.05$ ) xylanase activity of the incubation media by 17, 46, 56, 52, 68 and 43%, respectively. These results suggest that FA such as C14:0, C18:3, C18:2 and C18:1 may have the potential to reduce protozoal numbers and activity without adversely affecting bacterial fermentation in the rumen of cattle fed high-grain diets.

**Key Words:** Fatty acids, Rumen Protozoa, Fermentation

**1154 Immune response in feeder cattle fed different lipid sources.** T.B. Farran\*<sup>1</sup>, J.S. Drouillard<sup>1</sup>, M.F. Spire<sup>1</sup>, D.A. Blasi<sup>1</sup>, C.M. Coetzer<sup>1</sup>, J.J. Sindt<sup>1</sup>, H.J. LaBrune, S. B. Hogge<sup>1</sup>, S.P. Montgomery<sup>1</sup>, J.E. Minton<sup>1</sup>, and T.H. Elsasser<sup>2</sup>, <sup>1</sup>*Kansas State University, Manhattan*, <sup>2</sup>*USDA, Agricultural Research Service, Beltsville, MD*.

Crossbred beef steers (n=20; 312 kg) were used in a completely randomized design to evaluate the effect of dietary lipid sources on response to endotoxin (LPS) challenge. Steers were fed diets containing rolled full-fat soybeans at 20% (SOY), or tallow at 3.85% (TAL) DM basis. Diets

were fed to steers in individual pens for 14 d. On d 14, steers (n=16) were injected intravenously with bacterial endotoxin (0.2 µg/kg BW *E. coli* 055:B5 lipopolysaccharide; Sigma Chemical Company, St. Louis, MO). Two steers from each diet were injected with saline to establish baseline blood parameters and temperature readings. Blood samples, via jugular catheter, and rectal temperatures were obtained immediately before (0 h), then at 2, 3, 4, 5 and 24 h following LPS challenge. On d 17, cattle received a second injection of LPS. Blood samples and rectal temperatures were taken immediately before (0 h), then at 1, 2, 3, 4, 6, and 24 h following LPS challenge. All blood samples were analyzed for concentrations of prostaglandin E<sub>2</sub> (PGE<sub>2</sub>), tumor necrosis factor alpha (TNF), fibrinogen (FIB), haptoglobin (HAP), and total white blood cell count (WBC). Body surface temperatures were also measured using an infrared camera. Rectal temperatures at h 3 were greater ( $P < 0.03$ ) for TAL challenged animals than for SOY and tended ( $P = 0.08$ ) to be higher at h 4 for the first LPS challenge. Surface temperatures were not different ( $P > 0.7$ ) for SOY and TAL. TNF after the first challenge was greater ( $P < 0.01$ ) for SOY than TAL at h 2. TNF after the second challenge was greater ( $P < 0.03$ ) for SOY than TAL at both h 1 and h 2. HAP and FIB increased and WBC decreased in response to LPS, but were not different ( $P > 0.1$ ) for SOY and TAL. Concentrations of PGE<sub>2</sub> were variable and not different among treatments ( $P > 0.5$ ). Manipulating dietary lipid sources may alter immune and inflammatory responses in immune challenged cattle.

**Key Words:** Endotoxin Challenge, Immune Modulation, Lipids

**1155 Effects of supplemental high-oleate and high-linoleate safflower seed on fatty acid profiles of adipose tissue, milk, and blood plasma of primiparous beef heifers.** J.D. Bottger<sup>1</sup>, D.L. Hixon<sup>1</sup>, G.E. Moss<sup>1</sup>, B.W. Hess<sup>1</sup>, R.N. Funston<sup>2</sup>, and D.C. Rule\*<sup>1</sup>, <sup>1</sup>*University of Wyoming, Laramie*, <sup>2</sup>*USDA-ARS, Miles City, MT*.

The objective of this study was to determine effects of supplemental high-linoleate and high-oleate cracked safflower seeds on fatty acid profiles of blood plasma, milk, and adipose tissue of primiparous beef heifers. Thirty-six Angus x Gelbvieh beef heifers were provided ad libitum access to bromegrass hay and given one of three isocaloric and isonitrogenous supplements: corn/soybean meal control (C); cracked high-linoleic safflower seeds (L; 76% 18:2); and cracked high-oleic safflower seeds (O; 72% 18:1). Oil supplements were formulated to provide 5% of total intake as fat. All supplements were individually fed starting 72 h postpartum. Blood was sampled 0, 30, 60, and 90 d postpartum. Milk samples were obtained at the latter three times. Adipose tissue biopsies were taken 0, 45, and 90 d postpartum from the tailhead area. Fatty acid weight percentages were determined using capillary GLC. Heifers supplemented with C had highest ( $P < .05$ ) 14:0, 15:0, 16:0, 16:1, 17:0, and 17:1 in blood plasma, milk, and adipose tissue than O or L heifers. Milk 18:0 was highest in O heifers, plasma of L heifers, and in adipose tissue of C heifers ( $P < .05$ ). Heifers supplemented with L had the greatest ( $P < .05$ ) weight percentage of 18:2 in all tissues; whereas O heifers had the highest ( $P < .05$ ) weight percentage of 18:1 in all tissues. Plasma 18:3 and milk 18:3, 20:4, and 22:5 was greatest ( $P < .05$ ) in the C heifers. Heifers supplemented with O had the highest 22:6 in milk at all time periods ( $P < .05$ ). We conclude that supplemental safflower seeds affect fatty acid profiles of blood plasma, milk, and adipose tissue of primiparous beef heifers. These changes are such that the fatty acids of the particular tissue more closely resemble those of the particular seed being supplemented.

**Key Words:** Fatty Acids, Safflower Seeds, Beef Heifers

**1156 Effects of feeding calcium salts of CLA to finishing steers.** K. J. Gassman\*, D. C. Beitz, F. C. Parrish, and A. Trenkle, *Iowa State University, Ames*.

Conjugated linoleic acid (CLA) is present in highest concentrations in foods of ruminant origin. Health benefits as well as changed body composition have been ascribed to feeding CLA to laboratory animals and pigs. Objectives of this study were to determine if feeding Ca-salts of fatty acids of CLA-rich oil would alter performance, composition and quality traits of meat from finishing steers. Thirty mixed-breed steers weighing 360 kg were randomly assigned to three groups and fed corn-based finishing diets (88% concentrate) containing 0, 1.0 or 2.5% (calculated) CLA for an average of 130 d. Feed intake (kg DM/d), ADG (kg) and F/G were 11.2, 9.9 & 9.0 ( $P < .01$ ); 1.52, 1.20 & 1.20 ( $P < .01$ )

and 7.4, 8.6 & 7.6 ( $P < .05$ ) for 0, 1.0 and 2.5% CLA, respectively. Carcass weight tended to be reduced ( $P < .06$ ) and marbling scores were decreased ( $P < .04$ ) by feeding 2.5% CLA. There were no differences in dressing percent, yield grade or backfat. Percentages of lean in the carcasses calculated from physical separation of the rounds were 73.7, 77.7 and 78.8 ( $P < .04$ ) for 0, 1.0 and 2.5% CLA. CLA concentrations, mg/g of fat extracted from rib fat, round fat, rib lean and round lean were 5.5, 5.4, 5.2 & 6.3; 12.8, 10.8, 8.2 & 10.2 and 20.4, 16.5, 12.4 & 12.6 for 0, 1.0 and 2.5% CLA. Increasing CLA in beef had no effects on shelf life (TBAs), tenderness (Warner-Bratzler, sensory) and juiciness, flavor or flavor intensity (sensory) of rib steaks. It is concluded that feeding Casalts of CLA to finishing steers increased CLA concentration in lipids of adipose and lean tissue and increased the percentage of carcass lean, but decreased feed intake and rate of gain.

**Key Words:** Cattle, CLA, Beef

**1157 Effect of high oil corn or added corn oil on ruminal biohydrogenation and conjugated linoleic acid formation.** L. R. Kennington<sup>\*1</sup>, S. K. Duckett<sup>1</sup>, J. G. Andrae<sup>1</sup>, C. W. Hunt<sup>1</sup>, F. N. Owens<sup>2</sup>, and G. T. Pritchard<sup>1</sup>, <sup>1</sup>University of Idaho, Moscow, <sup>2</sup>Optimum Quality Grains, L.L.C., Des Moines, IA.

Three Angus steers (511 kg) cannulated in the rumen and at the proximal duodenum were used in a replicated 3 x 3 Latin Square. Dietary treatments included 1) typical corn (TC, 2.8% fatty acids, 79.2% of diet DM), 2) high oil corn (HOC, 5.5% fatty acid, 79.2% of diet DM), and 3) typical corn + corn oil (OIL, 5.1% fatty acids, 76.9% typical corn plus 2.37 % corn oil). All diets contained 14% grass hay and 6.8% supplement. Typical and high oil corns were isogenic. Duodenal samples were collected for 4 d following 10-d diet adaptation periods. Ruminal biohydrogenation of total unsaturated 18-C fatty acids was greater ( $P < .05$ ) for HOC and OIL than for TC (72.8 and 69.2%, respectively) though responses for individual fatty acids differed with diet. For oleic acid (C18:1), biohydrogenation was greater ( $P < .05$ ) for HOC than OIL and TC diets; for linoleic acid (C18:2), biohydrogenation was greater ( $P < .05$ ) for OIL than HOC and TC diets; and for linolenic acid (C18:3), biohydrogenation was greater ( $P < .05$ ) for OIL and HOC than TC diets. Despite less biohydrogenation, the amounts of unsaturated 18-C fatty acids in the duodenal digesta (dry matter basis) were 23% and 45% higher ( $P < .05$ ) with HOC and OIL diets than the TC diet. The amount (mg/g) of trans-11-vaccenic acid in the duodenal digesta was higher ( $P < .05$ ) for OIL than TC with HOC being intermediate. The amount (mg/g) of conjugated linoleic acid (CLA), c9t11, was similar ( $P > .05$ ) between diets but numerically greatest with HOC. The t10c12 isomer of CLA was detected in the duodenal digesta only from steers fed the OIL diet. Although biohydrogenation was greater for HOC and OIL diets than typical corn diet, the supply of unsaturated fatty acids in the duodenal digesta still was greater for HOC and OIL because greater amounts were provided in the diet. The amount of trans-11-vaccenic and CLA also was greater with HOC and OIL diets than the typical corn diet.

**Key Words:** High oil corn, Biohydrogenation, CLA

**1158 Dietary sunflower oil increases conjugated linoleic acid (CLA) concentration in beef.** M. Griinari<sup>1</sup>, K. Hissa<sup>2</sup>, and E.-L. Ryhanen<sup>\*3</sup>, <sup>1</sup>University of Helsinki, <sup>2</sup>Suomen Rehu Oy, <sup>3</sup>MTT, Agric. Research Center.

Milk and ruminant meat are the main sources of CLA in our diets. The effect of feeding on milk fat concentration of CLA has been demonstrated in a number of studies. However, the effect of feeding on concentration of CLA in ruminant meat has been examined only in a few studies. The objective of the present study was to examine the effect of dietary addition of sunflower oil (SFO) on concentration of CLA in beef fat. Four groups (n = 6) of Ayrshire bulls (age 6 months and 301 ± 18 kg live weight) were fed a diet of barley based compound feed and grass silage (40 and 60% of dry matter intake, respectively) for 6 months and supplemented with SFO (% of concentrate) according to the following scheme 1) control (C), 2) 4% SFO for the last 3 months (4%/3 mos.), 3) 4% SFO for 6 months (4%/6 mos.), 4) 8% SFO for the last 3 months (8%/3 mos.). Weight gains over the 6-month period did not differ among the treatments and they averaged 1100 g/d. Carcass weights were also similar across the treatments and averaged 267 kg. Concentration of CLA in tissue samples varied depending on the tissue site and generally increased as the level of SFO addition and the duration of the SFO

feeding increased. These results demonstrate, that dietary addition of sunflower oil is a feasible strategy to increase concentration of CLA in beef. Forage:concentrate ratio is likely to be an important determinant of the dietary oil response.

	Control	4% /3 mos.	4%/6 mos.	8%/3 mos.
Weight gain, g/d	1120 ± 81 <sup>1</sup>	1090 ± 80	1110 ± 95	1090 ± 81
Carcass weight, kg	266 ± 14	268 ± 15	267 ± 21	267 ± 14
Fat content, %				
Steak	1.6 ± 0.2	2.2 ± 0.5	2.4 ± 0.5	2.5 ± 0.8
Flank	21.3 ± 4.1	24.3 ± 6.5	26.7 ± 8.4	22.3 ± 1.8
CLA, % of fatty acids				
Kidney fat	0.29 ± 0.04	0.36 ± 0.06	0.45 ± 0.09	0.45 ± 0.11
Steak	0.40 ± 0.04	0.53 ± 0.09	0.65 ± 0.10	0.74 ± 0.20
Flank	0.53 ± 0.05	0.67 ± 0.11	0.84 ± 0.15	0.85 ± 0.22

<sup>1</sup>Values are mean ± standard deviation

**Key Words:** CLA, Beef, Sunflower oil

**1159 The influence of linoleamide on linoleic acid concentrations in ruminal in vitro cultures and in duodenal contents of sheep.** T. C. Jenkins<sup>\*</sup>, Clemson University, Clemson, SC.

The objective of this study was to determine if linoleamide resisted biohydrogenation and could increase linoleic acid (L) concentrations in rumen in vitro cultures or in duodenal contents of sheep. Both the in vitro substrate (ground grass hay) and the sheep diets contained either no added lipid (C), added unprotected fat as linoleic acid (UF), or added protected fat as linoleamide (PF). Fats were added at 10% of the in vitro hay substrate or at 5% of the sheep diets (DM basis). The three substrates were incubated with mixed ruminal microbes in triplicate and 5 mL of culture contents were taken at 0, 24, and 48 h for analysis of L by gas chromatography. The concentrations of corrected L at 0, 24, and 48 h were 2.51, 0.38, and 0.11 mg/5 mL for the UF cultures compared to 2.10, 1.35, and 1.08 mg/5 mL for the PF cultures. Three sheep with duodenal cannulae were fed diets C, UF, and PF in a 3 x 3 Latin square with 2 wk periods. Dry matter intakes were not affected ( $P > 0.05$ , SEM=196) by diet and averaged 1097, 1426, and 1139 g/day for diets C, UF, and PF, respectively. The UF diet increased ( $P < 0.05$ ) daily consumption of L from 11.9 to 45.8 g/day. Intake of L for the PF diet averaged 32.6 g/day and was lower ( $P < 0.05$ ) than the UF diet. Duodenal L concentration averaged 5.0% of total fatty acids when sheep were fed diet C. Both the UF and PF diets increased ( $P < 0.05$ , SEM = 1.2) L in duodenal samples (14.0 and 12.5% of total fatty acids, respectively). However, each sheep responded differently to the fat supplements. The concentration (% of total fatty acids) of L in duodenal contents for diets C, UF, and PF were 2.2, 11.5, and 16.1 for sheep 82, were 7.6, 21.3, and 14.1 for sheep 86, and were 5.3, 4.7, and 11.9 for sheep 89, respectively. In this study, the amide form of L was more effective than the free acid in enhancing the concentration of L in ruminal cultures but the two forms were equally effective in enhancing L in the duodenal contents of sheep. Differences in duodenal L concentrations between the amide vs free acid forms were affected by differences in L intake (29% lower for PF), variation among animals, and incomplete biohydrogenation of UF (which increased duodenal L concentration 180% over C).

**Key Words:** Linoleamide, Duodenum, Sheep

**1160 Biohydrogenation of unsaturated fatty acids in continuous culture fermenters fed orchardgrass or clover with three levels of ground corn supplementation.** J. J. Loo<sup>\*1</sup>, W. H. Hoover<sup>2</sup>, T. K. Miller-Webster<sup>2</sup>, C. E. Polan<sup>1</sup>, W. A. Wark<sup>1</sup>, and J. H. Herbein<sup>1</sup>, <sup>1</sup>Virginia Polytechnic Institute & State University, Blacksburg, <sup>2</sup>West Virginia University, Morgantown.

Concentrations of intermediates in the biohydrogenation of unsaturated fatty acids were determined in continuous cultures of mixed rumen microorganisms using two forages with three levels of ground corn as substrates. Orchardgrass and clover were harvested in Virginia during spring and fall, frozen, ground (6 mm), re-frozen, and transported to West Virginia. During 10-d incubations, fermenters were fed (25 g/12 h) only forage (50 g/d), 42 g/d forage + 8 g/d corn, or 34 g/d forage

+ 16 g/d corn. Linoleic (18:2) and linolenic (18:3) were the primary fatty acids in spring orchardgrass (15% 18:2, 47% 18:3), fall orchardgrass (13% 18:2, 47% 18:3), spring clover (16% 18:2, 39% 18:3), and fall clover (18% 18:2, 30% 18:3). Corn grain contained 34% c9-18:1, 52% 18:2, and 1% 18:3. The total effluent for the last 3-d of incubations was composited, and 500 mg of dry sample used for lipid extraction and fatty acid analysis. Overall, effects of season on fatty acid profiles in fermenters were minor compared with those due to forage type. Concentration of c9,t11-18:2 in effluents from clover (1.2 mg/g total fatty acids) was greater compared with those from orchardgrass (0.8 mg/g), and it increased by 75 and 47% with corn supplementation in effluents from clover and orchardgrass. Concentrations of t10-18:1 (11 vs. 7 mg/g), t11-18:1 (184 vs. 133 mg/g), and 18:0 (358 vs. 234 mg/g) in effluents from orchardgrass were greater compared with those from clover. Replacing portions of each forage with corn nearly doubled t10-18:1 concentration. However, addition of corn (0 to 16 g/d) decreased t11-18:1 in effluents from orchardgrass (184 to 151 mg/g), whereas corn increased t11-18:1 in effluents from clover (133 to 151 mg/g). Concentration of t10,c12-18:2 (0.3 mg/g) was similar across treatments and not affected by corn supplementation. Outflow of t11,c15-18:2 was greater for clover (110 mg/g) compared with orchardgrass (33 mg/g), but addition of corn caused a 50% decrease in concentration. Microorganisms hydrogenated unsaturated fatty acids in clover to c9,t11-18:2 and t11,c15-18:2 primarily, whereas in orchardgrass unsaturated fatty acids were hydrogenated to t11-18:1 primarily. Under grazing conditions, *trans* isomers of 18:1 and 18:2 in milk fat may differ due to type of forage and level of grain supplementation.

**Key Words:** CLA, Trans-10-18:1, Grazing

**1161 Dietary milk fat depression and *trans* -18:1 and CLA isomer distribution in milk of lactating cows.** L.S. Piperova\*<sup>1</sup>, B.B. Teter<sup>1</sup>, J. Sampugna<sup>1</sup>, M.P. Yurawecz<sup>2</sup>, I. Bruckental<sup>3</sup>, and R.A. Erdman<sup>1</sup>, <sup>1</sup>University of Maryland, College Park, <sup>2</sup>FDA, Washington D.C., <sup>3</sup>Volcani Institute, Bet Dagan, Israel.

Dietary milk fat depression (MFD) is associated with incomplete PUFA biohydrogenation in the rumen and increased *trans* fatty acids (tFA) and conjugated linoleic acid (CLA) content in milk. The objectives of this study were to examine the CLA and tFA isomer profiles in milk fat of lactating cows fed a MFD diet. Twelve multiparous Holstein cows in mid lactation were fed a Control diet (CT), containing 60% forage and 40% concentrate for a 2 week preliminary period. The cows were divided into 2 groups and fed either the CT diet or a high concentrate diet with 25% forage, and 70% concentrate supplemented with 5% soybean oil (HO), in a single reversal design. Milk samples were collected at the end of each treatment period. The analysis of the CLA methyl esters were performed by GC and Ag<sup>+</sup>HPLC. The individual *trans*-18:1 isomers were analyzed, using Ag<sup>+</sup>TLC and GC (100 m, SP 2560 capillary column). The HO diet decreased milk fat content by 43% (P<0.001). The total CLA were increased from 5.6 to 9.5mg/g fat, but the yield of total CLA (g/day) was not different from the CT. The *trans*-18:1 fraction in milk was increased from 1.9% to 15.6% (P<0.001) when the HO diet was fed. These changes were related to specific alterations in tFA and CLA isomer profiles. A ten fold increase in *trans*-10, *cis*-12 (P<0.001) and three fold increase in *trans*-7, *cis*-9 CLA (P<0.001) was observed in cows fed the HO diet. The *trans*-10-18:1 was the predominant *trans* monoene in the milk fat during MFD, representing around 60% of total tFA. The percent of *cis*-9, *trans*-11 CLA (P<0.001) and *trans*-11-18:1 (P<0.001) isomer was decreased during MFD. Except for *trans*-15 and 16 which were not affected by the HO diet, the amount (g/day) of all other *trans*-18:1 isomers was increased. The shift in the tFA and CLA isomer profiles indicated that the effects of the HO diet on milk fat synthesis were mediated via changes in rumen environment. The results are consistent with an effect of the *trans*-10, *cis*-12 CLA isomer on milk fat synthesis, but other changes observed in tFA and CLA isomers may also be important.

**Key Words:** Trans-18:1 Isomers, CLA, Milk Fat Depression

**1162 Comparison of *trans* octadecenoic isomer profiles in duodenal and milk lipids of cows fed different diets.** L. Piperova, J. Sampugna, B. Teter\*, K. Kalscheur, and R. Erdman, University of Maryland, College Park.

This study was undertaken to examine the *trans* fatty acid (tFA) isomer distribution in duodenal and milk samples previously collected from

lactating cows fed high concentrate (HC) or low concentrate (LC) diets with or without buffer addition. Four multiparous rumen fistulated Holstein cows in mid-lactation were fed different diets in a 2x2 factorial, 4x4 Latin square design with 3 week treatment periods. The diets had two levels of forage 25% (HC) or 60% (LC) with buffer (B) or without buffer (NB) (1.5% NaHCO<sub>3</sub> and 0.5% MgO). Milk fat depression (MFD) was observed only during the HC+NB treatment period and compared to the HC+B diet, the HC+NB diet resulted in increased tFA content in both the duodenal contents (66g/d vs. 120g/d) and the milk fat (33g/d vs. 56 g/d). Fatty acid butyl esters prepared from milk fat and duodenal samples were submitted to argentation TLC to obtain the total tFA fraction, which was separated using GLC (100m SP2560 capillary column) to obtain estimates of the individual *trans*-18:1 isomers. Except for the 6+7+8 and 13+14 positional isomers, all of the others were sufficiently resolved to allow individual quantification. In general the isomer patterns in the milk fat paralleled those observed in the duodenal samples. The distribution of isomers in the milk of cows fed LC+B, LC+NB, and HC+B diets was similar, with the major isomer, *trans*-11, being about 30% of total tFA. In cows fed HC+NB there was an increase in *trans*-9, 10, and 12 in the milk and the percent of the *trans*-10 isomer in the duodenal and milk samples of these cows was similar to that of the *trans*-11 (about 25 to 30%). In contrast, there was approximately three times more *trans*-11-18:1 than *trans*-10-18:1 in cows that were not milk fat depressed. This three fold ratio was also observed in preliminary studies involving cows fed oil supplemented diets which resulted in high levels of tFA in the duodenum and milk, but which did not result in MFD. Regardless of the tFA content, the only diet which reduced milk fat, HC+NB, also lowered rumen pH. These results demonstrate that alterations in rumen environment which change the tFA isomer pattern are characteristic of MFD.

**Key Words:** Trans-18:1 Isomers, Milk Fat Depression

**1163 Effect of type and level of dietary fat on rumen fermentation and performance of dairy cows fed corn silage-based diets.** S. G. Onetti\*, R. D. Shaver, and R. R. Grummer, University of Wisconsin, Madison.

Response to supplemental fat may vary depending on the level of dietary fat, fatty acid profile of the fat source, feed ingredients of the basal diet, or interactions between fat source and diet. The objective of this study was to investigate the effects of tallow (T) and choice white grease (CWG) fed at two levels on rumen fermentation and performance of dairy cows when corn silage is the sole forage source. Fifteen Holstein cows averaging 117 DIM were used in a replicated 5 x 5 Latin square design with 21-d periods. Treatments were 0% fat (control), 2% T, 4% T, 2% CWG, and 4% CWG (DM basis). The forage:concentrate ratio was 50:50, and diets were formulated to contain 32% NDF and 18% CP (DM basis). Cows were allowed ad libitum consumption of diets that were fed twice daily as TMR. Data are summarized in the table. Cows fed supplemental fat had lower DMI, produced less milk and milk fat, and had a lower acetate:propionate ratio (A/P) than control cows. There was no effect of fat source on DMI, milk production, or rumen measurements. Feeding 4% supplemental fat reduced milk production relative to feeding 2% fat, but there was no significant effect on any of the other parameters measured. There was a significant source of fat x fat level interaction for milk fat % and fat yield (kg fat/d). Including fat in corn silage-based diets had negative effects on production and rumen fermentation regardless of the source or level of supplemental fat.

	Control	2% T	2% CWG	4% T	4% CWG	Significant effects p<.05 <sup>1</sup>
DMI (kg/d)	26.28	24.82	24.39	23.69	23.81	A
Milk (kg/d)	42.28	40.75	41.54	38.07	38.06	A, C
Fat (%)	3.30	2.83	2.93	3.00	2.85	A, D
Fat (kg/d)	1.39	1.14	1.21	1.12	1.08	A, D
pH <sup>2</sup>	5.97	6.07	6.06	5.97	6.04	
VFA (mM) <sup>2</sup>	131.8	120.9	128.9	123.6	125.1	
A/P <sup>2</sup>	2.25	1.78	1.89	1.70	1.77	A

<sup>1</sup>A= control vs. fat, B= T vs. CWG, C= 2% vs. 4%, and D= type x level of fat interaction. <sup>2</sup>4 h post-feeding

**Key Words:** Type and Level of Fat, Rumen fermentation and Milk fat, Corn silage



**1164 Influence of fat supplementation on rumen fermentation and performance of dairy cows receiving diets with different corn silage:alfalfa silage ratios.** S. G. Onetti\*<sup>1</sup>, R. R. Grummer<sup>1</sup>, R. D. Shaver<sup>1</sup>, and D. L. Palmquist<sup>2</sup>, <sup>1</sup>University of Wisconsin, Madison, <sup>2</sup>The Ohio State University, Wooster.

Supplementing 2 or 4 % tallow or choice white grease (DM basis) to diets containing corn silage as the sole forage source has negative effects on milk production and rumen fermentation. We hypothesized that supplemental tallow will have decreasing negative effects on rumen fermentation, DMI, and milk fat percentage as the dietary ratio of alfalfa silage:corn silage is increased. Eighteen Holstein cows averaging 134 DIM were used in a replicated 6 x 6 Latin square design with 21d periods. Treatments were arranged in a 2 x 3 factorial design with 0% or 2% tallow (DM basis) and 3 forage treatments: 1) 50% of DM as corn silage, 2) 37.5% corn silage and 12.5% alfalfa silage, and 3) 25% corn silage and 25% alfalfa silage. Cows were allowed ad-libitum consumption of a TMR. Diets were formulated to contain 18% CP and 32% NDF. Fat supplemented cows had lower DMI and produced more milk with less milk fat content relative to non-supplemented cows. Increasing the proportion of alfalfa silage increased DMI, milk fat % and yield regardless of the fat content of the diet. Cows that received 2% tallow had a higher rumen pH, but there was no effect on total VFA or acetate:propionate ratio (A/P). Increasing the alfalfa silage:corn silage ratio resulted in an increase in pH and A/P for diets with or without fat. These results suggest there are no beneficial effects of replacing corn silage with alfalfa silage when tallow is supplemented at 2% of diet DM.

Corn Silage	0% tallow			2% tallow			Significant effects p<.05 <sup>1</sup>
	50	37.5	25	50	37.5	25	
DMI (kg/d)	23.16	24.64	24.67	22.35	23.73	23.97	A, B, C
Milk (kg/d)	35.17	36.60	36.17	37.46	36.99	37.73	A
Fat (%)	3.11	3.17	3.32	2.82	2.97	3.06	A, B
Fat (kg/d)	1.06	1.15	1.19	1.05	1.09	1.13	B
pH <sup>2</sup>	5.69	5.76	5.91	5.84	5.86	5.95	A, B
VFA (mM) <sup>2</sup>	120.3	118.0	118.0	109.7	116.4	119.8	
A/P <sup>2</sup>	2.00	2.03	2.21	1.98	1.94	2.24	B, C

<sup>1</sup>A= main effect of fat, B= linear effect of forage, C= quadratic effect of forage. <sup>2</sup>4 h post-feeding

**Key Words:** Tallow, Rumen fermentation and Milk fat, Corn silage and Alfalfa silage

**1165 Effect of long chain fatty acids on lactation performance and reproductive tissues of Holstein cows.** C.R. Staples\*<sup>1</sup>, M.C. Wiltbank<sup>2</sup>, R.R. Grummer<sup>2</sup>, J. Guenther<sup>2</sup>, R. Sartori<sup>2</sup>, F.J. Diaz<sup>2</sup>, S. Bertics<sup>2</sup>, R. Mattos<sup>1</sup>, and W.W. Thatcher<sup>1</sup>, <sup>1</sup>University of Florida, Gainesville, <sup>2</sup>University of Wisconsin, Madison.

The objective was to examine effects of specific fatty acids on milk production and composition, on a synchronized estrous cycle, and on the uterine secretion of PGF<sub>2α</sub> of early postpartum dairy cows. Various fat sources were prepared in a Ca salt form and formulated such that a different test fatty acid was delivered to the lower gut. The three fat supplements contained either 57% oleic acid, 45% linoleic acid, or 6.4% eicosapentaenoic (EPA) plus docosahexaenoic (DHA) acids. Fat mixtures were fed at 0 and 2.2% of dietary DM for 42 d. Multiparous cows (n = 29) averaged 64 ± 16 DIM at initiation of dietary treatments. Mean intake of DM (4.15, 4.24, 4.34, and 4.16% of BW, SE=0.02), mean milk production (7-d prior covariate-corrected) (45.0, 46.7, 47.5, and 46.1 kg/d, SE=1.0), and milk fat % (3.66, 3.49, 3.73, and 3.70%, SE=0.16) were similar among cows fed control, high oleic, high linoleic, and high EPA+DHA diets, respectively. Estrous cycles were synchronized using programmed injections of GnRH, PGF<sub>2α</sub>, and hCG. Blood samples were collected daily for progesterone analysis. Ultrasonography of ovarian structures was performed at strategic times. The number of days between ovulations (23.6, 26.7, 27.6, and 26.3 d, SE=0.8) and for regression of the CL to ovulation (3.7, 5.3, 5.6, and 5.3 d, SE=0.3) were lower for controls. Size of the dominant follicle was greater for cows fed supplemental polyunsaturated fats compared to those fed oleic acid (14.3, 14.4, 17.1, and 17.1 mm, SE=1.2). On d 15 of the synchronized cycle, 20 blood samples were collected from jugular catheters from 1 h before to 4 h after oxytocin injection and analyzed for PGF<sub>2α</sub> metabolite (PGFM). Differences in PGFM curves were not detected; however, induction of mRNAs for prostaglandin endoperoxide synthase-2 from uterine biopsy was greater for cows fed linoleic acid (124, 103, 230, and 120 copies per

cell, SE=35). Both fat and particular fatty acids can affect ovarian and uterine dynamics.

**Key Words:** Fat, Ovary, Uterus

**1166 Effects of feeding calcium soaps or whole oilseeds on feed intake and lactation performances of dairy ewes.** D. R. Osuna, R. Casals\*, E. Albanell, and G. Caja, *Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain.*

Objectives were: 1) to study the lactational effects of feeding supplemental fat coming from calcium soaps of palm oil fatty acids (CaS), whole cottonseed (WCS) or sunflower seeds (SFS), and 2) to compare the effects of fat supplementation in two breeds of dairy ewes (Manchega, MN; and Lacaune, LC), of different level of production. Experimental design was a replicated 4x4 latin square (3 wk periods), using 8 ewes of each breed (60 DIM) individually fed. Diets were offered as TMR, containing (DM basis) 18% corn silage, 23% dehydrated whole-plant corn, 23% dehydrated alfalfa, and 36% concentrate, where fat supplements were included. Treatments were: 1) Control (C); 2) 3.8% CaS (Magnapac<sup>®</sup>); 3) 14.2% WCS; and 4) 5.6% SFS. Diets were isonitrogenous (16% CP) and their ether extract increased from 2.7% (C) to 5.7% (fat supplemented). Feed intake (MN: 2.1, LC: 2.9 kg MS/d) and milk production (MN, 0.8; LC, 1.7 kg/d) were affected by the breed (P < 0.001), but not by fat supplementation. However, milk fat percentage increased (P < 0.05) in MN (C, 7.25; CaS, 8.63; WCS, 7.96; SFS, 7.73%) and LC ewes (C, 6.18; CaS, 7.46; WCS, 7.31; SFS, 6.98%) due to fat supplements. Milk protein (MN, 6.4; LC, 5.7%) and casein content (MN, 78; LC, 76% of CP) of milk were not significantly affected by treatments, but tended to be higher with WCS and lower with CaS. No interactions were found between breed and fat supplementation, despite the observed differences between MN and LC ewes in milk yield, and fat and protein percentages. Results suggest changes in the milk fatty acid profile and indicate a reduction (P < 0.05) of spontaneous lipolysis (0 to 24 h) of milk from ewes receiving fat (C, 31.2; CaS, 15.7; WCS, 18.1; SFS, 14.1 mg C<sub>16</sub>/100 g of fat). In conclusion, fat supplements, specially CaS and WCS, may help farmers to produce milk with high fat content, in accordance with spanish Manchego Cheese industry requirements. Acknowledgments: CICYT-Spain (Project AGF99-0773) and Norel S.A.

**Key Words:** Dairy Sheep, Calcium Soaps, Cottonseed and Sunflower Seeds

**1167 Milk composition in Holstein cows fed canola oil in various forms.** E. Desilets\*, D. Pellerin, and P.Y. Chouinard, *Laval University, QC, Canada.*

Use of calcium salts of fatty acids from canola oil in dairy cows diets was previously reported to reduce milk fat content, and to increase the proportion of conjugated linoleic acid (CLA) in milk fat (Chouinard et al. 1998. J. Dairy Sci. 81:471). The objective of this study was to determine if free canola oil or whole canola seed could lead to similar effects on milk composition. Eight Holstein cows in midlactation were used in a replicated 4 x 4 Latin square design with three weeks periods. Treatments were: CO) control diet, CS) control diet + 4% calcium salts of fatty acids from canola oil, FO) control diet + 4% free canola oil, and WS) control diet + 10% whole ground canola seed (DM basis). Diets were fed as TMR once a day and were formulated based on NRC (1989) recommendations. The addition of canola oil (FO, CS, or GS) increased the concentration of dietary ether extract from 4.8 to 8.3% on average. Milk yield and DMI were not influenced by treatments. Milk fat percentage was reduced when CS were fed compared to CO (-11%; P = 0.06). Feeding FO or WS had no effect on milk fat content. Dietary treatments did not affect milk protein and lactose (P > 0.1). Supplementation of canola oil (FO, WS, and CS) decreased the proportion of saturated fatty acid from C6 to C17, and increased the proportions of C18:0 and cis-C18:1 in milk fat (P < 0.01). Feeding canola oil in various forms also increased milk fat content of trans-C18:1, and the increase was greater for cows fed CS as compared with FO or WS (P < 0.01). Milk CLA contents were lower for cows fed CO (6.5<sup>c</sup> mg/g fat), intermediate for cows fed WS (10.1<sup>bc</sup> mg/g fat) and FO (12.1<sup>b</sup> mg/g fat), and higher for cows fed CS (17.1<sup>a</sup> mg/g fat). Since CLA have been demonstrated to have a range of positive health effects, feeding canola oil as calcium salts seems to be the best way to improve the nutritional

value of milk fat. Project supported by Dairy Farmers of Canada and NSERC.

**Key Words:** Milk fatty acids, Canola oil, CLA

**1168 Production performance of Holstein cows fed canola oil in various forms.** E. Desilets\*, D. Pellerin, and P.Y. Chouinard, *Laval University, QC, Canada.*

Dietary fat is used to increase energy value of dairy diets, but its use may cause digestive problems. The objective of this study was to determine the effect of feeding canola oil in various forms on nutrient digestibility and production performance in lactating dairy cows. Eight Holstein cows in midlactation were used in a replicated 4 x 4 Latin square design with three weeks periods. Treatments were: CO) control diet, CS) control diet + 4% calcium salts of fatty acids from canola oil, FO) control diet + 4% free canola oil, and WS) control diet + 10% whole ground canola seed (DM basis). Diets were fed as TMR once a day and were formulated based on NRC (1989) recommendations. Total tract apparent digestibilities of DM and dietary nutrients were determined using chromic oxide as a marker. The addition of canola oil (FO, CS, or WS) increased the concentration of dietary ether extract from 4.8 to 8.3% on average. Dietary treatments did not affect apparent digestibilities of DM, OM, CP, ADF, NDF, and cellulose ( $P > 0.1$ ). Apparent digestibility of dietary ether extract was 40.0%<sup>c</sup>, 59.3%<sup>ab</sup>, 72.0%<sup>a</sup>, and 53.6%<sup>bc</sup> for CO, CS, FO, and WS, respectively. Dry matter intake, milk yield and feed efficiency (kg FCM/kg DMI) were not affected by treatments ( $P > 0.1$ ). The BW was higher for cows fed FO (691<sup>a</sup> kg) and CS (697<sup>a</sup> kg) as compared with those fed WS (684<sup>b</sup> kg) or CO (682<sup>b</sup> kg) ( $P = 0.06$ ). This increase in BW could be related to the higher digestive utilisation of ether extract for cows supplemented with FO or CS. Feeding canola oil as SC or FO increased the availability of fat for absorption as compared with WS without affecting total tract apparent dry matter digestibility. Project supported by Dairy Farmers of Canada and NSERC.

**Key Words:** Dairy cows, Canola oil, Ca salts of fatty acids

**1169 The effect of abomasal infusion of conjugated linoleic acid on milk fat of lactating dairy cows.** J.C. Thorson\*, R.A. Erdman, L.S. Piperova, B.B. Teter, J. Sampugna, and T.L. Auchtung, *University of Maryland, College Park.*

Previous experiments with abomasal infusion of conjugated linoleic acid mixtures (CLA) have shown a decrease in milk fat in lactating dairy cows. Two experiments were conducted using abomasal infusion of a CLA mixture in lactating cows to determine: 1) the length of time after cessation of CLA infusion for the milk fat to return to control levels, and 2) to examine the dose response of milk fat to increasing rates of abomasal CLA infusion. In Experiment 1, five rumen fistulated multiparous Holstein cows in mid lactation were abomasally infused with 90g per day of a commercial CLA mixture (CLA 60, Jarrow's Formulas Inc, Los Angeles, CA) for five days followed by a 12 day post-infusion period. Six non-fistulated cows were maintained as controls during the experiment. All cows were fed a diet containing 55% forage:45% concentrate as a total mixed ration. Milk samples were collected twice daily and analyzed for milk composition. Milk fat was reduced by 45% (2.13 in CLA vs. 3.89 in controls,  $P < 0.0001$ ) in the CLA infused cows at the end of the second day of infusion and remained constant through the end of infusion. Milk fat percent did not return to the control levels until day 6 post infusion. These results suggest a substantial carryover effect of abomasal infusion of CLA on milk fat synthesis. In Experiment 2, four rumen fistulated cows used in Experiment 1 were infused with 0, 10, 30 or 90 g/day of CLA-60 corresponding to 0, 6, 18, and 54 g of CLA for 5 days in a 4x5 Latin rectangle design. A 9 d recovery period was used between each infusion to reduce carryover effects. Milk samples for analysis were collected at the end of each infusion period. Cows were fed the same diet as in Experiment 1, but 100g of corn oil was used as carrier during infusion. Milk fat percent decreased linearly (3.89, 3.33, 2.91, and 2.76%) with increasing amount of CLA infused ( $P < 0.03$ ). Milk production was not changed by CLA infusion. Maximum rates of milk fat depression occurred with as little as 30g of CLA mixture infusion (18g CLA) confirming the potent effect of CLA on fat synthesis.

**Key Words:** Conjugated Linoleic Acid, Milk Fat Depression

**1170 Contribution of dietary roasted soybeans and milk components to the development of spontaneous oxidized milk flavor.** J. S. Timmons\*, W. P. Weiss, D. L. Palmquist, and W. J. Harper, *OARDC / The Ohio State University, Wooster, OH.*

The effects of feeding roasted whole soybeans (RSB) on the milk fatty acid profile and the development of spontaneous oxidized flavor were determined in a field study performed from December, 1998 through April, 1999 using 20 herds in the vicinity of Wooster, Ohio. Herds were fed 0 to 15.3% of diet DM as RSB. Storing milk at 4°C for 3 days, reduced concentrations of  $\alpha$ -tocopherol,  $\beta$ -carotene, and ascorbic acid and increased flavor score at 3 and 8 d. Concentrations of milk fatty acids did not change during 8 d of storage. The development of spontaneous oxidized flavor at day 8 post-sampling was correlated with increased concentrations of polyunsaturated milk fatty acids ( $r = 0.51$ ), RSB ( $r = 0.33$ ), and copper ( $r = 0.26$ ) in the milk. The concentrations of polyunsaturated milk fatty acids ( $r = 0.82$ ) in particular 18:2 ( $r = 0.86$ ) and 18:3 ( $r = 0.68$ ) were correlated with the amount of dietary RSB. Multiple linear regression models were developed to determine the relationship of measured variables to the development of off-flavor milk at 8 d post-sampling. Xanthine oxidase activity, copper and polyunsaturated milk fatty acids in milk and dietary RSB were related to increased flavor score ( $P < 0.10$ ). This study suggests that RSB increased the polyunsaturated fatty acid content in milk fat, thereby increasing the susceptibility of milk to spontaneous oxidation.

**Key Words:** Roasted Soybeans, Spontaneous Oxidized Flavor, Milk Fatty Acids

**1171 Ruminant lipolysis and biohydrogenation of long-chain fatty acids.** P. J. Moate\*, R. C. Boston, and W. Chalupa, *University of Pennsylvania, Kennett Square.*

The accuracy with which nutrition models (such as CPM-Dairy) can predict total fat concentration and the concentrations of the major fatty acids in milk will depend on an accurate estimation of the rates of lipolysis (Klip) and biohydrogenation (Kb) of long-chain fatty acids (LCFA) in the rumen. Objectives of this research were to estimate Klip of the major fat sources and the Kb of C18 fatty acids. To estimate these, we developed a model of the lipolysis / biohydrogenation processes. The main model assumptions are: dietary lipid first either passes out of the rumen or undergoes lipolysis in the rumen to produce free LCFA. In the rumen, LCFA containing 18 carbon atoms are biohydrogenated in a stepwise process (C18:3  $\rightarrow$  C18:2  $\rightarrow$  C18:1trans  $\rightarrow$  C18:0; C18:1cis  $\rightarrow$  C18:0). At each step, the specific fatty acid can either pass out of the rumen or be biohydrogenated. Data used were from 30 dietary ingredients in 16 diets from four published experiments that reported daily intakes and duodenal flows of LCFA in dairy cows. We used an XL spreadsheet to iteratively alter Klip and the Kb to obtain a "best fit" of the model predictions to observed duodenal flows of LCFA. The estimated Klip (%/h) of lipids from forages, concentrates, tallow, and megalac are 115, 60, 50 and 45, respectively. These Klip are reduced by 5% for each % of dietary LCFA. The estimated Kb (%/h) of C18:3, C18:2, C18:1 trans and C18:1cis are 58, 50, 22 and 13, respectively. The Kb of a specific fatty acid is independent of the fat source from which it was derived, and Kb (18:2) is reduced by 5% for each % of dietary C18:2. Sensitivity analysis shows a 10% change in the magnitude of Klip causes less than 3% change in the extent of lipolysis while a 10% change in a particular Kb generally results in < 5% change in the duodenal flow of the relevant fatty acids. These in vivo Klip are consistent with published rates determined in vitro, while the in vivo Kb have similar ranking but are substantially greater than Kb determined in vitro.

**Key Words:** Rumen, Lipolysis, Biohydrogenation

**1172 Ruminant production of long-chain fatty acids.** P. J. Moate, R. C. Boston, and W. Chalupa, *University of Pennsylvania, Kennett Square.*

The aim of this research was to develop equations to be used in nutrition models to predict the ruminal production of long-chain fatty acids (LCFA) in dairy cows. Data used were from 31 diets in nine published experiments that reported intakes and duodenal flows of LCFA (g/cow/day). Regression analyses indicated that daily duodenal flows of total LCFA (DTLFA), total C16 fatty acids (DTC16) and total C18 fatty acids (DTC18) were closely related ( $R^2 \geq 0.91$ ) to intakes of total

fatty acid (TIFA), total C16 fatty acids (TIC16) and total C18 fatty acids (TIC18) respectively:

$$\text{DTLFA} = 42.7 (\pm 55.1) + 1.01(\pm 0.06) * \text{TILFA}$$

$$\text{DTC16} = 16.4 (\pm 10.6) + 0.93(\pm 0.05) * \text{TIC16}$$

$$\text{DTC18} = 40.8 (\pm 31.6) + 1.07(\pm 0.05) * \text{TIC18}$$

The intercepts of these equations suggest there is production of LCFA in the rumen and the standard errors indicate production is variable. Further analysis showed that the discrepancies (DisC16, DisC18) between the respective duodenal flows and intakes of total C16 and C18 fatty acids could be described by multiple linear regression equations involving fat-free dry matter intake (FFDMI), bodyweight (BW), TIC16 and TIC18. We conclude ruminally produced LCFA are mainly C18, that the coefficients associated with FFDMI and BW indicate de novo fatty acid synthesis and endogenous fatty acid secretion respectively, and that fatty acid intake has a negative effect on de novo fatty acid synthesis.

Model term	Regression Coefficients ( $\pm$ S.E.)	
	DisC16 (g/day)	DisC18 (g/day)
Constant	-217 $\pm$ 24	-295 $\pm$ 92
FFDMI (kg/day)	5.7 $\pm$ 0.7	13.3 $\pm$ 2.8
BW (kg)	0.28 $\pm$ 0.04	0.45 $\pm$ 0.13
TIC16 (g/day)	-0.33 $\pm$ 0.08	-
(TIC16) <sup>2</sup>	0.00043 $\pm$ 0.00014	-
TIC18 (g/day)	-	-0.50 $\pm$ 0.18
(TIC18) <sup>2</sup>	-	0.00034 $\pm$ 0.00014

**Key Words:** Cattle, Long-chain fatty acids, Ruminal synthesis

### 1173 Digestion of long-chain fatty acids in dairy cows. P. J. Moate\*, R. C. Boston, and W. Chalupa, *University of Pennsylvania, Kennett Square.*

The accuracy with which nutrition models (such as CPM-Dairy) can predict milk yield and in the future, the concentrations of the major fatty acids in milk, will depend in part on the accuracy with which these programs can predict the true intestinal digestion (absorption) of long chain fatty acids. The objective of this research was to determine the digestion coefficients of the major long chain fatty acids in dairy cows. Data used were from 33 diets in nine published experiments that reported flows of fatty acids (g/day) to the duodenum and to feces. Linear regression analysis was used to relate duodenal flows of specific fatty acids to the quantity of fatty acid apparently absorbed. Y intercepts were generally negative and not significantly different from zero. We interpret this to mean that post duodenal endogenous secretions of fatty acids were negligible. The slopes (true digestibility coefficients  $\pm$ SE) for the major fatty acids were: myristic, C14:0 (0.81 $\pm$ 0.06); palmitic, C16:0 (0.76 $\pm$ 0.01); palmitoleic, C16:1 (0.90 $\pm$ 0.13); Stearic, C18:0 (0.71 $\pm$ 0.03); Oleic, C18:1cis (0.88 $\pm$ 0.02); Elaidic, C18:1trans (0.88 $\pm$ 0.02); linoleic, C18:2 (0.82 $\pm$ 0.02) and linolenic, C18:3 (0.82 $\pm$ 0.01). The digestion coefficient for total fatty acids was 0.75 $\pm$ 0.01. Despite the fact that diets covered a wide range in fatty acid intakes as well as diverse fatty acid sources, simple linear regressions could accurately describe the true absorption of the major fatty acids. However, the following quadratic equation better predicted ( $R^2 = 0.97$ ) the absorbed stearic acid (S) from duodenal stearic acid (D):

$$S = -21\pm 13 + 0.99\pm 0.09 * D - 0.00038\pm 0.00011 * D^2$$

We conclude that if duodenal flow of fatty acids is known or can be predicted, the quantity of fatty acids absorbed can be accurately predicted.

**Key Words:** Cattle, Long-chain fatty acids, Digestibility

### 1174 Effects of fat with high melting point on ruminal environment and forage digestion in grazing dairy cows. G.F. Schroeder\*<sup>1</sup> and G.A. Gagliostro<sup>2</sup>, <sup>1</sup>CONICET-Fac. Cs. Agrarias UNMdP, <sup>2</sup>INTA EEA Balcarce, Argentina.

The objective of this study was to determine if saturated fat (tryglycerides, melting point 58-60°C) could affect ruminal parameters and forage cell wall digestion in grazing dairy cows. Six Holstein cows (three in early and three in mid-lactation) fitted with ruminal cannulae were allotted to a replicated 3x3 Latin square with three treatments: 0 kg (T0), 0.5 kg (T0.5) and 1 kg (T1) of hydrogenated dried oil (30% C16:0 and 60% C18:0). Fat was added to basal concentrate composed by ground corn (5 kgDM/d), fish meal (0.4 kgDM/d) and calcium chloride (20 gDM/d) offered in two equal feeds during milking. Cows were under strip grazing in alfalfa (*Medicago sativa*) and orchardgrass (*Dactylis*

*glomerata* L.) mixed pastures (24.4% DM, 38.2% NDF, 23.4% CP and 73.2% IVDMD). Dacron bags containing fresh forage (5 g DM/bag) were incubated in the rumen and removed at 0, 4, 8, 12, 16, 20, 24, 26, 32, 40 and 48 h. Ruminal pH, NH<sub>3</sub>-N concentration, molar proportions of individual volatile fatty acids (VFA) and total VFA concentrations were not changed by treatments. All parameters of in situ disappearance of forage NDF were not affected by fat supplementation. may be a suitable way to avoid the negative effects on rumen environment and fiber digestion of unprotected fat feeding to ruminants

	T0	T0.5	T1	SEM	P $\leq$
pH	5.7	5.7	5.7	0.05	0.98
NH <sub>3</sub> -N (mg/dl)	17.8	18.1	14.5	1.53	0.25
VFA (mmol/L)	88.3	85.8	79.3	5.92	0.56
Acetate:Propionate	3.3	3.2	3.1	0.12	0.51
Soluble NDF (%)	0.3	0.3	1.0	0.37	0.36
Degradable (%)	76.9	73.6	75.5	1.59	0.41
Rate (kd) (%/h)	5.5	6.0	5.9	0.59	0.78
Effective degradability (kp= 7%/h) (1)	32.5	32.6	33.6	1.04	0.72

1- Rate of passage assumed

**Key Words:** fat supplementation, grazing, ruminal digestion

### 1175 Effect of nonenzymatically browned sunflower seeds on ruminal fermentation and milk composition in dairy cows. R.J. Grant<sup>1</sup>, T.J. Klopfenstein<sup>1</sup>, K. Fanning\*<sup>1</sup>, and C. Wilson<sup>1</sup>, <sup>1</sup>University of Nebraska, Lincoln.

Our hypothesis was that an effective nonenzymatic browning of ground sunflower seeds would increase mono- and polyunsaturated milk fatty acids with minimal impact on ruminal fermentation. The ground, nonenzymatically browned sunflower seeds (NEBS) that we developed contained 59.5% ruminally undegradable lipid measured in situ. Eight lactating Holstein cows (150 DIM) were assigned to one of four diets in a 4 x 4 Latin square with 3-wk periods. The control diet contained 50% forage (DM basis) with no added lipid. The remaining diets contained 50% forage and 4% added lipid from sunflower oil (SFO), ground, untreated sunflower seeds (GSF), or NEBS. The SFO diet resulted in the lowest ( $P \leq 0.05$ ) DMI (22.3 kg/d), the GSF diet was intermediate (23.5 kg/d), and the NEBS and control diets were similar (24.6 kg/d). Production of 4% FCM was greatest ( $P \leq 0.05$ ) for the NEBS diet (27.8 kg/d), intermediate for the control and GSF diets (25.9 kg/d), and lowest for the SFO diet (23.7 kg/d). Ruminal pH was unaffected ( $P \geq 0.10$ ) by diet (6.18). Fractional digestion rate of NDF from soybean hulls incubated in the rumen was highest ( $P \leq 0.05$ ) for the control and NEBS diets (0.062 /h), intermediate for the GSF diet (0.049 /h), and lowest for the SFO diet (0.039 /h). Ruminal acetate to propionate ratio was lowest ( $P \leq 0.05$ ) for cows fed the SFO diet (3.09), intermediate for the GSF diet (3.69), and highest for the control and NEBS diet (3.80). Milk fatty acids of chain length C14:0 or less were uniformly reduced with addition of oil from any sunflower product. The amount of C16:0 in milk fat was reduced by 56% with SFO, GSF, or NEBS compared with control diet ( $P \leq 0.05$ ). The NEBS diet resulted in the greatest C18:3, C18:2, and C18:1 *cis* fatty acids in milk fat ( $P \leq 0.05$ ). The SFO and GSF diets resulted in elevated C18:1 *trans* fatty acids ( $P \leq 0.05$ ). These results indicate that the oil in NEBS was protected from ruminal fermentation and successfully elevated the poly- and monounsaturated fatty acid content of milk fat. These desirable changes in milk fat composition were coupled with an increase in milk fat production.

**Key Words:** sunflower seeds, milk fat, dairy cows

### 1176 Development and application of a mechanistic model to study substrate degradation, microbial synthesis and gas production. J. Dijkstra\*<sup>1</sup>, J. France<sup>2</sup>, M.S. Dhanoa<sup>3</sup>, and S. Lopez<sup>4</sup>, <sup>1</sup>Wageningen University, Netherlands, <sup>2</sup>The University of Reading, UK, <sup>3</sup>Institute of Grassland and Environmental Research, UK, <sup>4</sup>University of Leon, Spain.

A mechanistic model was developed to study the relationships between substrate degradation, microbial synthesis, and gas production in the *in vitro* gas production technique. The model was based on standard substrate and microbial growth kinetics and consisted of six state variables that represented undegradable substrate ( $Q_U$ ), insoluble degradable substrate ( $Q_D$ ), soluble substrate ( $Q_S$ ), microbial biomass ( $Q_M$ ),

volatile fatty acids ( $Q_{VFA}$ ), and gas ( $Q_G$ ). Hydrolysis of  $Q_D$  was assumed to obey mass-action kinetics. Microbial uptake of  $Q_S$  was represented by saturation kinetics. The substrate taken up was utilized for microbial growth and non-growth requirements. A fixed microbial non-growth requirement was assumed. The amount of VFA and gas produced were calculated based on stoichiometric principles. Simulations were terminated when non-growth requirements exceeded substrate uptake, representative of the situation of maximal microbial biomass. Gas production profiles were simulated for five feedstuffs with different degradation characteristics. The feedstuffs evaluated were a good (G1) and a poor quality grass silage (G2), sugarbeet pulp (SB), pressed potato pulp (PP) and soy hulls (SH). All simulated cumulative gas production profiles had realistic sigmoidal shapes. Fast degrading feeds reached the point of maximal microbial biomass more quickly than slow degrading feeds. The incubation time at maximal microbial biomass varied between 15.3 (SB) and 27.8 (SH) h. Besides, fast degrading feeds tended to have a higher efficiency of microbial synthesis compared with slow degrading feeds. Microbial efficiency at the point of maximal biomass varied between 257 (SH) and 317 (SB) g microbial biomass / kg substrate truly degraded. The simulations provided a quantitative understanding of the relationships between substrate degradation, microbial biomass, and gas production.

**Key Words:** Gas Production, Mathematical models

**1177 Challenging a model of dairy cattle metabolism to describe responses to dietary rumen undegradable protein content.** M. Woodman\* and J. McNamara, *Washington State University, Pullman.*

The objective was to test behavior and sensitivity of a mechanistic model of digestion and metabolism in dairy cattle for describing responses to changes in dietary rumen undegradable (RUP) content. From published literature, a set of 25 treatment groups were collated. Range of milk productions was 18.8 to 35.7 kg/d; DIM was 21 to 136; DMI was 17.2 to 25.4 kg/d. Diets ranged from 14.3% to 23.8% CP with 25.9% to 59% RUP as a percent of protein. Most control diets were soybean-based and test diets were protected soybean, oil seed or animal-based protein. Initial body weights, DIM, DMI, nutrient intake, milk production and milk composition of controls were inputs into the model. The model used was the MOLLY model from the University of California. MOLLY uses feed nutrients as explicit inputs and biochemical equations to describe responses. Dietary protein is allotted to insoluble or soluble, with insoluble protein being slightly higher than the measure of RUP for a given feed. Simulations of predicted milk production (PMP) and predicted protein production (PP) were output by the model. The equation for predicting PMP from observed milk production (OMP) was  $PMP = 1.073 \times OMP + 3.002$ ,  $r^2 = .799$ ,  $SE_{xy} = 2.23$ . The equation for predicting PP from observed milk protein yield (OP) was  $PP = 1.084 \times OP + 0.068$ ,  $r^2 = .736$ ,  $SE_{xy} = .078$ . Mean bias was .70 and -.053, line bias was .126 and .00015, and residual bias was 3.30 and .0036 kg/d for milk and milk protein yield. Data and simulations support the concept that substituting soybean protein with increased RUP does not increase milk or milk protein yield at these production levels. The model describes milk and milk protein yield in response to increased RUP within the range of this data. However, it is not adequate to describe the metabolic and production effects of changing RUP such as change in body composition. Further data on effects of changing other dietary ingredients and absorbed amino acid pattern are needed to improve our ability to predict changes to these components.

**Key Words:** Protein, Model, Lactation

**1178 Comparison of predicted changes in duodenal flow of crude protein and amino acids caused by changing the diet fed to lactating dairy cows.** H. G. Bateman, II<sup>\*1</sup>, J. H. Clark<sup>1</sup>, C. J. Peel<sup>2</sup>, R. A. Patton<sup>3</sup>, and C. G. Schwab<sup>4</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Degussa-Hüls, Inc., Ridgefield Park, NJ, <sup>3</sup>Nittany Dairy Nutrition, Mifflinburg, PA, <sup>4</sup>University of New Hampshire, Durham.

The objective of this research was to investigate the inferences obtained from simulated flows of CP and AA to the duodenum of lactating cows and to compare those inferences with those obtained from measured data. Duodenal flows of CP and AA from 6 research trials published between 1989 and 1995 were simulated using the 1989 NRC equations,

the Mepron Dairy Ration Evaluator (MEPRON), the Cornell Net Carbohydrate and Protein System (CNCPS), the University of Pennsylvania release of the CNCPS (PENN), and the CPM dairy program. Both predicted and measured protein fractions were analyzed by ANOVA and compared to determine if statistical inferences obtained from predictions by the models were similar to those from the measured data. The ANOVA of measured data did not always agree with those for predicted data. All models responded to changes in diet composition and often predicted that dietary changes would result in statistically different amounts of protein and amino acids passing to the duodenum that were not observed in the experimentally measured data. The NRC model predicted the correct direction of change in flow of CP for 40% of treatment comparisons. All other models predicted the correct direction of change in total protein flows for 57 to 60% of the treatment comparisons. However, the PENN, CNCPS, and CPM models only predicted the correct direction of change for AA flows in 45% of the treatment comparisons while the MEPRON model predicted the correct direction of change in AA flows for 60% of treatment comparisons. Discrepancies in ANOVA and interpretations between predicted and measured data may be because of the inherent nature of modeling, associative effects of feeds not accounted for by models, inaccurate equations in the models, inaccurate description of feeds, or experimental error in measured data.

**Key Words:** Modelling, Protein, Amino Acids

**1179 Estimating ruminal crude protein degradation with *in situ* and chemical fractionation procedures.** S. Shan-nak, K.-H. Suedekum\*, and A. Susenbeth, *University of Kiel, Germany.*

A new system for the estimation of the protein value of feedstuffs for dairy cattle was recently introduced in Germany. Key variable in the system is the amount of total crude protein (CP) reaching the duodenum ("nutzbares Rohprotein", nXP), which is the sum of microbially synthesized CP and ruminally undegraded CP (UDP) and is estimated from *in vivo* trials on duodenally cannulated dairy cows. The objective of this study was to utilize the fractionation of feed CP of the Cornell net carbohydrate and protein system (CNCPS) as a basis for estimating UDP values of feedstuffs obtained from *in situ* trials. Unlike the CNCPS, our approach aimed at determining one single UDP value for each feedstuff from multiple linear regression equations instead of estimating four different UDP values. Thirty-two feedstuffs were inserted in polyester bags and incubated inside the rumen of three steers. Values for *in situ* UDP at assumed ruminal passage rates of 2, 5, and 8%/h, respectively, ranged from 6 to 57, 12 to 78, and 16 to 84% of CP. When fish meal data (n = 2) were excluded from the data set, multiple regression equations that were based on concentrations of CP and cell wall, and on the A, B, and C fractions of the CNCPS fractionation schedule, explained 85, 93, and 95%, respectively, of the variation in UDP values at assumed ruminal passage rates of 2, 5, and 8%/h. At 8%/h of passage, the difference between UDP values derived from *in situ* and chemical fractionation procedures was greater than five units for only four out of 30 feedstuffs. We conclude that *in situ* UDP values, which serve as one key variable in many protein evaluation systems for dairy cattle, may be reliably and accurately predicted from chemical fractionation of feed CP according to the CNCPS.

**Key Words:** Rumen, Protein, Cattle

**1180 Assessment of the value of cannulated pigs for measuring intestinal protein digestibility of ruminal undegraded protein of canola meal.** A. F. Mustafa, J. J. McKinnon\*, P. A. Thacker, and S. Y. Qiao, *University of Saskatchewan, Saskatoon, Canada.*

The objective of the study was to determine whether cannulated pigs could serve as a model to measure intestinal digestibility of ruminal undegraded protein (RUP). Intestinal digestibility of RUP from canola meal (CM) heated at 125 or 145 °C for 0, 10, 20, and 30 min was measured in two experiments using either duodenally cannulated steers or pigs. Two Hereford steers fitted with ruminal and duodenal cannulas were used in the first experiment. Nylon bags containing 1 g of the CM samples were incubated in the rumen for 12 h followed by a 3-h incubation in a pepsin-HCl solution. The bags were then inserted into the duodenum of the steers and recovered in the feces. Rumen undegraded residues were obtained in the second experiment by incubating nylon bags containing the CM samples in the rumen of two fistulated Holstein cows for 12 h. Following incubation, washed rumen undegraded

residues from each treatment were pooled and ground. Nylon bags containing 1 g of rumen undegraded residues with or without pepsin-HCl pre-incubation were inserted in the duodenum of three duodenally cannulated pigs and recovered in the feces. The results showed that intestinal digestibility of RUP for CM heated at 125 °C was similar to unheated CM using both animal models. With both models, heating CM at 145 °C significantly reduced the intestinal digestibility of RUP. The regression equations relating pig and steer estimates showed that cannulated pigs accounted for 96% of the variation in intestinal digestibility of RUP with a standard error of prediction of .073%. When forced through the origin, the bias was 6% overprediction of intestinal digestibility. It was concluded that duodenally cannulated pigs could be used to estimate intestinal digestibility of RUP of heat-treated CM for ruminants. Further studies are required to validate the model for other feedstuffs.

**Key Words:** Ruminant undegraded protein, Cannulated pig, Intestinal digestibility

**1181 Comparison of phospholipid phosphorus and purines as markers of microbial crude protein in duodenal digesta of cattle.** R.A. Mass<sup>\*1</sup>, R.A. Drijber<sup>1</sup>, K.W. Creighton<sup>1</sup>, W.W. Stroup<sup>1</sup>, and T.J. Klopfenstein<sup>1</sup>, <sup>1</sup>University of Nebraska, Lincoln.

Quantification of microbial CP (MCP) flow from the rumen requires a reliable, accurate MCP marker. Of all the criteria required of a marker, assay ease and precision often limit marker analysis. Although purines (PUR) are commonly assumed to be an accurate microbial marker, that method is deficient in these analytical criteria. Phospholipid phosphorus (PP) has been shown to be highly correlated ( $r = .98$ ) to microbial cell mass and MCP in mixed cultures where radiolabelled phosphorus incorporation was measured. The objective of this experiment was to compare PUR and PP as markers of MCP. Duodenal digesta samples ( $n = 12$ ) were collected as part of another experiment in which cattle were fed different amounts of alfalfa hay. Samples were analyzed in duplicate for both PUR (2 N perchloric acid hydrolysis, silver nitrate in the wash solution) and PP. Estimates of MCP concentration were made by applying marker:MCP ratios obtained from in situ analysis. Alfalfa hay NDF was incubated in situ for 12 h and then analyzed for both markers and CP. There was a positive linear relationship between the MCP estimates from the two methods (MCP from PUR =  $.63(\text{MCP from PP}) + 1.37$ ;  $r^2 = .68$ ). Although it is unclear why the slope of the regression differs from one, we hypothesize that this is the result of marker:MCP ratios which interact between methods and stage of microbial growth. A statistical test of assay precision was conducted by comparing assay mean square errors using an F test. Analytical error for PP tended to be lower ( $P = .09$ ) than PUR, suggesting a difference in precision of these methods. Although the ease of an assay is more difficult to assess, it could be described by the hours of labor required to complete it. For this set of samples, it took 8 h to assay for PUR and 5 h to assay for PP. Similar equipment is required for each assay. Consistency of marker:MCP ratios across rumen microbial growth stages must be clarified before a definite conclusion can be made about the accuracy of PP as MCP marker.

**Key Words:** Ruminants, Microbial Protein, Markers

**1182 Analytical evaluation of a low infusion dose of [<sup>15</sup>N<sup>15</sup>N]urea to determine urea production, gut entry rate and recycling in dairy cows.** H. Lapierre<sup>\*1</sup>, E. Milne<sup>2</sup>, and G.E. Lobley<sup>2</sup>, <sup>1</sup>Dairy and Swine R&D Centre, Lennoxville, Quebec, Canada, <sup>2</sup>Rowett Research Institute, Aberdeen, Scotland, UK.

Infusion or injection of [<sup>15</sup>N<sup>15</sup>N]urea and collection of urine and feces, allows quantification of total urea production (UP) plus partition of the urea-N that enters the digestive tract between catabolism (recycling to the ornithine cycle (ROC) and feces) and anabolism. To assess the potential of the method for dairy cows, the analytical precision was evaluated under conditions that simulate 0.25 of the [<sup>15</sup>N<sup>15</sup>N]urea dose currently used for sheep. Three criteria needed to be met: precise measurement of 1) lower isotopic enrichment (IE) of [<sup>15</sup>N<sup>15</sup>N]urea (UP measurement); 2) lower IE of [<sup>14</sup>N<sup>15</sup>N]urea; 3) the ratio of [<sup>14</sup>N<sup>15</sup>N] to [<sup>15</sup>N<sup>15</sup>N]urea (ROC quantification). The precision of the [<sup>15</sup>N<sup>15</sup>N] measurements was determined on standard solutions (STD), and of [<sup>14</sup>N<sup>15</sup>N]urea, on urine samples from a previous study involving 4 sheep infused with [<sup>15</sup>N<sup>15</sup>N]urea. The IE of urea was measured by isotope ratio of N<sub>2</sub> produced by monomolecular reaction of LiOBr on urea: mass 29 refers to N<sub>2</sub> from [<sup>14</sup>N<sup>15</sup>N]urea and mass 30 to [<sup>15</sup>N<sup>15</sup>N] urea. The

variances of mass 30 measurements for the STD were small, CV averaged 0.1, 1.5 and 1.8 % for STD of 0.1215, 0.0628 and 0.0324 ape, respectively. The proportion of mass 29 due to the non-monomolecular reaction was not affected by IE ( $P > 0.10$ ; 4.7, 4.6 and 4.3 % of total IE for the 3 STD). Furthermore, the CV for mass 29 of undiluted (0.0299 ape) and diluted (0.0089 ape) urine were 1.1 and 1.0 % respectively. Consequently, the ratio of mass 29:mass 30 IE was not altered ( $P > 0.10$ ; 38.9 and 38.7 %) at lower IE. In the dairy cow, an infusion of 0.15 mmol/h of [<sup>15</sup>N<sup>15</sup>N]urea would yield an IE of approximately 0.03 ape for mass 30 and thus the total amount of [<sup>15</sup>N<sup>15</sup>N]urea required for a single dose or a 60-h infusion would be 0.6 g. Urea kinetics can, therefore, be quantified in high yielding dairy cows at doses of [<sup>15</sup>N<sup>15</sup>N]urea that are economically acceptable.

**Key Words:** Cow, Urea, Kinetics

**1183 Urea flux in beef steers: effects of forage species and fertilization.** S. L. Archibeque<sup>\*</sup>, J. C. Burns, and G. B. Huntington, North Carolina State University, Raleigh.

The effects of forage species and fertilization level on urea kinetics and whole body nitrogen (N) metabolism were evaluated in 8 Angus growing steers (initial weight 217  $\bar{n}$  15 kg, final weight 252  $\bar{n}$  9 kg). In a replicated 4x4 latin square design, steers were fed four hays, dried with forced air, from two warm season grasses, gamagrass (*Tripsacum dactyloides*, G) and switchgrass (*Panicum virgatum*, S), which were fertilized with either 56.2 (L) or 168.5 (H) kg of N per hectare. Diets were fed to provide adequate energy for 0.5 kg ADG. Following 21d of adjustment, N balance was measured from days 22 - 27 of each period. Bis-<sup>15</sup>N urea was infused (0.137 mmol/hr) via a jugular catheter for 56 h and urine was collected from 48-56 h to measure urea kinetics. Jugular blood was collected during the balance trial prior to and at scheduled intervals during infusion, and analyzed for blood urea N (BUN). G differed from S ( $P < 0.05$ ) in daily DMI (4273 vs 4185 g), N intake (72 vs 67 g), DM digestibility (60.95 vs 63.59%), fecal N (30.59 vs 28.33 g/d), urine N (20.19 vs 19.58 g/d), urine urea N (10.54 vs 8.03 g/d), and percent of urinary N present as urea N (53.51 vs 39.99%). By design, daily N intake was lower ( $P < 0.05$ ) for L (63 g) than for H (76 g). L also differed from H in DM digestibility (61.27 vs 63.27%), urine N (13.56 vs 25.94 g/d), and N retained as a percent of N digested (57.3 vs 43.5%). After adjustment by covariance for differences in N intake, fecal N excretion was ( $P < 0.09$ ) greater for G than S. Compared to S, G had greater BUN, N digestibility, and N digested as fertilization level increased (forage x fertilization interactions  $P < 0.05$ ). As fertilization level increased, N retention increased from 19.5 to 23.5 g/d in G and decreased from 20.5 to 18.1 g/d in S (interaction  $P < 0.07$ ). Urea kinetics for one replication of the Latin square (4 steers), indicate that gut entry rate of urea N was greater ( $P < 0.10$ ) for H (31.7 g/d) than for L (25.5 g/d), yet there was no difference ( $P = 0.13$ ) in the amount of N that was recycled to the ornithine cycle (9.8 g/d). In summary, fertilization affected N metabolism of steers more when fed G than when fed S and the bis-<sup>15</sup>N urea method of monitoring urea flux appears to be a viable alternative to surgical procedures that have typically been used in the past.

**Key Words:** Beef Steers, Nitrogen, Forage

**1184 A pilot project to introduce the routine use of milk urea N analysis for diet evaluation.** J.S. Jonker<sup>\*1</sup>, R.A. Kohn<sup>1</sup>, J. High<sup>2</sup>, and A. Grove<sup>3</sup>, <sup>1</sup>University of Maryland, College Park, <sup>2</sup>Lancaster Dairy Herd Improvement Association, Manheim, PA, <sup>3</sup>Maryland and Virginia Milk Producers Cooperative, West Reston, VA.

Milk urea N can be used by dairy farmers to monitor the nutritional status of their cows and to examine N nutrient loading to water resources from dairy farms. The objectives of this study were to introduce the routine use of milk urea N to monitor dairy cattle diets and determine the potential economic and environmental impact of overfeeding protein to dairy cows in the Chesapeake Bay drainage basin. A confidential mail survey was conducted with members of the Maryland and Virginia Milk Producers Cooperative ( $n = 1156$ ). A total of 454 dairy surveys (return rate = 39.3%) were returned. All dairy herds from the milk cooperative were tested for milk urea N for six months ending May 1999. Farmers who returned the survey were provided with lab results and recommendations for adjusting diets each month. Milk production was observed

to have the greatest effect on milk urea N presumably because of increased protein requirements for the greater production. Dairy farmers who received our correspondence saw a relative decrease in their milk urea N concentration by 0.52 mg/dl from the beginning to the end of the testing period compared to non-participating farmers. When comparing observed to target milk urea N concentrations, a wide variation in protein feeding management was observed. However, as milk production increased, milk urea N decreased compared to target levels. Over 40% of the dairy farms had milk urea levels above their target concentrations for herds fed according to NRC recommendations. This excess feeding of protein was estimated to reduce net farm income by \$1500/yr per dairy farm due to increased feed costs and reduced milk production. Furthermore, 1.4 million kg/yr of N loading could be reduced if dairy cows were fed according to recommendations. Routine use of milk urea N reduced excess CP being fed to cows, and thereby reduced N excretion and nonpoint N loading to the Chesapeake Bay.

**Key Words:** Milk Urea N, Chesapeake Bay, Dairy Farm

**1185 Post-ruminal delivery of biologically active proteins using *Pichia pastoris*: definition of growth conditions.** C. Strauss<sup>\*1</sup>, T. A. McAllister<sup>1</sup>, and L. B. Selinger<sup>2</sup>, <sup>1</sup>Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, <sup>2</sup>University of Lethbridge, Lethbridge, AB.

The *Pichia pastoris* expression system could be useful for post-ruminal delivery of protein, but only if the cells remain intact throughout their residence in the rumen, i.e., for at least 12 h, if they associate with the fluid phase of ruminal contents, 36 h if with the particulate phase. Plate counts measure viability, but do not detect non-viable cells that remain cellularly intact. Accurate assessment of integrity following ruminal incubations is pivotal to developing cultivation techniques for large-scale production of transgenic *P. pastoris* as a feed additive for ruminants. The gene encoding Green Fluorescent Protein (GFP) was inserted into *P. pastoris* GS115, which then allowed detection of cellular integrity independent of viability. The recombinant strain was used to identify the fractions of ruminal fluid that effect degradation of *P. pastoris* cells, and to define yeast culture conditions to improve survival of intact *P. pastoris* for passage from the rumen. With the yeast culture conditions used initially, only 35% of *P. pastoris* cells inoculated remained intact after 9 h of incubation in the bacterial (i.e., protozoa-free) fraction of ruminal fluid (RF), compared with 100% maintenance of integrity after 48 h in clarified (cell-free) RF and distilled water ( $n = 5$ ). In contrast, when complex carbohydrates were omitted from the yeast culture medium, cellular integrity was maintained by 100% of *P. pastoris* cells after 36 h of incubation in bacterial fraction ( $n = 7$ ), but by only 28% of cells incubated in whole RF ( $n = 3$ ). Work is ongoing to further define yeast culture conditions to enhance survival of intact *P. pastoris* cells in the presence of ruminal protozoa. Methanol-induced intracellular expression of bioactive peptides, enzymes and high-value proteins in recombinant *P. pastoris* could be effective for providing ruminal escape protein to ruminants, once yeast culture conditions are optimized.

**Key Words:** Bypass protein, Enzymes, Green Fluorescent Protein (GFP)

**1186 Determining protein quality of a supplemental feed block based on whole cottonseed, broiler litter and molasses for growing cattle.** D. Kumar<sup>\*</sup>, M.A. Froetschel, H.E. Amos, C.A. McPeake, and M.Q. Lowder, *The University of Georgia, Athens.*

A feed block supplement that contained 25% whole cottonseed, 45% broiler litter and 30% molasses was developed to provide cost-effective nutrition for growing cattle. Depressed post-absorptive concentrations of lysine in growing calves fed the feed product suggests that its utilization was limited by protein quality. The potential to improve protein quality of this feed product was investigated by substituting graded levels (0, 8, 12 and 24%) of a blend of fish meal and dried distillers grains (58:42) for the whole cottonseed and broiler litter in the feed product. Protein quality was determined by measuring nitrogen retention in four Holstein steers (average initial weight = 201 kg) fed feed blocks and free choice Bermudagrass hay in a 4x4 Latin Square designed experiment. Experimental periods were 14 d in length. Feed block and hay intake were measured daily. On day 8 the steers were fit with indwelling jugular catheters and blood sampled at hourly intervals from 0-6 h after feeding and assayed for insulin, glucose, urea N and amino acids. Steers consumed an average 5.42 kg DM/d of feed block and 1.61 kg DM/d of

hay. Steers fed increasing levels of fish meal and dried distillers grains increased N retention in a linear manner ( $P < .01$ ) from 36.0 to 51.1 g/d. Post-ruminal amino acid flow was measured in four ruminally and abomasally cannulated steers (average weight = 496 kg) fed similar levels of the feed blocks and hay, as a % of body weight, for 14 d periods in a 4 x 4 Latin Square designed experiment. Chromic oxide was used as a digestibility marker. Abomasal flow of lysine increased in a linear fashion ( $P < .01$ ) from 54.7 to 79.6 g/d as steers were fed incremental levels of protein supplement. Protein supplementation of a feed block composed of regionally available byproduct feeds should improve cost effective performance of backgrounded cattle.

**Key Words:** Supplemental feed block, Protein quality, Nitrogen retention

**1187 Influence of broiler litter stacking method and monensin inclusion on performance and *Salmonella* shedding of growing calves.** D. J. Capucille, M. H. Poore<sup>\*</sup>, and G. M. Rogers, *North Carolina State University, Raleigh.*

An 84-d growing trial was conducted with 60 calves (initial wt. 284 kg) to determine performance on a control diet containing 33% corn silage (CS), 33% cottonseed hulls (CSH), 22% corn and 11% soybean meal (SBM), as compared to broiler litter diets containing 15% CS, 15% CSH, 35% broiler litter (BL) and 35% corn. Broiler litter was *Salmonella* positive at cleanout and was stacked to a depth of approximately 2.5 m (DS, peak temperature 55 °C), or to approximately 1 m (SS, peak temperature 40 °C). Half the calves on each treatment had monensin included at 30 g/ton DM to make a 2 x 3 factorial arrangement of treatments. After the growing period, calves underwent a shipping protocol, and were then placed on a finishing diet. There were no interactions of diet and monensin. Both types of BL were *Salmonella* negative at feeding, and biweekly fecal sampling showed no shedding of *Salmonella* during the growing trial, after shipping, or during the finishing phase. Calves fed the control diet gained faster ( $P < .05$ ) than either BL ration, while calves fed DS tended ( $P < .09$ ) to gain faster than SS (1.53, 1.29, and 1.19 kg/d for control, DS and SS, respectively). Dry matter intake (DMI) tended to be higher for control than DS ( $P < .09$ ) and both were higher ( $P < .05$ ) than SS (10.1, 9.6 and 8.6 kg/d for control, DS and SS, respectively). Feed efficiency was higher ( $P < .02$ ) for control than BL diets, but did not differ between DS and SS (.152, .134 and .138 for control, DS and SS, respectively). Monensin inclusion did not influence daily gain (1.34 kg/d), but decreased DMI ( $P < .01$ ; 9.8 vs 9.1 kg/d) and improved feed efficiency ( $P < .02$ ; .147 vs .136). Diet during the growing phase influenced starting weight on the finishing phase, but had little influence on finishing performance or carcass characteristics. In this study, improper stacking of *Salmonella* positive BL did not result in detectable *Salmonella* shedding, but reduced feed intake and cattle performance.

**Key Words:** Broiler litter, Monensin, *Salmonella*

**1188 Determining the energetic value of whole cottonseed as compared to corn and cottonseed meal in a block supplement for growing cattle based on broiler litter and molasses.** M. A. Froetschel<sup>\*</sup>, H. E. Amos, D. Kumar, V. Pattarajinda, and C. A. McPeake, *The University of Georgia, Athens.*

There is a significant opportunity to background more cattle in the Southeast if an economical feed supplement was available. A feed product was developed and tested as a supplement in growing beef cattle. The product consisted of 25% whole cottonseed (WCS), 45% broiler litter and 30% molasses and fed as a pressed block. Initial feeding trials indicate that the feed product was palatable, contained 65% TDN and 18% CP and cost from \$.64 - .97 /kg of gain. This feeding trial was conducted to determine the optimal inclusion rate of whole cottonseed in comparison to a mixture corn and cottonseed meal in the feed product fed as a feed-block. Eight growing Angus steers (average initial body weight 234 kg). Feed blocks of varying composition (6.8 kg block plus chopped hay ad-libitum) were fed to each of the steers in a replicated 4 x 4 Latin square designed experiment. The level of broiler litter was set at 45% and molasses at 30%; whereas, the rest of the feed block mixture (25%) consisted of either whole cottonseed or mixtures of ground corn and cottonseed meal. A 60:40 ratio of corn to cottonseed meal was used to substitute for 0, 5, 10 and 15% of the whole cottonseed in the feed block. Steers were fed diets for 28 d periods. Performance of the cattle was assessed by measuring both body weight change and nitrogen balance. Steers were fit with indwelling jugular catheters and hourly blood samples were collected, on d 28, -1 to 8 h after feeding and analyzed for

glucose, insulin and urea nitrogen and plasma amino acids. DM intake of the feed block and hay averaged 1.9 and 1.1% of body weight, respectively. Average daily gain were quadratically related ( $P < .05$ ) to the level of substitution of corn and cottonseed meal for whole cottonseed and was lowest in cattle fed blocks that had intermediate levels of corn and cottonseed meal substitution. Digestible energy and N retention were not influenced by the composition of the feed block ( $P > .05$ ). Even though, the feed product resulted in cost effective gains of growing cattle the higher energy value of WCS relative to a mixture of corn and cottonseed meal was not realized.

**Key Words:** Supplemental feed block, Whole cottonseed, Digestible energy

**1189 Use of concentrated separator by-product in receiving diets for beef steers.** E. R. Loe\*, M. L. Bauer, G. P. Lardy, and J. C. Caton, *North Dakota State University, Fargo.*

One hundred thirty-two crossbred steers ( $263.6 \pm .8$  kg) were fed for 27 d to evaluate effects of concentrated separator by-product (CSB; desugared molasses) on DMI, gain, and health of receiving steers. Steers were shipped 300 km and allowed free access to water and long-stem hay upon arrival. Steers were processed, blocked by previous management, and allotted randomly to dietary treatment. Previous management blocks included 1) weaning day of shipping and 2) weaning at least 3 weeks prior to shipping. Dietary treatments were concentrated separator by-product (CSB) and control (CON). The CSB diet contained 40% dry-rolled corn, 5% CSB, 50% grass-alfalfa hay, and 5% supplement on a DM basis. The CON diet contained 43% dry-rolled corn, 50% grass-alfalfa hay, and 7% supplement on a DM basis. Water was added (equal to the as fed weight of CSB) to CON diet to minimize differences in ration acceptability between treatments. Both treatments were formulated to contain .5 mg/kg decoquinat, 13.5% CP, .85% Ca, .45% P, and a minimum of 1.3% K. Steers were weighed weekly. Initial and final weights were an average of two-d weights. Performance data were analyzed using the GLM procedure of SAS and health data were analyzed with Chi-square. Steers fed CSB had greater DMI (8.3 vs 7.6 kg/d;  $P = .06$ ) and DMI as a percentage of BW (2.70 vs 2.51% BW;  $P = .06$ ). Calves weaned prior to day of shipping were treated fewer times ( $P = .002$ ) for signs of bovine respiratory viral complex than calves weaned day of shipping. Other measurements ( $P > .10$ ) were not affected by treatment. Addition of CSB to receiving diets increases dry matter intake and may be a useful feed ingredient in diets where intake is expected to be low.

Item	Treat ment, %DM		SEM	P
	CSB	CON		
Final weight, kg	307.1	302.8	2.5	.23
DMI, kg/d	8.31	7.64	.23	.06
DMI, %BW	2.70	2.51	.07	.06
ADG, kg/d	1.37	1.23	.08	.20
Gain:Feed	.167	.160	.009	.59

**Key Words:** Concentrated Separator By-Product, Receiving, Steers

**1190 Optimizing the digestion of soybean hulls by limit-fed cattle.** A. M. Trater\*, E. C. Titgemeyer, C. A. Loest, and B. D. Lambert, *Kansas State University, Manhattan.*

Twenty Holstein steers (319 kg) were used in a randomized complete block design to evaluate the optimal level of alfalfa inclusion in limit-fed, soybean hull-based diets. Treatments were a soybean hull mix (95.7% soybean hulls, 3% molasses, 0.5% urea, 0.8% mineral mix; DM basis) fed with 0, 10, 20, and 30% (DM basis) coarsely chopped alfalfa hay (SH100, SH90, SH80, SH70, respectively), or only alfalfa (ALF). Steers were allotted to four blocks based on body weight. Diets were fed once daily at 1.75% (DM basis) of body weight for 16 d (10-d adaptation, 6-d collection). In some cases orts were present, but intakes of DM and OM were not affected by treatment. However, digestions of DM (DMD) and OM (OMD) for ALF (56.2 and 58.1%, respectively) were lower ( $P < 0.01$ ) than for diets containing soybean hulls (DMD = 67.5, 70.9, 67.2, and 70.9%, SEM = 2.0, and OMD = 68.7, 72.3, 68.6, and 72.3%, SEM = 1.9, for SH100, SH90, SH80, SH70, respectively). There were no differences in DMD or OMD among diets containing soybean hulls, although there were positive associative effects between soybean hulls and alfalfa (significant only for SH70). Liquid and solid passage rates were estimated by labeling a portion of the ration with Cr-EDTA and Yb chloride and subsequently collecting fecal samples 24, 48, 72, and 96 h after dosing (liquid passage) or 48, 72, 96, and 120 h after dosing (solid passage). Liquid dilution rates (4.6, 6.2, 5.6, 7.4, and 7.7%/h,

SEM = 0.5, for SH100, SH90, SH80, SH70, and ALF, respectively) were higher for ALF than for SH100 and were increased ( $P < 0.05$ ) by addition of 10 or 30% alfalfa to the soybean hull diet. Solid passage rates (4.1, 5.0, 4.2, 7.0, and 4.0%/h, SEM = 0.5, for SH100, SH90, SH80, SH70, and ALF, respectively) were highest ( $P < 0.05$ ) for SH70. Positive associative effects were observed on both liquid and solid passage rates for SH70 ( $P < 0.05$ ). Addition of 30% alfalfa to diets consisting primarily of soybean hulls led to positive associative effects on diet digestibility, but paradoxically increased liquid and solid passage rates.

**Key Words:** Soybean hulls, Digestion, Cattle

**1191 Evaluation of various by-products for use in stocker cattle diets.** D.L. Rankins, Jr.\* and B.E. Gamble, *Auburn University, Auburn, AL.*

Two trials were conducted to evaluate various backgrounding diets for stocker steers. Both trials used crossbred steers for a period of 112 d. **Trial 1.** Fifty steers (initial BW  $276 \pm 15$  kg) were allotted to one of five diets (5 steers/pen; 2 pens/diet). All diets were 53% cracked corn and 47% broiler litter (DM basis) fed free-choice with the following roughage sources offered free-choice: 1) bermudagrass hay (76% NDF, 36% ADF), 2) peanut hulls, 3) pelleted peanut hulls (74% NDF, 65% ADF), 4) cotton mote (81% NDF, 72% ADF) and 5) gin trash (57% NDF, 47% ADF). Total DMI was greater ( $P < .05$ ) for steers fed hay and peanut hulls compared to those fed the other three roughage sources (12.9 and 13.3 kg versus 12.1, 11.6 and 11.9, respectively). Daily gains were fastest by steers fed the hay and peanut hulls (1.46 and 1.37 kg/d) and slowest for those fed the pelleted hulls and cotton mote (1.13 and 1.15 kg/d;  $P < .05$ ). **Trial 2.** Fifty steers (initial BW  $211 \pm 12$ ) were allotted to one of five diets (5 steers/pen; 2 pens/diet): 1) 53% cracked corn and 47% broiler litter, 2) 53% soyhull pellets and 47% litter, 3) 53% citrus pulp and 47% litter, 4) equal quantities of corn, soyhulls and citrus pulp to equal 53% and 47% broiler litter and 5) 55% corn and 45% peanut hulls. All diets were supplemented with free-choice bermudagrass hay. Total DMI was greatest for steers fed diets 1 and 5 (11.0 and 11.4 kg) and lowest for those fed diet 3 (8.6 kg;  $P < .05$ ). Diets 2 and 4 were intermediate (10.7 and 10.1 kg). Daily gains were fastest for steers fed diets 1, 2 and 5 (1.21, 1.15 and 1.13 kg/d;  $P < .05$ ) and slowest for steers fed diet 3 (.78 kg/d). Steers fed diet 4 gained 1.03 kg/d. When feeding a broiler litter-based diet, the supplemental roughage source should be selected based on ADF content. In litter-based diets corn and soyhulls are equivalent as an energy source; however, citrus pulp is not as effective.

**Key Words:** by-products, broiler litter, beef cattle

**1192 In vitro mixed ruminal microorganism fermentation of whole cottonseed coated with gelatinized corn starch and urea.** J. K. Bernard\*<sup>1</sup>, S. A. Martin<sup>2</sup>, and T. C. Wedegaertner<sup>3</sup>, <sup>1</sup>The University of Georgia, Tifton, <sup>2</sup>The University of Georgia, Athens, <sup>3</sup>Cotton Incorporated, Cary, NC.

A replicated completely randomized design in vitro mixed ruminal microorganism fermentation study was conducted to determine the effect of coating whole cottonseed (WCS) with gelatinized corn starch and feed grade urea. Treatments were arranged as a 3 x 4 factorial to provide three levels of starch (0.0, 2.5, and 5.0%) and four levels of urea (0.0, 0.25, 0.5, and 1.0%). All treatments were prepared from one lot of WCS. Fermentations (40 mL) were conducted using medium that contained 20% (vol/vol) ruminal fluid in 160-ml serum bottles. Treated WCS was ground to pass through a 1-mm screen and weighed amounts (0, 0.4, 0.8, and 1.2 g) were added to the serum bottles. As starch increased, pH, hydrogen, methane, total VFA, and molar proportions of propionate (P) increased linearly ( $P < 0.001$ ), whereas molar proportions of acetate (A) and A:P ratio decreased linearly ( $P < 0.001$ ). Concentrations of L-lactate were highest ( $P < 0.01$ ) with 2.5% starch compared to either 0 or 5.0%. As the amount of urea included in the coating increased, pH ( $P < 0.001$ ) and methane ( $P < 0.01$ ) increased linearly whereas hydrogen concentrations decreased linearly ( $P < 0.05$ ). A quadratic response was observed for ammonia concentrations due to moderate increases with 0.25 and 0.5% additions and a greater increase with 1.0% urea (410, 442, 456, and 560 mg/L, respectively). Interactions ( $P < 0.01$ ) among starch and urea were observed for hydrogen, methane, and L-lactate. Hydrogen and L-lactate concentrations decreased as urea increased with 0 and 2.5% starch, but increased with 5% starch. Methane concentrations increased as urea increased with 0 and 5% starch, but remained constant, except for an increase with 0.5% urea, for 2.5% starch. These

results indicate that coating WCS with up to 0.5% urea with gelatinized corn starch can potentially improve ruminal fermentation.

**Key Words:** Whole cottonseed, starch, urea

**1193 Nutritive evaluation of a food industry byproduct for feedlot cattle.** A. S. Bertin\*, H. W. Harpster, V. H. Baumer, J. W. Comerford, and E. H. Cash, *The Pennsylvania State University, University Park.*

Bakery byproduct (BB), a recycled food industry waste consisting of 38% cookie, 29% bread and dough, 19% cake, 7% chips, and 7% pretzels, was evaluated as a replacement for corn in feedlot diets. Nutrient values (DM basis) were DM 93.1%; CP 12.0%; NDF 17.3%; ADF 4.7%; Ether Extract 9.5%; starch 48.9%; and ash 3.6%. Ten Angus crossbred and two Angus purebred yearling steers (404.13 kg) were blocked by weight and randomly allotted to three treatments (DM basis): 1. Control: 60% cracked corn (CC), 40% corn silage (CS) plus a vitamin/mineral mix providing 30 g/T monensin sodium (VMM); 2. BB: 60% BB, 40% CS + VMM; 3. Blend: 30% BB, 30% CC, 40% CS + VMM. Diets were individually fed in Calan<sup>®</sup> electronic doors. Steers were slaughtered based on a predetermined (ultrasound scan) external fatpoint of 1.0 cm (seven/treatment at 84 d; five/treatment at 112 d). One Blend steer was lost due to reasons unrelated to diet. There were no treatment X slaughter group interactions for any criteria ( $P > .10$ ). Least-square means for the three respective diets were: DMI (kg/h/d) 11.70, 10.79, 11.79 (1 vs. 2  $P < .06$ ; 2 vs. 3  $P < .04$ ); ADG (kg/h) 1.82, 1.86, 2.06 (1 vs. 2  $P < .08$ ; 1 vs. 3  $P < .03$ ); and Gain/Feed .159, .178, .176 (1 vs. 2  $P < .01$ ; 1 vs. 3  $P < .02$ ). Mean external fat at slaughter was 1.16, 1.25, and 1.14 cm, respectively ( $P > .10$ ). Respective least-square means (external fat as a continuous covariate) for treatments 1, 2, and 3 were: marbling, 502.4, 464.2, 494.4 (1 vs. 2  $P < .07$ ) (400 = slight; 500 = small); USDA quality grade, 18.58, 18.25, 18.54 (18 = high Select; 19 = low Choice); longissimus area (cm<sup>2</sup>), 82.50, 85.35, 83.74; kidney, pelvic, heart fat (%), 2.45, 2.46, 2.35; hot carcass weight (kg), 357.9, 355.6, 359.1; lean color, 2.57, 2.37, 2.41 (2 = light; 3 = ideal cherry red); and yield grade, 3.06, 2.91, 2.99. These data suggest that BB was equal to corn at a level of 60% in feedlot diets. Performance advantages were noted for the Blend diet, while carcass characteristics were similar among treatments.

**Key Words:** Byproduct, Beef, Carcass Characteristics

**1194 Palatability of byproduct feeds and their effect on ruminal pH and carcass characteristics for meat goats.** J.A. Moore, M.H. Poore, J.M. Luginbuhl, and M.E. Joyner, *North Carolina State University, Raleigh.*

Twenty-four crossbred wether goats (50% Boer, 6 per diet) averaging 27.4 kg at initiation of the study were fed either wheat midds (WM), soyhulls (SH), or corn gluten feed (CGF) at 1% of body weight along with orchardgrass hay (10.4% CP) offered to ad libitum consumption for 70 d. The control (hay) diet was supplemented with soybean meal to bring total dietary protein to 12.5% (5.7% soybean meal). Byproducts were brought to a 2:1 Ca:P ratio with limestone (corn gluten feed, 5.7%; wheat midds, 5.4% limestone) or dical (soyhulls, 0.7% dical and 12.8% soybean meal). Protein level of the byproduct feeds after minerals were added was: soyhulls, 17.3%; wheat midds, 16.6%; corn gluten feed, 21.9%. Goats readily consumed the byproduct feeds, which were offered 30 minutes prior to hay. Goats were fed individually in indoor raised pens and had trace-mineralized salt and automatic waterers. Initial weight ( $P = .25$ ), final weight ( $P = .48$ ), and average daily gain ( $P = .56$ ) did not differ for the four treatments. Carcass weight was greatest ( $P = .05$ ) for the SH goats (16.0 kg), intermediate for WM (15.6 kg) and CGF (15.3 kg), and lowest for control (14.5 kg) goats. Carcass grade did not differ ( $P = .80$ ) and averaged 5.42 with a score of 5 being choice and 6 being choice-minus. Dressing percentage tended ( $P = .12$ ) to be lower for the control goats (46.4%) as compared to SH (48.3%), CGF (48.3%), and WM (48.8%) diets. Ruminal pH by ruminocentesis 2.4 hr after feeding was highest ( $P < .01$ ) for control goats (6.52) and lowest for WM goats (6.23) with SH (6.41) and CGF (6.35) being intermediate. In summary, goats readily ate the byproducts at 1% of body weight, and byproducts either had no effect (carcass grade, gain) or a positive effect (carcass weight, dressing percentage). Ruminal pH was lower for goats

fed the byproducts, but remained above 6. Soyhulls, corn gluten feed, and wheat midds appear to be viable feed supplements for meat goats.

**Key Words:** Byproducts, Goats

**1195 Effects of solid passage rate, pH, and level of linoleic acid on the production of *cis*-9, *trans*-11-octadecadienoic acid (CLA) in continuous culture.** X. Qiu\*<sup>1</sup>, M.L. Eastridge<sup>1</sup>, K.E. Griswold<sup>2</sup>, and J.L. Firkins<sup>1</sup>, <sup>1</sup>*The Ohio State University, Columbus*, <sup>2</sup>*Southern Illinois University, Carbondale.*

A dual-flow continuous culture system consisting of 4 fermentors was used in a 4 x 4 Latin square design. The 4 treatments were: 1) control = pH 6.5, 1% linoleic acid (LA), 4%/h solid dilution rate (SDR), 2) HSDR = pH 6.5, 1% LA, 8%/h SDR, 3) HLA = pH 6.5, 3% LA, 4%/h SDR, and 4) LPH = pH 5.8, 1% LA, 4%/h SDR. Inoculum was collected 6 h after feeding from a cow fed 40% alfalfa hay and 60% grain. The temperature was held at 39 + 0.1 °C, and liquid dilution rate at 0.12/h. Fermentors were continuously fed a diet (120 g/d DM) containing alfalfa hay (40%), corn (28%), and soybean hulls (26%). All diets except HLA contained 2% tallow. The LA was dissolved in buffer and continuously infused into the fermentors. Each period consisted of 10 d with the last 3 d for sample collection. The CLA content in outflow was lowest for control (0.14, 0.17, 0.20, and 0.21 mg/g DM, respectively). The CLA flows were 9.42, 10.92, 14.52, and 12.48 mg/d, respectively. The LPH increased CLA content, possibly by inhibiting biohydrogenation and bacteria growth. This was also reflected by a lower flow of stearic acid and higher flows of *trans*-18:1, oleic acid, and linoleic acid for LPH than control. The NDF and ADF digestibilities were not affected by pH. The HSDR increased CLA content, possibly because a shorter solid retention time lead to incomplete biohydrogenation. The OM, NDF, and ADF digestibilities and bacteria number were reduced by HSDR. With more LA available as a substrate for CLA, HLA resulted in a higher content and flow of CLA than control. The HLA resulted in the highest OM, NDF, and ADF digestibilities, biohydrogenation, and bacteria number. Continuous infusion of LA into the fermentors may have prevented any adverse effect on bacteria. *In vivo* data are needed to verify the effects of SDR, pH, and LA on CLA flow to the small intestine and incorporation of CLA into milk fat.

**Key Words:** Conjugated Linoleic Acid, Continuous Culture, Biohydrogenation

**1196 Concentrations of conjugated linoleic acid in beef carcasses are not increased by supplementing a high-corn diet with 5.0% soybean oil.** A.D. Beaulieu\*, J.K. Drackley, N.R. Merchen, and E.L. Falkenstein, *University of Illinois, Urbana.*

Conjugated linoleic acid (CLA) has many beneficial effects including decreased tumor growth in animal models. Although CLA is formed in the rumen few data relate this synthesis to tissue concentrations. Our objective was to determine if supplementing a high-corn diet with soybean oil (SBO) increases the concentration of CLA in the rumen and tissues. Four rumen-cannulated steers were used in a Latin-square design with 28-d periods. A control diet (80% cracked corn, 2.0% corn steep liquor, 8.0% ground corn cobs, and 10% supplement) was supplemented with 2.5, 5.0, and 7.5% (DM) SBO. Supplementation with SBO did not affect rumen pH or VFA concentrations. The proportion and amount (mg FA/g DM rumen contents) of *cis*-9, *trans*-11 CLA (9,11 CLA) was not increased with increasing SBO. However, the proportion and amount of the *cis*-10, *trans*-12 (10, 12 CLA) isomer was increased ( $P < 0.05$ ) by 5.0% and 7.5% SBO. *Trans*-C18:1 isomers in rumen contents were increased ( $P < 0.05$ ) by 7.5% soybean oil. Proportions of *trans*-C18:1 isomers were correlated negatively ( $P < 0.05$ ) with 9,11 CLA and positively ( $P < 0.0001$ ) with 10,12 CLA. The control diet, supplemented with 0% or 5% SBO, was fed individually to 20 Angus-Waygu heifers for 90 d in a randomized design to determine the effect of SBO on tissue deposition of CLA. Supplementation with SBO did not affect feed intake, feed efficiency, or carcass quality. Tissue samples were obtained from the hind, loin, forequarter, liver, large and small intestines and subcutaneous, mesenteric, and perirenal adipose depots. The only CLA isomer identified in tissue extracts was 9,11; the concentration was greatest in subcutaneous adipose tissue but was not affected in any tissue by SBO. Supplementing high-corn diets with SBO does not increase CLA concentrations in tissues of fattening heifers. Research is needed to identify pathways of biohydrogenation that can account for



increased concentrations of 10, 12 CLA in rumen contents when high-oil diets are fed.

**Key Words:** Conjugated linoleic acid, Rumen fatty acids, Tissue fatty acids

**1197 Effects of supplemental safflower seeds on conjugated linoleic acid in blood plasma, adipose tissue, and milk of primiparous beef heifers.** J.D. Bottger\*<sup>1</sup>, D.L. Hixon<sup>1</sup>, B.W. Hess<sup>1</sup>, G.E. Moss<sup>1</sup>, R.N. Funston<sup>2</sup>, and D.C. Rule<sup>1</sup>, <sup>1</sup>University of Wyoming, Laramie, <sup>2</sup>USDA-ARS, Miles City, MT.

Thirty-six Angus x Gelbvieh primiparous heifers were used to determine effects of supplementing cracked safflower seeds on conjugated linoleic acid (CLA) and trans-vaccenic acid (TVA) in blood plasma, adipose tissue, and milk. Heifers were randomly assigned to one of three isocaloric and isonitrogenous treatments at parturition: cracked corn and soybean meal (C); cracked high-linoleate safflower seeds (L; 76% 18:2); or cracked high-oleate safflower seeds (O; 72% 18:1). Safflower supplements were formulated to provide 5% of intake as fat and all were individually fed at 0700 daily for 90 d starting 72 h postpartum. Heifers were provided ad libitum access to bromegrass hay. Adipose tissue biopsies were taken from the tailhead area 0, 45, and 90 d postpartum. Blood plasma was collected at 0, 30, 60, and 90 d postpartum, and milk samples were collected at 30, 60, and 90 d. Fatty acid profiles were determined by capillary GLC. Weight percentages of TVA, 9c11t CLA, and 10c12c CLA were highest in milk of L-fed heifers at d 30, 60, and 90 ( $P = .06$ ,  $.04$ , and  $.02$ , respectively). Treatment means for the L heifers were greatest ( $P < .05$ ) for TVA (17.0%), 9c11t CLA (2.6%), 10c12t CLA (.02%), and 10c12c CLA (.09%). Treatment means for 9c11t CLA in adipose tissue were higher ( $P < .05$ ) in L heifers (1.1%) than in C heifers (1.0%). Blood plasma TVA was highest ( $P = .07$ ) in L heifers at d 30, 60, and 90. Heifers fed C had the greatest ( $P < .01$ ) blood plasma weight percentage of 9c11t CLA at d 60 (.17%), with no differences at the other collection times. Heifers fed C had the highest blood plasma weight percentage of 10c12t CLA at d 60 and 90 ( $P = .01$  and  $.02$ , respectively), but contained the lowest ( $P = .03$ ) weight percentage of this fatty acid at d 90. We conclude that supplemental high-linoleate safflower seeds increased CLA in adipose tissue and milk, and increased TVA in milk and blood plasma of primiparous beef heifers.

**Key Words:** Conjugated Linoleic Acid, Safflower Seeds, Beef Heifers

**1198 Dry matter intake is decreased more by abomasal infusion of unsaturated free fatty acids than by unsaturated triglycerides.** J. K. Drackley, S. Thire, N. B. Litherland\*, and A. D. Beaulieu, University of Illinois, Urbana.

Previous experiments from our group have demonstrated that abomasal infusion of unsaturated free fatty acids (FFA) markedly decreases DMI. In contrast, experiments from other groups have noted smaller decreases in DMI when unsaturated triglycerides (TG) were infused post-ruminally. Our hypothesis was that unsaturated FFA would be more potent inhibitors of DMI than an equivalent amount of unsaturated TG. Four Holstein cows were used in a single reversal design. Cows were fed a TMR (15.5% CP, 20.4% ADF) of (DM) 23% alfalfa silage, 23% corn silage, 40.3% ground shelled corn, and 10.5% soybean meal. Two cows received soy FFA (0, 200, 400, 600, 0 g/d) and two received soy oil (TG) in the same amounts; cows then were switched to the other lipid source. Cows were abomasally infused with each amount for 4-d periods. The daily amount of lipid was pulse-dosed in 4 equal portions at 0600, 1000, 1700, and 2200 h. No emulsifiers were used; infusions did not result in diarrhea. Both lipid sources linearly decreased DMI, with a significant interaction between lipid sources ( $P < 0.01$ ). Slope-ratio analysis indicated that FFA were about 2.25 times more potent in decreasing DMI than were TG. Milk production decreased similarly to DMI. Milk fat content was increased linearly by lipid infusion. Milk fat yield decreased markedly for soy FFA infusion, but was relatively unaffected by infusion of TG (source by linear amount,  $P < 0.01$ ). Contents of 4:0 and 6:0 in milk fat were unaffected by lipid infusions, but 8:0, 10:0, 12:0, 14:0, and 16:0 decreased as either infusate increased. Contents of 18:2 and 18:3 were increased linearly by abomasal infusion of either soy source; 18:1 (cis-9) was unaffected. Transfer of infused 18:2 to milk fat was 31, 37, and 24% for 200, 400, and 600 g/d of FFA and 34, 39, and 34% for TG. Unsaturated FFA reaching the abomasum decreased DMI to a greater extent than did infusion of an equivalent amount of

unsaturated TG, perhaps because of differences in release of intestinal hormones such as cholecystokinin (CCK).

**Key Words:** dry matter intake, free fatty acids, triglycerides

**1199 The effects of organic chromium on glucose uptake and protein synthesis in primary fetal bovine muscle cells and glucose clearance of ruminants.** G.V. Pollard\*, J.L. Montgomery, T.C. Bramble, and C.R. Richardson, Texas Tech University, Lubbock.

The objective of this study was to evaluate the effects of organic chromium (Cr) on glucose metabolism and protein synthesis in ruminants. Glucose uptake and protein synthesis were conducted using serum from feedlot steers fed organic chromium diets, and glucose clearance was studied utilizing sheep as a model. One-hundred-five crossbred steers (283 kg) were fed typical finishing diets for 196 d and serum samples were collected via jugular venipuncture for *in vitro* glucose uptake and protein synthesis determination. Cultures of primary fetal bovine muscle cells were grown in RPMI media and 10% fetal bovine serum until 50% confluent. Protein synthesis and glucose uptake were measured as a percentage increase in dpm for serum treated cells over non-serum treated cells, utilizing [<sup>14</sup>C] labeled amino acid mixture and [<sup>3</sup>H] labeled glucose. Sixteen crossbred lambs were utilized for determination of glucose clearance following a 21 d feeding trial. To determine glucose clearance fasted sheep were challenged with 500 mg glucose/kg BW introduced via i.v. venipuncture and followed by collection of blood samples at -10, 0, 5, 10, 15, 20, 25, 30, 45, 60, 90, 120, and 150 min. Using a completely randomized design, treatments were: CON (0 ppb supplemental Cr), 200Cr (200 ppb Cr diet), and 400Cr (400 ppb Cr diet). Harvested serum from 200Cr and 400Cr increased ( $P < .01$ ) protein synthesis in primary bovine muscle cells. Glucose uptake by muscle cells was increased ( $P = .088$ ) by 200Cr and 400Cr serum in muscle cells. Glucose clearance was also improved by addition of Cr to the diet. These results suggest that carcass modifications in ruminants fed Cr containing diets are due to alterations in amino acid uptake and glucose metabolism within muscle cells.

**Key Words:** Chromium, Glucose, Feedlot Steers

**1200 Influence of supplementing cobalt in the receiving ration on performance of heifers new to the feedlot environment.** T. J. Wistuba, E. B. Kegley\*, D. L. Galloway, and S. M. Williamson, University of Arkansas, Fayetteville.

Cobalt is an essential element in the formation of vitamin B<sub>12</sub> by microorganisms in the rumen. The cobalt requirement for cattle is currently 0.1 mg/kg. Vitamin B<sub>12</sub> enzymes synthesize one-carbon units, making it important in the metabolism of nucleic acids, proteins, carbohydrates, and lipids. Recent work has suggested that immune response is depressed in cobalt deficient cattle. The influence of dietary cobalt concentration on performance of growing heifers was studied using 86 crossbred heifers (211 ± 16.5 kg initial BW) in a 42-d receiving trial. Treatments consisted of a control diet that had an estimated cobalt concentration of 0.1 mg/kg of DM or an additional 0.1 mg of supplemental cobalt/kg of DM from cobalt carbonate. Heifers were allocated randomly within 8 weight blocks (16 pens) to treatment, with 6 heifers/pen in the lightest three blocks and 5 heifers/pen in the remaining blocks. Heifers were weighed on day 0, 7, 14, 28, and 42 and were observed daily for signs of clinical disease. For the entire 42-d study ADG (1.07 vs 1.01 kg), ADFI (6.22 vs 6.17 kg as fed) and gain/feed (0.17 vs 0.16) did not differ ( $P > 0.10$ ) for the control heifers vs the heifers supplemented with cobalt, respectively. Supplemental cobalt did increase ADG ( $P = 0.07$ ) and gain/feed ( $P < 0.06$ ) from d 7 to 14. However, from d 14 to 28 control calves had increased ADG ( $P = 0.09$ ) and gain/feed ( $P = 0.07$ ). Percentage morbidity was not affected ( $P > 0.10$ ) by supplemental cobalt (65%) vs control (76%), nor were medication costs, \$12.37 for cobalt supplemented calves vs \$12.57 for controls. Supplementing cobalt in the present study did not improve growth performance or lower medication costs for stressed calves.

**Key Words:** Cobalt, Cattle, Performance

**1201 Effects of soybean oil and dietary copper on ruminal and tissue lipid metabolism in finishing steers.** T. E. Engle<sup>\*1</sup>, J. W. Spears<sup>2</sup>, V. Fellner<sup>2</sup>, and J. Odle<sup>2</sup>, <sup>1</sup>Colorado State University, Fort Collins, <sup>2</sup>North Carolina State University, Raleigh.

An experiment was conducted to determine the effects of copper (Cu) and soybean oil (SBO) supplementation on ruminal and tissue lipid metabolism and carcass characteristics in finishing steers. Sixty Angus steers (369.0 ± 10.1 kg) were stratified by weight and randomly assigned to treatments in a 2 x 2 factorial arrangement with factors being 0 or 20 mg supplemental Cu/kg DM from Cu sulfate and 0 or 4% SBO. Steers were fed a high concentrate basal diet that contained 5.3 mg Cu/kg DM. Average daily gain and feed intake were reduced (P < .01) by SBO but were not affected by Cu. Gain:feed was not affected by treatment. Liver Cu concentrations were higher (P < .01) in steers receiving supplemental Cu and lower (P < .04) in SBO supplemented steers. Copper supplementation tended to reduce (P < .12) and SBO supplementation tended to increase (P < .11) serum cholesterol concentrations. Backfat depth was reduced (P < .10) by Cu and SBO supplementation. Longissimus muscle polyunsaturated fatty acids tended to be increased (P < .14) and the C18:1 trans isomer tended to be decreased (P < .12) in Cu-supplemented steers. Longissimus muscle C18-conjugated dienes and the C18:1 trans isomer were increased (P < .05) in SBO supplemented steers. Ruminal fluid C18:3 was increased (P < .05) and the C18:1 trans isomer was decreased (P < .05) in Cu supplemented steers. These results indicate that as little as 20 mg supplemental Cu/kg DM can reduce backfat, and may alter lipid metabolism in steers fed high concentrate diets.

**Key Words:** Copper, Steer, Fatty acid

**1202 Metabolic responses of periparturient Holstein cows and heifers supplemented with chromium picolinate.** B.T. Crochet<sup>\*1</sup>, C.C. Williams<sup>1</sup>, L.D. Bunting<sup>1</sup>, and J.M. Fernandez<sup>1</sup>, <sup>1</sup>LSU Agricultural Center, Baton Rouge, LA.

Sixteen multiparous and 18 primiparous Holstein cows were used to determine the effects of supplemental chromium on carbohydrate and lipid metabolism during the transition period. From approximately 3 weeks prior to anticipated calving date until parturition, Cr treated cows were given 51 mg Cr picolinate via a gelatin capsule bolus three times weekly, equivalent to an average daily intake of 2 ppm Cr. Control cows were given empty gelatin capsules. All cows were fed total mixed rations, with one ration fed to dry cows, a second to lactating cows for the first week postpartum (transition), and a third to lactating cows thereafter. Blood samples were collected via jugular venipuncture at 1, 2, and 3 wk prior to anticipated calving date as well as immediately following calving, 3 d post calving, and 1, 2, and 3 wk post calving. Samples were analyzed for glucose, insulin, and NEFA. Within 1 wk prior to calving, an i.v. glucose tolerance test (IVGTT) was performed, and samples were analyzed for glucose and insulin. Plasma glucose response to the IVGTT was evaluated by calculating the half-life (T<sub>1/2</sub>) and fractional turnover rate (k) for the period from 2 min to 19 min after glucose infusion. Supplemental Cr did not affect circulating concentrations of glucose, insulin, or NEFA (P > .10). Plasma NEFA concentrations were higher in primiparous cows (P < .01) throughout the experiment, with the difference being most apparent during the 3 wk postpartum. Glucose peaked higher at time of calving in primiparous cows (P = .07). The IVGTT revealed increased glucose clearance rate (P = .06) and a trend toward decreased glucose half-life (P < .10) in primiparous cows supplemented with Cr. Insulin peak concentrations were unaffected by treatment or parity (P > .10). Data suggest that Cr supplementation may alter carbohydrate metabolism in primiparous cows during the transition period.

**Key Words:** Transition cows, Chromium, Metabolism

**1203 Interaction of dietary zinc and Synovex-H<sup>®</sup> on weight gain, carcass traits and zinc in tissues of growing beef heifers.** M. Huerta<sup>\*1</sup>, R. L. Kincaid<sup>1</sup>, J. R. Busboom<sup>1</sup>, J. D. Cronrath<sup>1</sup>, C. K. Swenson<sup>2</sup>, and A. B. Johnson<sup>2</sup>, <sup>1</sup>Washington State University, Pullman, <sup>2</sup>Zinpro Corporation.

To examine the interactions of dietary Zn and growth implants, 60 beef heifers (379 kg BW) were randomly assigned to six treatments in a 2 x 3 factorial arrangement. The treatments were with or without Synovex-H<sup>®</sup> implants combined with either a control diet containing 40 ppm Zn or diets supplemented with an additional 200 ppm Zn from ZnSO<sub>4</sub> or

Zn-methionine (Zn Met; Zinpro Corp., Eden Prairie, MN). The heifers were fed for 120 d to determine ADG, followed by slaughter to collect carcass data. At d 50 the heifers were vaccinated with a modified live virus and subsequent titers against bovine viral diarrhea and concentrations of IgG were measured. Liver samples were obtained 7 d prior to the start of the experiment and on d 50 and 120. Blood samples were taken at d 0, 50, 74, 88 and 116. The data were analyzed by the GLM or mixed procedures of SAS for variables with a single measurement or with repeated measures, respectively. Means were compared with pre-planned orthogonal contrasts. Average daily gains were highest (P < .05) for non-implanted heifers fed Zn-Met. The percent of cattle that graded Choice was highest for the Zn-Met diet (70%), intermediate for the control diet (57%) and lowest for the ZnSO<sub>4</sub> diet (40%). Supplementation with Zn-Met increased (P < .05) the concentrations of Zn in serum, and the Synovex-H<sup>®</sup> implant reduced concentrations of Zn and Cu in liver at d 50. Antibody titers and concentrations of IgG in serum were highest (P < .05) in heifers fed ZnSO<sub>4</sub> compared to heifers fed the control or Zn-Met supplemented diets. The results of this study indicate both the level and source of Zn supplementation in diets of feedlot heifers affect their response to growth implants.

**Key Words:** Zinc, Heifers, Growth Implants

**1204 Effect of supplemental copper on copper status, serum cholesterol and milk fatty acids in Holstein cows.** T.E. Engle, V. Fellner<sup>\*</sup>, and J.W. Spears, North Carolina State University, Raleigh.

Twenty four lactating Holstein cows were fed corn silage based diets to determine the effects of dietary copper (Cu) on liver and plasma copper concentrations and lipid metabolism. Sets of 3 cows closest in age, days in milk, milk yield and parity were separated into 3 groups with 8 cows per group. Cows were housed in free-stalls and fed individually with the aid of Calan gates; experimental diets were fed for a total of 61 days. Each group was randomly assigned to one of three treatments: 1) control 8.9 mg Cu/kg of basal diet (no supplemental Cu), 2) 10 mg of supplemental Cu/kg DM, and 3) 40 mg of supplemental Cu/kg DM; the source of Cu was CuSO<sub>4</sub>. At the end of 61 d, liver Cu concentrations were higher (P < .01) in cows receiving supplemental Cu compared with the control group; cows fed 40 mg Cu/kg DM had higher liver Cu concentrations (826 mg/kg of DM vs 431 mg/kg of DM) than cows fed 10 mg Cu/kg DM. Plasma Cu concentrations were similar across all treatments. Feeding supplemental Cu resulted in an increase (P < .05) in total serum cholesterol concentrations with the levels being highest for cows receiving 40 mg Cu/kg DM. Dry matter intake, milk yield, and milk composition were not affected by treatment. Concentrations of C18:1 trans isomer and total C18-conjugated dienes in the milk were lower (P < .05) in cows receiving supplemental Cu compared to the non-supplemented controls. Feeding 10 mg of supplemental Cu/kg DM resulted in a higher (P < .01) C18:2 and total polyunsaturated fatty acid content in milk. These results indicate that Cu can alter lipid metabolism in high producing dairy cows and Cu supplementation at 40 mg/kg DM for 61 d significantly increases liver Cu concentrations to marginally toxic levels.

**Key Words:** Copper, Dairy Cows, Milk lipids

**1205 Stability in the rumen of protected vitamin A measured by nylon bag technique.** J.C. Robert, G. Dumont, and S. Bourdeau, *Aventis Animal Nutrition, Antony, France.*

This experiment was designed to study the release in the rumen of vitamin A from encapsulation (Microvit A, I.U./g 500.000 - Aventis Animal Nutrition) originally used to guarantee stability during pre-mixes and compound feed manufacturing. A cross over experimental design was used with 2 periods of ten days each, 2 different types of ration and 2 cows per type of ration. The two rations were constituted : % D.M. (H) : hay 70, cereals 20, SBM 10 and (CS) : corn silage 82, SBM 6.0, hay 12. Quantities distributed were 8 kg per animal per day with two meals. Adapted nylon bag technique was used with 2.2 x 2.5 cm nylon bag size (internal), pore size : 48µ and 253 mg Microvit A introduced to get weight to surface exchange : 23 mg/cm<sup>2</sup>. Nylon bags were incubated 3, 6, 12, 18, 24, 36 and 48 hours. After incubation nylon bags were gently washed with cold water and the vitamin A content determined by spectrophotometry at wavelength 325 nm after saponification with alcoholic potassium hydroxide and extraction with hexane. The results

desmonstrate the good stability of the encapsulation process in the rumen for rumen retention time up to 12 hours corresponding to standard figures for lactating dairy cows. Resistance of the encapsulation [% resistance : (vitamin A in nylon bag at times 3, 6, 12, 18, 24, 48/vitamin A in nylon bag at time 0) x 100] was significantly lower with H compared to CS. This could be due to rumen pH differences with conditions more or less favorable for the solubilisation of the encapsulation material.

Vitamin A encapsulation : % rumen resistance:

Incubation times (h)	3	6	12	18	24	36	48
Ration : H	89 <sup>a</sup>	87 <sup>a</sup>	76 <sup>a</sup>	55 <sup>a</sup>	42 <sup>A</sup>	18 <sup>A</sup>	12 <sup>A</sup>
CS	88 <sup>a</sup>	89 <sup>a</sup>	88 <sup>b</sup>	82 <sup>b</sup>	76 <sup>B</sup>	61 <sup>B</sup>	50 <sup>B</sup>
SED	4.2	4.1	6.3	9.9	8.5	12.7	11.3

\* a, b, A, B : means in the same row with different superscripts are significantly different (a,b : p<0.05 - A,B : p<0.01)

**Key Words:** ruminant, vitamin A, rumen stability

**1206 Liver storage of vitamin A as a function of elevated dietary supply in ruminants.** J.C. Robert, G. Dumont, and A. Motte, *Aventis Animal Nutrition, Antony, France.*

This experiment was designed to study the effect of increasing levels of ingested vitamin A on liver storage of vitamin A in ruminants. Trial was carried out during 90 days on 90 early weaned ruminant lambs, 3 months of age, weight 12 kg at start of trial. Ration fed : straw (50 g/anl/day), concentrate ad libitum, composed of (% D.M.) : barley (45), wheat (22), SBM (8), wheat bran (12), palm kernel meal (8), ammonium chloride (1) and a mineral vitamin premix with or without vitamin A (4). Experimental design was block x treatment (15 x 6) ; the six treatments were 6 levels of vitamin A supplementation, using Microvit A (750.000 IU/g, Aventis Animal Nutrition) measured in I.U./g concentrate : T1 : 0 (control) ; T2 : 20, T3 : 40, T4 : 60, T5 : 80, T6 : 100. Vitamin A concentrations in concentrates were measured by the Carr Price method. Individual concentrate quantities ingested were measured. At slaughter, livers were collected, weighed and frozen. After defreezing, vitamin A concentration was dosed by spectrophotometry on an aliquot of total liver after grinding and homogenisation. Liver storage ratio [(I.U. vitamin A in the liver/I.U. ingested vitamin A) x 100 after taking the basal line into account through control values] was around 30 % for a supplementation of 20 I.U./g feed. Liver storage ratios were reduced, when levels of supplementation were increased. This could be due to saturation either of the intestinal absorption pathway or the liver's capacity to store vitamin A or a combination of the two.

Diets	T1	T2	T3	T4	T5	T6	SED
Vit. A in feed IU/g	2.4	19.8	45.6	61.3	83.1	109.2	
Vit. A intake IU/anl x 10(3)	186 <sup>aA</sup>	1.680 <sup>bB</sup>	4.036 <sup>cC</sup>	5.141 <sup>dD</sup>	7.200 <sup>eE</sup>	9.844 <sup>fF</sup>	224
Tot. liver storage IU x 10(3)	11 <sup>aA</sup>	522 <sup>bB</sup>	967 <sup>cC</sup>	928 <sup>cC</sup>	898 <sup>cC</sup>	999 <sup>cC</sup>	81
Liver stor. ratio %	-	34.1 <sup>aA</sup>	25.0 <sup>bB</sup>	18.9 <sup>cC</sup>	12.1 <sup>dD</sup>	10.1 <sup>dD</sup>	1.9

\* a, b, c, ..., A, B, C, ... : means in the same line with different superscripts are significantly different (a,b, ... : p<0.05 - A,B, ... : p<0.01)

**Key Words:** ruminant, vitamin A, liver storage

**1207 Starch source affects phosphorus digestion and excretion by lactating dairy cows.** A.D. Guyton<sup>\*1</sup>, K.F. Knowlton<sup>1,5</sup>, D.P. Casper<sup>2,5</sup>, B.P. Glenn<sup>3,5</sup>, and V.A. Wilkerson<sup>4,5</sup>, <sup>1</sup>Virginia Polytechnic Institute and State University, Blacksburg, <sup>2</sup>Agri-King, Inc., Fulton, IL, <sup>3</sup>Federation of Animal Science Societies, Bethesda, MD, <sup>4</sup>Land O'Lakes, Inc., Denver, CO, <sup>5</sup>Formerly at USDA-ARS, Beltsville, MD.

The objective of this study was to evaluate the effects of forage type and starch source on P excretion using samples from previously reported digestion experiments. Preliminary results from one study indicated that

replacing dry corn with high moisture corn reduced P excretion. To evaluate this, feed, feces, and urine samples from four digestion trials were analyzed for total P. Two experiments (14 cows, 54 observations) compared high moisture (HM) and dry (D) corn, either ground (G) or rolled (R) in a 2x2 factorial arrangement of treatments. As previously reported, ruminal and total tract starch digestibility and NEL content were increased with HM vs. D, and with G vs. R. High moisture corn tended to increase P availability (33.8 vs. 29.9%, P < .11) vs. D. Phosphorus balance was numerically greater with HM vs. D (7.2 vs. 1.8, P < .18). Grinding corn had no effect on P digestion or retention. Two experiments (8 cows; 32 observations) compared orchardgrass (OG) and alfalfa (A) silage, and dry ground barley (B) and dry ground corn (C) in a 2x2 factorial arrangement of treatments. In these studies C increased total tract starch and NSC digestibility vs. B (data previously reported). Corn increased apparent P digestibility vs. B (36.3 vs. 26.5%; P < .01) and increased P balance (13.3 vs. 1.1 g/d; P < .03) vs. B. Although dry matter and fiber digestibility were higher for OG than for A (previously reported), forage type had no effect on apparent P digestibility or P balance. In four digestion experiments, more digestible dietary starch sources (HM corn vs dry, or corn vs. barley) decreased fecal P excretion as a percent of P intake, most likely due to improved availability of dietary P.

**Key Words:** Phosphorus Excretion, Starch Digestibility, Lactating Cows

**1208 Automated system for collection of ruminal fluid and blood of ruminants.** M. S. Allen\*, M. Oba, and C. S. Mooney, *Michigan State University, East Lansing, MI.*

A system was developed to collect samples of ruminal fluid and blood during feeding behavior studies at periodic intervals or at times triggered by animal responses such as eating and ruminating. A computer program controls one peristaltic pump and fraction collector for each group of up to four animals for collection of ruminal fluid or blood. For ruminal fluid collection, Tygon<sup>®</sup> tubing (1.6 mm i.d., 7.5 m length, 14.8 ml void volume), protected within the rumen by a 60 cm length of milk line tubing (1.6 cm i.d.) is inserted through a ruminal cannula. Filtered ruminal fluid is withdrawn from a reservoir (5.7 cm diameter perforated rubber ball) covered with a 10 cm x 20 cm dacron bag with 53 μm pore size. The reservoir is weighted to remain in the ventral rumen and vented to prevent negative pressure following ruminal contractions. Ruminal fluid within the tubing is voided into a waste container before sample collection. Blood is collected via catheter and Tygon<sup>®</sup> silicone tubing (1.6 mm i.d., 7.5 m length, 14.8 ml void volume) which is autoclaved before use. Blood is completely flushed from tubing with saline containing heparin (10 USP units/ml) after sampling to prevent coagulation. This process requires a reversible pump and pinch valve to divert blood and anticoagulant. The solution containing anticoagulant as well as contaminated blood are completely flushed from the system into a waste container. The criterion used to determine pumping time required to flush all contaminated blood was restoration of hematocrit. The system was evaluated in a duplicated 4x4 Latin square experiment in which two 7.5 ml samples of ruminal fluid and blood were collected every 20 min for 24 h per period from each cow. The system successfully collected 97.9% and 99.5% of the total samples for ruminal fluid and blood, respectively (4,608 samples each). This system allows blood and ruminal fluid measurements to be related to feeding behavior that is recorded simultaneously.

**Key Words:** Blood collection, Rumen fluid collection, Feeding behavior

**1209 Diurnal variation in ruminal parameters of lactating dairy cows fed diets varying in fermentability..** M. Oba\* and M. S. Allen, *Michigan State University, East Lansing, MI.*

Diurnal variation in ruminal pH and VFA concentrations were evaluated for cows fed diets varying in fermentability. Eight multiparous ruminally and duodenally cannulated lactating Holstein cows (55 ±15.9 DIM; Mean ±SD) were used in a duplicated 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments. Experimental diets contained either ground high moisture corn (HM) or dry ground corn (DG) at two dietary starch contents (32 vs. 21%). Diets were fed once daily as TMR and cows were housed in tie-stalls. Ruminal fluid was collected every 20 min for 24 h, and ruminal pH was monitored with a computerized data acquisition system. Although true ruminally fermented OM was greater for HM compared to DG both in high starch

diets (11.3 vs. 10.3 kg/d) and low starch diets (9.3 vs. 7.7 kg/d), most ruminal parameters were not affected by conservation method of corn grain. High starch diets reduced daily mean ruminal pH (6.13 vs. 6.29) and increased daily variation range for ruminal pH ( $\pm 0.60$  vs.  $\pm 0.53$ ) compared to low starch diets. Although the highest correlation between single time-point samples and minimum daily ruminal pH was observed 4 h after feeding, the 95% CI for predicted minimum daily ruminal pH was  $\pm 0.41$  pH. Daily mean and daily variation range (95% CI) for acetate content were not affected by treatment, averaging 60.4 and  $\pm 24.1$  mM, respectively. High starch diets increased daily mean for propionate content (26.7 vs. 21.6 mM), and its daily variation range ( $\pm 13.8$  vs.  $\pm 10.2$  mM) compared to low starch diets. Daily minimum propionate content was not affected by treatments, averaging 12.1 mM. However, daily maximum propionate content was greater for high starch diets compared to low starch diets (40.4 vs. 31.7 mM). High starch diets decreased daily mean acetate to propionate ratio (APR; 2.45 vs. 2.97) and daily variation range for APR ( $\pm 0.52$  vs.  $\pm 0.69$ ) compared to low starch diets. These observations suggest that large diurnal variations exist for ruminal parameters and experimental results based on infrequent sampling of ruminal fluid must be used with caution.

**Key Words:** VFA, Ruminal pH, Diurnal variation

**1210 The effect of protein and energy supplement added to a basal diet fed in 2 or 7 meals daily on milk yield and urinary excretion of purine derivatives.** M.C. Thivierge<sup>\*1</sup>, J.F. Bernier<sup>1</sup>, and H. Lapierre<sup>2</sup>, <sup>1</sup>Universite Laval, QC, Canada, <sup>2</sup>Dairy and Swine R & D Center, Lennoxville, QC, Canada.

Increasing feeding frequency (FF) stabilises conditions in the rumen that could result in increased microbial protein synthesis, making cows less responsive to rumen-undegradable protein (RUP) and energy supplement (P&E). Therefore, the effect of a P&E supplement fed 7 times per day and added to a basal TMR fed in 2 or 7 meals/d was investigated using 8 Holstein cows in a 2 x 2 factorial arrangement using a replicated 4 x 4 Latin square design with 14-d experimental periods. The P&E supplement corresponded to 0 or 1.83 kg of Pro-Lak<sup>®</sup> (76% CP; 53% RUP, H.J. Baker & Bro., Inc.) + 1 kg of dry molasses. The TMR provided 71% CP, 90% rumen-degradable protein, 54% RUP, and 96% of NE<sub>L</sub> daily requirements. The TMR intake was restricted to 95% of previous ad libitum intake, to insure similar intake among FF. Milk yield components and urinary excretion of purine derivatives (PD: allantoin + uric acid) were measured over the last 3 d of each experimental period. Milk yield increased with P&E supply but this increment was similar for the two FF. Crude protein yield increased by 4% with increasing FF and by 12% with the P&E supplement. Globally excreted urinary PD, an index of microbial protein synthesis, were not affected by treatments. Although increasing FF tended to increase milk and protein yield, it did not affect the response of the cows to P&E supplement and the excretion of PD.

FF:	2	meals 7	meals	Con	trast	(P)	
				SEM	FF	FFx	
P&E supply:	-	+	-	+	SEM	P&E	P&E
TMR intake;							
kg/d	19.6	19.4	19.5	19.2	0.15	0.29	0.18
Milk							
Yield;							
kg/d	26.8	30.1	27.7	30.9	0.46	0.11	≤0.01
CP yield;							
g/d	850.1	969.8	899.5	997.7	18.8	0.06	≤0.01
Urinary;							
mmol/d							
Allantoin	271.3	244.9	261.3	236.1	16.1	0.57	0.13
Uric acid	37.5	42.6	34.5	36.6	2.0	0.04	0.09
PD	308.8	287.5	295.9	272.7	17.0	0.43	0.21

**Key Words:** Cows, Feeding frequency, Purine derivatives

**1211 The role of pH in regulating ammonia production by mixed ruminal bacteria.** L. T. Cunha, R. P. Lana\*, A. C. Borges, and J. S. Oliveira, Universidade Federal de Vicosa, Vicosa-MG, Brazil.

This research evaluated the pH effect by adding increasing levels of corn starch in deamination and growth of mixed ruminal bacteria. The rumen fluid was taken from a fistulated steer in a 40 percent concentrate diet, and centrifuged at 500xg in 15 minutes to remove feed particles and protozoa. The incubations were done in an anaerobic environment at 39°C. It was used 150 mg of tripticase and 0, 25, 50, 75, 100, 200 and 300 mg of corn starch in 10 mL rumen fluid. Samples were collected over the incubations and the pH measured. After that, the samples were centrifuged at 5200xg in 10 minutes and the supernatant was frozen for ammonia determination. The pellets were washed in a 0.9 percent saline solution for microbial protein determination. The starch had small effect on microbial growth, but levels of 50 mg/10 mL or greater inhibited completely the ammonia production. The inhibition was probably due to pH effect, once that it showed higher correlation with ammonia production than the starch (0.95 versus -0.59). Because the largest amount of the utilized tripticase was for ammonia production, and it was highly inhibited by acidity, mild decrease in ruminal pH by concentrate utilization can be useful to reduce losses of food protein by ruminal fermentation. This means that when higher level of starch is added to the ration, greater amount of degradable protein can be added to the ration, without increasing losses of protein as ruminal ammonia.

**Key Words:** Ammonia, pH, Rumen

**1212 A comparison of filter bag methods with conventional tube methods of determining the in vitro digestibility of forages.** D. Wilman and A. Adesogan, IRS, University of Wales, Aberystwyth, UK.

In vitro digestibility of forages is commonly estimated by two-stage methods in which the various samples are kept completely separate from one another, using tubes. A possible alternative approach, which may save labour, is to use larger vessels, within which up to as many as 25 samples are incubated, each contained in its own filter bag. The two approaches were compared for estimating apparent dry matter (DM) digestibility, apparent digestible organic matter in DM, true DM digestibility, true digestible organic matter in DM and digestibility of neutral detergent fibre. The forage samples analysed comprised all 72 combinations of two forage species (Lolium multiflorum and Medicago sativa), three plant parts (whole crop, leaf and stem), three degrees of particle breakdown (0.5, 1.0 and 1.5 mm sieve size when milling) and four field replicates. Rumen fluid from sheep was used for two field replicates and rumen fluid from cattle for the other two. There was no discernible effect on digestibility of the sieve size used when milling, e.g. true digestible organic matter in dry matter using filter bags was 674, 677 and 663 g kg<sup>-1</sup>, respectively, (SE 6.4) with the 0.5, 1.0 and 1.5 mm sieves. There were smaller differences between the two forage species (in respect of whole crop, stem and leaf) with the filter bag than with the tube method. The standard errors and coefficients of variation were higher with the filter bag than with the tube method; of 16 coefficients of variation calculated for each method, the mean with filter bags was 4.0 % and the mean with tubes was 2.7 %. Linear regression indicated that true and apparent digestibility in tubes were accurately predicted by the respective estimates from filter bags. However, true digestibility was predicted more precisely ( $r^2$  0.92 – 0.95) than apparent digestibility ( $r^2$  0.83 – 0.91). Forage digestibility estimates obtained using rumen fluid from sheep were very similar to those obtained when cattle rumen fluid was used. It is concluded that the traditional tube methods gave more precise estimates than the filter bag methods. However, the lower labour input of the filter bag methods suggests that they are more attractive for routine analysis.

**Key Words:** In vitro, Digestibility, Silage

**1213 Estimating digestibility from measurements of fermentation by rumen microorganisms in dual-flow continuous cultures.** J-S. Eun\* and V. Fellner, North Carolina State University, Raleigh.

Rumen microbial populations incubated in dual-flow continuous cultures received diets with three forage to concentrate ratios (70:30; 50:50, and 30:70). Forage consisted of pelleted alfalfa and the concentrate mix

included ground corn and soybean meal. The nominal volume of the culture vessels was 700 ml and saliva was infused continuously at .73 ml/min resulting in a fractional dilution rate of 6.3 %/h. Actual measurements of short chain fatty acid concentrations and methane output were used to compute stoichiometric estimates of digestibility. Total short chain fatty acid production averaged 65 mmol/L/d and was not affected by level of concentrate in the diet. Acetate production increased from 2.2 mmol/g of dry matter intake to 2.6 mmol/g of dry matter intake and propionate decreased from 1.6 mmol/g of dry matter intake to 1.2 mmol/g of dry matter intake with an increase in the forage to concentrate ratio; there was no effect of diet on rate of butyrate production which averaged 0.5 mmol/g of dry matter intake. Methane output by ruminal cultures receiving the high forage diet averaged 948 nmol/ml and declined by 16 % and 43 % as the amount of concentrate increased to 50 % and 70 %, respectively. Based on the total substrate used for short chain fatty acid production, apparent digestibilities averaged 30 % across all treatments. Including the amount of substrate used for gas production would increase estimates of digestibility. Total short chain fatty acid production and methane output were much lower when compared to in vivo numbers but accounting for the total dry matter intake resulted in estimates that were remarkably similar to those observed in vivo. Microbial fermentation in dual-flow continuous culture systems is a reliable model to simulate in vivo conditions. Results are discussed with reference to specific constraints that may impact fermentation within the ruminal cultures

**Key Words:** Dual-flow continuous cultures, Digestibility, Short chain fatty acid production

**1214 In vitro culture of *Entodinium exiguum* and *E. caudatum*, with or without rumen bacteria.** M. Fondevila\*<sup>1</sup> and B.A. Dehority<sup>2</sup>, <sup>1</sup>University of Zaragoza, Zaragoza, Spain, <sup>2</sup>Ohio State University, Wooster.

Two rumen amylolytic protozoa, *Entodinium exiguum* (EE) and *E. caudatum* (EC), were cultured with or without antibiotics, to evaluate if their dependence on living bacteria for growth would affect short term incubations. The protozoa were isolated from sheep rumen contents, cultivated in medium M (Dehority, 1998. J. Anim. Sci., 76:1189-1196), and fed 0.1 ml of a 1.5% wheat and 1.0% orchardgrass suspension daily. In preliminary studies with EE, the addition of antibiotics (2000 U penicillin and 130 U streptomycin per ml of medium) reduced bacterial concentrations by over 99% in 4h and essentially removed them entirely after 8h. In contrast, protozoal concentrations increased (107 ±5.6, 122 ±5.2 and 208 ±14.4 % after 4, 8 and 24h), indicating they were apparently not affected. Generation time after 24h was 23.3 ±1.97h. In the principal study, treatments were: protozoa plus antibiotics (PA), PA plus autoclaved bacteria (PAB) or protozoa plus living bacteria (PLB). Two tubes per treatment were inoculated with either EE or EC, fed daily, and sampled at 12, 24, 48, 72 and 96h. Inoculum for treatments PA and PAB was pre-incubated 4h with antibiotics. Generation time after 24h was shorter for EE (22.8h) than for EC (31.0h; P<0.05); however, no differences were found at later sampling times (P>0.10). In both species, concentrations (as a % of initial concentration) were unaffected by the absence of bacteria up to 48h. At 72 h in EE, PLB was higher than either PA or PAB (620, 300 and 342 %, respectively; P<0.05), but no difference was observed for EC at 72h. After 96h, there were differences in growth of EE between PLB and PA and PAB (P<0.01), but differences between PLB and PAB were not significant in EC (1214, 236 and 442 % in EE, and 740, 398 and 487 % in EC, for PLB, PA and PAB). The need for rumen bacteria in EE is manifested in culture periods longer than 48h and in EC after 72h. Differences between PAB and PA, though non significant, might indicate an effect related to a nutritive contribution by the bacteria.

**Key Words:** rumen Protozoa, In vitro culture, presence of bacteria

**1215 Total purines as a bacterial marker: comparison of two procedures.** C. J. Fu\* and M. S. Kerley, University of Missouri, Columbia.

Two procedures for measuring total purine content of mixed ruminal bacteria (MRB) were compared. Samples were from a continuous culture study which was designed to determine the effect of monensin on microbial protein requirements. The basal diets were corn and casein. The isolated bacteria and effluent were freeze-dried and stored at 4°C. The classic procedure was published by Zinn and Owens in 1986 (J.

Anim. Sci. 66:157-166). This procedure utilizes 0.5 N HCl as the blank in reading absorbance. The standards are RNA from torula yeast. The purine precipitation of the samples and standards are washed by H<sub>2</sub>SO<sub>4</sub> (pH2) solution before reading absorbance at 260nm. The new procedure utilizes 0.5 N HCl and adenine and guanine solution as the blank and standard, respectively. The purine precipitate of samples and standards are washed by precipitation solution instead of H<sub>2</sub>SO<sub>4</sub> solution because the authors believe that H<sub>2</sub>SO<sub>4</sub> solution can potentially wash out purines (primarily adenine) and result in overestimating microbial nitrogen flow out of the rumen. The precipitation solutions are composed of (per 100ml) 0.625ml 11.7 M HClO<sub>4</sub> in 4.375 ml 0.0285M NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>, 5.0 ml 0.4M AgNO<sub>3</sub>, and 90.0 ml 0.2M NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>. The results indicated that total purine content (% of DM) and purine:nitrogen ratio, in bacteria and effluent residues, are significantly higher (P<.01) using the classic procedure than that measured using the new procedure. However, the percentage of bacterial nitrogen in effluent nitrogen, bacterial nitrogen production, and microbial growth efficiency were not affected by the analysis method. We concluded that it is feasible to employ the classic procedure to determine the total purine content and to use it as bacterial marker for estimating bacterial growth and efficiency. °

**Key Words:** Bacterial marker, Purine, Precipitate

**1216 Evaluation of Primary Rumen Epithelial Cell Culture Techniques in Sheep.** R.C. Gillis\*<sup>1</sup>, J.L. Klotz<sup>1</sup>, R.L. Baldwin, VI<sup>2</sup>, and R.N. Heitmann<sup>1</sup>, <sup>1</sup>The University of Tennessee, Knoxville, <sup>2</sup>USDA/ARS, Beltsville, MD.

Objectives of this study were to determine if number of cells incubated in primary rumen epithelial cell cultures affects production rates of metabolites and to standardize reporting criteria by obtaining an optimum mode of data expression. Epithelial tissue was excised from 5 Suffolk Dorset crossbred sheep and subjected to serial tryptic digestion to isolate cells. Isolated cells were incubated for 90-minutes in 25 mM propionate and 10 mM butyrate at concentrations of .5, 1, 5, 10, 20 and 40-million cells per flask (total vol. = 3ml). Production of acetoacetate (ACAC), β-hydroxybutyrate (βHBA), lactate (LAC) and pyruvate (PYR) were measured. Data were expressed as either cell number, cell dry matter or cell total protein alone or per epithelial wet tissue weight, body weight (BW) or metabolic BW to generate twelve different forms of data expression. Coefficients of variation were calculated for all 12 modes of expression. Expressing data per cell number resulted in the lowest variation (P<.05) and data adjusted for metabolic BW had less variation than BW. ACAC concentrations were largest at .5-million cells/flask (P<.05) and there were no differences between 1, 5, 10 and 20 and only 40 differed from .5 and 5-million cells/flask. βHBA concentrations were largest at 1 and 5-million cells/flask. However, 1 and 5 only differed significantly (P<.05) from 20 and 40-million cells/flask. LAC and PYR concentrations were largest at 1-million cells/flask, but no significant differences were found. βHBA:ACAC ratios were below one for .5 and 1-million cells/flask indicating low mitochondrial redox potentials (P<.05). A suggested range of rumen epithelial cells to include in incubations is 5 to 20-million/flask. This range will minimize the potential for altered metabolite production caused by incubating large cell quantities as well as the experimental error associated with using low cell numbers. When rumen tissue is taken from animals of the same species, size and stage of development, data adjusted by cell number are preferred.

**Key Words:** Rumen Mucosa, Cell Culture, Sheep

**1217 Comparison of three methods for determining proteolytic activity of ruminal fluid.** A. N. Hristov\*<sup>1</sup>, T. A. McAllister<sup>2</sup>, Z. Xu<sup>2</sup>, and C. J. Newbold<sup>3</sup>, <sup>1</sup>Department of Animal and Veterinary Sci., University of Idaho, Moscow, <sup>2</sup>Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB, Canada, <sup>3</sup>Rowett Research Institute, Aberdeen AB, UK.

A novel method for determining proteolytic activity (PA) of ruminal fluid utilizing <sup>15</sup>N-labeled casein was compared to two published procedures. Four heifers were fed two isonitrogenous diets containing (on a DM basis): 49.5% barley silage; 45.2% rolled barley grain; and 5.3% soybean meal (HF) or 8% barley silage; 88% rolled barley grain; and 5.3% soybean meal (HG) in a cross-over arrangement. Rumen fluid was analyzed either fresh (FSH) or after being frozen at -40°C for 45 days (FRZ). The PA methods tested differed in substrate preparation: <sup>15</sup>N-labeled casein (15N, produced via infusion of (<sup>15</sup>NH)<sub>2</sub>SO<sub>4</sub> into the

rumen of a lactating dairy cow),  $^{14}\text{C}$ -labeled casein (14C, Rowett Research Institute), and Azocasein (AZO, Sigma Chem. Co.). Incubations were carried out for 20 min at 39°C in 0.2 M phosphate buffer (pH 6.8). PA for the 15N method was estimated by three approaches: as N soluble in 5% trichloroacetic acid (TCA), as N soluble in 5% TCA corrected for microbial N uptake (TCAM) and as N depleted from the soluble protein N pool (SOLPR). Proteolytic activity in 14C and AZO was determined as TCA soluble radioactivity or dye (respectively) released during the incubation. Across treatments, the highest ( $P < 0.001$ ) proteolytic activity was measured by the SOLPR method (averaged 14.9) followed by TCAM (11.0), TCA (7.9) and 14C (6.5) with the lowest activity being associated with the AZO method (2.0 mg N released per ml rumen fluid per min). Within the 15N and 14C methods, HG and FRZ rumen fluid had higher ( $P < 0.05$ ) proteolytic activity as compared to HF and FSH, respectively. Similar results between the 15N and 14C methods demonstrates that the proposed 15N method can be successfully used to measure proteolytic activity of ruminal fluid. Increasing the proportion of grain in the diet and freezing was found to increase the proteolytic activity of the rumen fluid.

**Key Words:** Rumen, Proteolytic Activity, Methods

**1218 Assessing the potential of stable carbon and nitrogen isotopes at natural abundance levels for measuring rumen microbial attachment to corn silage.** J. G. Andrae<sup>1</sup>, C. W. Hunt<sup>1</sup>, K. A. Johnson\*<sup>2</sup>, and J. Marshall<sup>1</sup>, <sup>1</sup>University of Idaho, Moscow, <sup>2</sup>Washington State University, Pullman.

Plants that utilize  $\text{C}_3$  and  $\text{C}_4$  photosynthetic pathways have different stable carbon isotope ratios ( $^{13}\text{C}:^{12}\text{C}$ ;  $\delta\text{C}$ ). Nitrogen ratios ( $^{15}\text{N}:^{14}\text{N}$ ,  $\delta\text{N}$ ) may also differ between feeds as a result of fertilization regimes. The objective of this study was to determine if natural levels of  $\delta\text{C}$  and  $\delta\text{N}$  could be used to label ruminal microbes and measure their attachment to corn silage. Two ruminally cannulated cows were fed a  $\text{C}_3$  diet of 45% barley and 55% alfalfa hay for 21 d prior to in situ incubation of duplicate samples of unprocessed and mechanically processed (rolled) corn silage. Corn silage was not further processed (i.e. dried or ground) prior to incubation. Silage samples were weighed into 25 x 30 cm dacron bags and ruminally incubated for 0, 1, 2, 3, 6, 12, or 24 h. Following incubation, samples were analyzed using mass spectrometry. Processed and unprocessed residue responses to time were assessed using simple linear regression, and subsequently compared using dummy variable regression techniques. Isotope ratios from ruminal microbes isolated immediately prior to in situ bag insertion were similar to the diet (-26.97  $\delta\text{C}$  and 3.32  $\delta\text{N}$ ). Unincubated corn silage samples had  $\delta\text{C}$  typical of  $\text{C}_4$  plants (-11.75) and high  $\delta\text{N}$  (8.50) values.  $\delta\text{N}$  and  $\delta\text{C}$  of residues showed a significant linear decrease ( $P < .05$ ) across time, which we suggest represents microbial attachment. Slopes of  $\delta\text{N}$  differed ( $P < .05$ ) for processed and unprocessed silage suggesting processed silage was more rapidly colonized by bacteria than unprocessed silage. Carbon ratios responded similarly; however, increased variability during early incubation times prevented the statistical detection of differences between silage types. Natural abundance levels of stable nitrogen isotopes may be useful for measuring rumen microbial attachment to corn silage. Similar carbon isotope results suggest this isotope may also be useful in measuring attachment, but variability between samples must be controlled.

**Key Words:** bacteria, attachment, silage

**1219 Methane oxidation in the rumen.** H. Kajikawa\*<sup>1</sup> and C. J. Newbold<sup>2</sup>, <sup>1</sup>National Institute of Animal Industry, Tsukuba, Japan, <sup>2</sup>Rowett Research Institute, Aberdeen, UK.

The reduction of methane generated from the ruminal fermentation could contribute the economical and ecological benefits because it is an emission of a greenhouse gas as well as loss of dietary energy. Methane oxidation, which has been reported for many aerobic and anaerobic environments, is not known to occur in the rumen. This study was done to investigate the extent of methane oxidation in the rumen, and identify the electron acceptor for that oxidation, if occurred. The ruminal fluid was taken from three ruminally fistulated Suffolk sheep before morning feed. After being mixed and diluted three-fold with a buffer, the ruminal fluid (30 ml) was incubated in a glass bottle with 10 ml of  $^{13}\text{CH}_4$  or  $^{12}\text{CH}_4$  gas at 39°C, balancing the remaining headspace gas with  $\text{CO}_2$ . The extent of methane oxidation was determined from the difference in the  $^{13}\text{C}$  amounts in both the  $\text{CO}_2$  gas and microbial cells between

the  $^{13}\text{CH}_4$  and  $^{12}\text{CH}_4$  treatments measured using a Gas Isotope Mass Spectrometer. Methane oxidation anaerobically occurred with an extent of 0.3% of methane added. Although depletion of dissolved oxygen by action of facultative anaerobes after incubation for 3 hr did not further promote the oxidation, methane oxidation was suppressed mostly by addition of 0.5% oxygen, and completely by addition of 2.0% oxygen of headspace gas. Proportion of  $^{13}\text{C}$  accumulated in the cells was about 9% of total  $^{13}\text{C}$  oxidized. Methane oxidation was suppressed by both 2-bromoethanesulfonate and molybdate, which inhibited methane production and sulfate reduction, respectively, but was not suppressed by tungstate, which decreased nitrate reduction. These results suggest that methane oxidation occurs anaerobically in the rumen in consort with sulfate reduction, but its extent is not critical for reduction of methane production.

**Key Words:** Methane oxidation, Rumen, Oxygen

**1220 Effect of enzyme feed additives and method of application on in vitro feed digestibility.** D.P. Morgavi, R. Wuerfel, V.L. Nsereko, K.A. Beauchemin, and L.M. Rode, *Agriculture and Agri-Food Canada.*

Interest in the use of enzyme additives to improve feed digestion in ruminants is increasing. However, positive effects of this technology are not always reported in in vivo studies. Differences may originate in the production trait measured, type of enzyme(s), feed composition, and method of application. The aim of this work was to evaluate the effect of exogenous enzyme mixtures on in vitro feed dry matter (DM) and neutral detergent fiber (NDF) digestibility and determine whether method of enzyme application affects these parameters. Two commercially available enzyme mixtures were tested. Incubations were performed in revolving digestion incubators (Daisy II, ANKOM Technology, Fairport, NY) using the filter bag technique. Enzyme mixtures were applied by spraying an aqueous solution on the feed 24 h before incubation or by direct addition into the digestion vessel. Incubations were carried out for up to 48 h. When enzymes were applied in the liquid, the effects were inconsistent and in most cases, enzyme mixtures failed to increase digestion. In contrast, positive effects on DM and NDF disappearance were observed when enzymes were applied on the feed. However, the concentrations that elicited a response in vitro were higher than levels that are efficacious in vivo. Differences in digestibility due to enzyme mixtures were maintained up to 24 h of incubation ( $P < 0.05$ ). DM and NDF contents of enzyme treated feeds measured before incubation were lower than controls. As much as 24.4% of NDF disappeared from corn silage treated with a high level of enzyme compared to 10% NDF disappearance for controls. One enzyme mixture was more effective in promoting digestion, but this effect could not be explained by the cellulase or xylanase activity present. Enzyme additives increased total in vitro DM and NDF disappearance when applied on the feed only, indicating that application method is an important factor in the successful adoption of this technology.

**Key Words:** Feed enzymes, Application method, Digestion

**1221 Fermentation of feeds in lactating dairy cow diets by cultures and cocultures of amylolytic, proteolytic, and fibrolytic bacteria.** G.A. Busher, A.H. Smith, M.R. Murphy, and E.J. Friedman\*, *University of Illinois, Urbana.*

Interactions among an amylolytic (*Streptococcus bovis* JB1), a proteolytic (*Selenomonas ruminatum* lactilytica HD1), and a fibrolytic (*Fibrobacter succinogenes* AC3) species of ruminal bacteria in fermenting alfalfa hay, corn silage, a ground corn-soybean meal based concentrate mix, and a totally mixed diet were studied in vitro. The pH decreased 0.1 to 0.3 units in 24 h (from 6.8) for cultures and cocultures fermenting the alfalfa, corn silage, or totally mixed diet; however, it decreased 0.1 to 1.1 units in 24 h for for cultures and cocultures fermenting the concentrate mix, depending on the inoculum. The most rapid change in pH (modeled as a sigmoidal curve with an average  $R^2 = 0.97$  and all parameters  $P < 0.001$ ) occurred 3 h earlier in cultures fermenting the concentrate mix that were inoculated with both *S. bovis* and *F. succinogenes* than it did in cultures inoculated with *S. bovis* but not *F. succinogenes* (at 6.5 vs. 9.5 h, respectively). Dramatic and dynamic changes in end product concentrations also occurred when the concentrate mix was fermented. The apparent interaction between the

amylolytic and the fibrolytic species in fermenting the concentrate mix suggests that more research on this topic is needed.

**Key Words:** Fermentation, Dairy cow, Diet

**1222 Effect of sample processing on *in situ* degradation of corn silage dry matter.** R.G.S. Bruno, M.N. Pereira\*, R.G. Von Pinho, and A.H. Fonseca, *Federal University of Lavras, Lavras, MG/Brazil.*

Unground macro *in situ* analysis of fermented silage has been proposed as the methodology to evaluate corn hybrids ruminal degradation. We wanted to know if we could extrapolate macro *in situ* data from data obtained with ground samples. Fifteen corn hybrids were cultivated in triplicate during the rainy season of 1998/1999 and ensiled at half milk line stage in mini-silos. Silage processing before rumen incubation differed within cultivar: dried for 48 hours at 58°C and ground through a 5 mm mesh, frozen ground through a 5 mm mesh, and undried and unground. Incubations were performed at once in 8 non-lactating cows fed sorghum silage *ad libitum* and 2 kg of corn-soybean meal concentrate. Five grams of dried and ground samples were inserted into 10x15 cm polyester bags and rumen incubated for 0, 12, 24, and 96 hours. Effective ruminal DM degradation (EFET) was calculated as the sum of the assumed instantaneously degradable DM fraction plus the slowly degradable DM times [kd/(kd+kp)], kp at 0.04/h. Disappearance of DM from the 24-hour bag was recorded (DEG24). Samples were frozen ground and fifteen grams incubated for 24 hours in 10x15 cm bags (FROZEN). Eighty grams of undried and unground samples were incubated for 24 hours in 25x30 cm macro bags (MACRO). For the 15 cultivars, the NDF as a % of silage DM was 51.8 ± 2.9 (mean ± DP), tons of DM per hectare 18.9 ± 1.3, EFET 56.3 ± 1.7, DEG24 61.1 ± 1.7, FROZEN 57.9 ± 5.0, and MACRO 51.2 ± 3.8. Correlation analysis on measures of ruminal digestibility was performed within cow-cultivar (N=120 per degradation procedure) (P<.001). Linear regression models to estimate MACRO were (as % of DM): -2.681 + 0.9556 EFET, 10.982 + 0.6579 DEG24, 30.172 + 0.3624 FROZEN. Extrapolation of macro *in situ* data from ground-sample data was not reliable.

Correlations	DEG24	FROZEN	MACRO
EFET	.93	.47	.45
DEG24		.32	.41
FROZEN			.37

**Key Words:** Corn silage, In situ, Macro bag

**1223 Effect of a yeast/enzyme supplement on the performance of newly-arrived feeder steers.** R. Dvorak\*, *Alltech Inc., Nicholasville, KY.*

The objective of the study was to determine the effects of feeding a combination additive containing a live yeast culture (Yea-Sacc<sup>8417</sup>), cellulases and extract from the Yucca plant (De-Odorase<sup>TM</sup>) on the performance of newly-arrived feeder calves. Two hundred four crossbred steer calves averaging 250 kg were assigned to this trial. Animals were assigned to 20 pens based on weight and genetic background. Cattle were fed either the standard diet or the standard diet to which the combination additive (YCD) had been added at a rate to supply 15 g/hd/day. Treatments were assigned to pens in a randomized complete block design with ten replications (pens) per treatment. Calves received a full feed of long-stemmed grass hay upon arrival, which was gradually replaced with a complete, pelleted receiver feed over 7 days. The complete diets contained all natural protein and the assigned additive. No medications were used in the complete feeds. No death losses or serious health challenges occurred during the study. Dry matter intake (DMI) was significantly increased (P<0.05) by the YCD treatment during the first 13 days in the feedlot (5.56 vs 5.80 kg/day). For the entire 28 day trial period the YCD treatment resulted in a trend toward greater dry matter intake and average daily gain (ADG) (1.50 vs 1.56 kg/day ADG; 6.49 vs 6.60 kg/day intake). These results indicated a positive impact of the YCD supplement on dry matter intake and weight gain of feedlot cattle during the receiving period.

**Key Words:** Yeast culture, Yucca extract, feedlot

**1224 Effects of Hydroxy Methyl Butanoic acid on *in vitro* and *in situ* degradability of forages.** A. F. Mustafa\*, D. A. Christensen, B. Sloan, and J. J. McKinnon, *University of Saskatchewan, Saskatoon, Canada.*

Two ruminally fistulated cows were used in a switchback design to determine the effects of Hydroxy Methyl Butanoic (HMB) acid on degradability of ruminant feeds. Cows were fed a 50:50 forage:concentrate diet and treatments were control (no HMB) and 20g/d of HMB. The effect of HMB on *in vitro* true DM digestibility was determined using samples of canola meal, alfalfa silage (AS), alfalfa hay (AH) and barley silage (BS). To determine the effects of HMB on ruminal disappearance of DM, CP, and NDF, samples of AH, AS, BS, and barley straw were incubated in the rumens of the two fistulated cows for 12, 24, and 48 h. Results of the *in vitro* study shows that feeding HMB improved (P < .05) *in vitro* true DM disappearance of AH, AS, and BS but not canola meal. Feeding HMB to cows increased (P < .05) ruminal disappearance of DM for barley straw and AS incubated in the rumen for 48 h. Similar effects were also observed for barley straw and barley silage samples incubated in the rumen for 24 h. It was concluded that feeding HMB at a level of 20 g/d could improve dry matter degradability of forage materials.

**Key Words:** Hydroxy methyl butanoic acid, Forage degradability

**1225 Potential use of *Propionibacterium acidipropionici*, strain DH42, as a Direct-Fed Microbial for cattle.** S.-W. Kim\*, D.G. Standorf, H. Roman-Rosario, M.T. Yokoyama, and S.R. Rust, *Michigan State University, East Lansing.*

An experiment was conducted to evaluate the effects of *Propionibacterium acidipropionici*, strain DH42, on rumen fermentation of steers fed a high concentrate diet. Four, ruminally, cannulated steers (444 ± 6 kg) were used in a 4 X 4 factorial arrangement of treatments with 4 additives (Control, DH42, *Lactobacillus plantarum* (LAB), and DH42+LAB) and four sequential dose levels (10<sup>7</sup>, 10<sup>8</sup>, 10<sup>9</sup>, 10<sup>10</sup> cfu/hd/d). Steers were adjusted to the experimental diets over a 14 day period and fed a diet consisting of 85% dry rolled corn, 10% corn silage and 5% protein-mineral supplement. The diet contained 11.5% crude protein and was fed once daily at 0830. Each treatment was soaked onto 1500 g of the diet as an admixture of the appropriate microorganisms in 200 ml of distilled water. Control received a sham treatment of 200 ml of distilled water. After the 1500 g of the diet had been consumed, steers were fed the remainder of the untreated diet to appetite. Each dose level was fed for 7 days, respectively. Ruminal samples were collected at 1, 4, 7, 10, 13, 16, 19 and 22 h after the daily dose of inoculants were consumed. With DH42, all dose levels had similar effect on acetate and propionate concentrations. The acetate/propionate ratio decreased with all treatments. Ruminal pH was not affected. Dietary inclusion of *Propionibacterium acidipropionici*, strain DH42, increased production of propionate at the expense of acetate at a minimal inclusion rate of 10<sup>7</sup> cfu/hd/d.

	Control	DH42	LAB	DH42+LAB	SEM
	mol/100mol <sup>a</sup>				
Acetate	58.63 <sup>b</sup>	44.81 <sup>d</sup>	48.13 <sup>c</sup>	48.39 <sup>c</sup>	0.424
Propionate	21.45 <sup>e</sup>	42.98 <sup>b</sup>	40.21 <sup>c</sup>	32.53 <sup>d</sup>	0.628
Lactate	0.13	0.07	0.20	0.08	0.031
Acetate/ Propionate	2.80 <sup>b</sup>	1.05 <sup>d</sup>	1.22 <sup>d</sup>	1.57 <sup>c</sup>	0.048

<sup>a</sup> Means of four treatment dose levels. <sup>bcd</sup> Means in the same row with unlike superscripts differ (p<.001).

**Key Words:** *P. acidipropionici*, DFM, Rumen fermentation

**1226 Effect of soy hulls and Fibrozyme on intake, digestion, and milk production by dairy cows fed high corn silage diets.** H. Al-Jobeile and R. Shaver\*, *University of Wisconsin, Madison.*

Twenty-four multiparous Holstein cows (8 fitted with rumen cannulae) were used in a replicated 4 x 4 Latin square design with 35 d periods. Treatments were soy hulls- (SH) or corn-based (C) concentrates each fed with or without Fibrozyme (Alltech Inc., Nicholasville, KY). Diets were comprised of 33.5% corn silage, 16.5% alfalfa silage, and 50% of the respective treatment concentrate (DM basis). The grain and protein supplements included in concentrate C were dry ground shelled corn (47%),

44%-soybean meal (24%), and expeller soybean meal (20%). Concentrate SH was the same as concentrate C except that 50% of the corn was replaced with soy hulls. Sodium bicarbonate (1.5%) and magnesium oxide (.4%) were included in both concentrates. Diets formulated to contain 18% CP (DM basis) were fed as TMR once daily. Fibrozyme (0 or 15 g/cow/day) was added to the TMR in 57 g/cow/day placebo or Fibrozyme premixes. The corn silage averaged 40% DM and was harvested at a .95 cm TLC without crop processing. Dry matter intake and milk yield averaged 26.9 kg/d and 38.6 kg/d, respectively, and were unaffected by treatment. Milk fat percent and yield were higher ( $P < 0.001$ ) for SH than C (3.27 vs 2.90% and 1.23 vs. 1.11 kg/d). Milk protein percent and yield were lower ( $P < 0.001$  and 0.05, respectively) for SH than C (3.01 vs. 3.11% and 1.14 vs. 1.21 kg/d). Fibrozyme did not affect milk composition or component yields. Body weight change was unaffected by treatment. Fibrozyme increased ( $P < 0.05$ ) rumen pH averaged across 0, 3, 6, 9, and 12-h post-feeding sampling times (6.22 vs. 6.14). Rumen pH was increased ( $P < 0.05$ ) at 3 h (6.19 vs. 6.07) and 6 h (6.04 vs. 5.90) post-feeding by Fibrozyme. Rumen pH was higher ( $P < 0.05$ ) for SH than C, but only at 3 h post-feeding (6.20 vs. 6.06). Ruminal 24-h DM disappearances from corn silage and alfalfa silage were unaffected by treatment.

**Key Words:** Soy Hulls, Milk Production, Digestion

**1227 Microbial degradation of oligofructans may limit their potential as prebiotics for ruminants.** Y. Wang\*, T. A. McAllister, D. A. Gaudet, L. J. Yanke, and A. Laroche, *Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB.*

In response to rising public concern over the use of antibiotics in livestock production, and the impact of manure on the environment, researchers are investigating non-pharmaceutical agents that will promote or sustain high levels of productivity with minimal environmental impact. Oligofructans (OF) are polysaccharide derivatives produced by some plants as carbohydrate energy stores. Used as prebiotics for non-ruminants, OF have been shown to stimulate growth of *Bifidobacteria* and to reduce counts of *Bacteroides*, *Fusobacterium* and *Clostridium* spp. To investigate the potential of using OF to improve ruminant animal production, an in vitro incubation was conducted to assess ruminal degradability of a mid-sized OF isolated from winter wheat. Preliminary studies showed that *Bifidobacterium* spp. grew well on this OF. Stock solutions of the OF (and of corn starch, CS, for comparison) were added to ruminal fluid (20 mL) and substrate (300 mg) in serum vials to yield final OF or CS concentrations of 0, 500 or 1,000  $\mu\text{g/mL}$ . Substrate was ground mixed ration comprising 60% barley silage, 35% barley grain and 5% supplement, and incubations were conducted anaerobically at 39°C. Triplicate vials were terminated at 0, 2, 6, 12 and 24 h to measure gas production, concentrations of OF and reducing sugars (RS), and in vitro DM disappearance (IVDMD). Oligofructans were not detectable in any vials beyond 0 h. Accordingly, RS concentrations were higher ( $P < .05$ ) at 2 h in all OF and CS vials than in the controls. More gas was present in OF and CS vials at 6, 12 and 24 h than in controls ( $P < .05$ ) and amount of gas increased with OF or CS concentration ( $P < .05$ ), but treatment did not affect 24-h IVDMD ( $P > .05$ ). Isolated OF were rapidly and completely degraded in ruminal fluid within 2 h. Thus, steps must be taken to protect these compounds against ruminal degradation before the positive effects observed with nonruminant animals may be extended to ruminants.

**Key Words:** Oligofructans, Ruminal degradation, Prebiotics

**1228 Effects of exogenous fibrolytic enzymes on epiphytic microbial populations of barley and corn silages.** Y. Wang\*<sup>1</sup>, T. A. McAllister<sup>1</sup>, L. M. Rode<sup>1</sup>, K. A. Beauchemin<sup>1</sup>, D. P. Morgavi<sup>1</sup>, V. L. Nsereko<sup>1</sup>, A. D. Iwaasa<sup>2</sup>, and W. Yang<sup>1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB*, <sup>2</sup>*Agriculture and Agri-Food Canada Research Centre, Swift Current, SK.*

The effects of applying exogenous enzymes to barley and corn silages on release of reducing sugars (RS) and on epiphytic microbial populations were examined in three 2 × 3 factorial experiments. The silages were treated either directly upon removal from the silos (BS, CS) or after having been autoclaved (ABS, ACS); in addition, CS removed from the silo (i.e., aerobically exposed) 24 h prior to processing was also studied (XCS, XACS). Treatments ( $n = 3$ ) comprised applying 10 mL of water (control), a xylanase/ $\beta$ -glucanase enzyme mix (E), or autoclaved enzymes (AE) per kg DM. After 24 h, RS concentrations were recorded,

and total bacteria (TB) and yeasts + moulds (YM) were enumerated. Autoclaving increased ( $P < .05$ ) RS in both types of silage. Enzymes increased ( $P < .05$ ) RS in fresh and autoclaved silages, more so ( $P < .05$ ) with autoclaving than without. Treatment with AE did not affect RS. Microbial numbers were higher ( $P < .05$ ) on XCS than on CS, and were below detectable limits on ABS, ACS, and XACS. Enzymes increased ( $P < .05$ ) TB on both types of silage, more so on XCS+E than on CS+E. In a repeat study, ethylene oxide (EO) replaced autoclaving, and RS were measured 0 and 24 h after treatment. In both types of silage, RS were higher ( $P < .05$ ) at 24 h than at 0 h, irrespective of EO. At 24 h, RS in enzyme-treated silages were higher ( $P < .05$ ) with EO than without. Enzyme-associated increases in RS likely increased TB on the silages. Reducing epiphytic microbiota conserved enzyme-liberated RS in the silages. Aerobic exposure prior to applying enzymes enhanced RS-associated increases in microbial numbers. In releasing RS, exogenous enzymes may encourage silage deterioration if the interval between treatment and feeding is excessive. Enzymes effectively released RS from silages, but utilization of the RS by inherent epiphytic microorganisms may limit their availability to the ruminant.

**Key Words:** Feed enzymes, Silage, Reducing sugars

**1229 Evaluation of folic acid supplementation in calf milk replacer on calf performance and health.** M. A. Fowler\*, B. L. Miller, T. E. Johnson, D. E. Housken, H. B. Perry, and M. R. Higgins, *Land O'Lakes, Inc., Webster City, IA.*

A calf performance trial was conducted with 41 Holstein bull calves (46.4 kg. average initial weight) to evaluate two levels of folic acid supplementation in an all milk protein calf milk replacer (CMR). Treatments consisted of two levels of folic acid supplementation – .5 ppm (NRC); 20 ppm. All calves received a medicated calf milk replacer (22% crude protein, 20% crude fat). Calves were allotted to treatment based on body weight and serum Ig status. Calves were fed CMR twice daily. Calves were weighed weekly with CMR consumption and subjective fecal scores recorded daily. All data are mean values for a 28-day period. Weight gain, CMR consumption and feed conversion for respective treatments were as follows – .5 ppm - 11.3 kg., 21.6 kg., 2.08 kg./kg. gain; 20 ppm - 12.1 kg., 21.2 kg., 1.90 kg./kg. gain. No differences in calf weight gain, CMR consumption, feed conversion, average fecal score and scour days were observed among treatments ( $P > .05$ ).

**Key Words:** Folic acid, calf milk replacer

**1230 The effect of Fermenten feeding on growth parameters in Holstein replacement heifers.** B.N. Ellison<sup>1</sup>, I.J. Lean\*<sup>2</sup>, M.A. Curtis<sup>3</sup>, and W.E. Julien<sup>1</sup>, <sup>1</sup>*Biovance Technologies, Inc., Omaha, NE*, <sup>2</sup>*Bovine Research Australia, Camden, NSW*, <sup>3</sup>*Pictou, NSW.*

Six hundred and thirty eight Holstein heifers located on four different sites were used to evaluate the effects of Fermenten feeding on wither height, weight gain, and loin length *lastribtocaudalpointofipsilateralpinbone*. Heifers at each site were either stratified on age or physical measurements, and randomly assigned to a Control or Treatment group. The Control diet was the existing ration at each site. The Treatment diet was formulated to give an isonitrogenous, isocaloric, isofibrous ration with respect to the Control diet. Fermenten was fed at the rate of 227 g for heifers weighing less than 182 kg, and 341 g for heifers weighing over 182 kg. All heifers were measured at day 0, 14, 35, 56, and 77 after trial initiation. A range of in growth responses was observed across trial locations, however, heifers fed the Treatment diet demonstrated a positive response in all measured growth parameters  $P_{10.01}$  regardless of management system, stage of growth, diet ingredients, or season of year. After controlling for site, heifers fed the Treatment diet gained 20.76% more height at the withers  $P_{10.01}$ , 20.27% more length  $P_{10.01}$ , and 10.24% more weight  $P_{10.01}$  than the control heifers. This series of studies demonstrated a nutritional intervention that can accelerate volumetric growth in Holstein dairy replacement heifers.

**Key Words:** Holstein heifers, Volumetric growth, Accelerated growth



**1231 Effect of increasing level of dietary protein on growth and mammary development of Holstein heifers consuming a moderate-energy diet.** R. Lopez\*, C.R. Krehbiel, M.G. Thomas, B. Obeidat, D.M. Hallford, E. Castellanos, G. Bethard, R. Flores, and L. Balstad, *New Mexico State University, Las Cruces.*

Enhanced knowledge of the relationship between nutritional management of the heifer and lifetime milk production is important for maximizing dairy cow productivity. The dietary level of CP and the CP:ME dietary ratio could be used as a tool to manipulate physiological processes of growth and mammary gland development and increase lifetime milk production. Herein, twenty-four Holstein heifers (initial BW = 143 ± 30 kg) 120 d of age were individually fed a 52:48 concentrate:roughage diet (NEm = 1.61 Mcal/kg; NEg = 1.01 Mcal/kg) with increasing levels of protein (12, 14, 16, and 18% CP from soybean meal [SBM]; DIP = 68.5% of CP; n=6 heifers per protein level) or CP:ME ratio (75, 87, 100, or 112) until they reached puberty (291 ± 8.2 days). After puberty, heifers were slaughtered during the mid-luteal phase. Body weights were recorded at two-week intervals before and on the d of slaughter. At slaughter, viscera and organ weights were recorded. Body weights were greater ( $P < .01$ ) across time in heifers consuming 16% CP relative to 12, 14, or 18% (263 ± 9 > 239 ± 7, 244 ± 7, 247 ± 7 kg) and a treatment x time interaction suggested that ADG was greater ( $P < .01$ ) in heifers consuming 16% CP relative to heifers consuming 12, 14, or 18% for d 28-105 (1.2 ± .1 ≥ 1.0 ± .16, 1.06 ± .12, .96 ± .1 kg/d). Average daily DMI and gain:feed ratios were similar ( $P = .18$ ) across these levels of protein consumption. Heifer BW on the d of slaughter was greater ( $P = .02$ ) for heifers consuming 16% CP than in heifers consuming 18, 14, or 12% (412 ± 16 > 368 ± 14, 366 ± 13, and 335 ± 16 kg) as was hip-height (127 ± 3 > 119 ± 3, 119 ± 3, 114 ± 3 cm;  $P < .03$ ), while BCS were similar ( $P = .32$ ). No differences were observed ( $P > .28$ ) in age at puberty or weights (g/kg BW) of viscera, liver, heart, spleen, lungs plus trachea, or mammary glands. Although maximum growth rate was achieved when heifers were fed 16% CP, these results suggest that levels of 12 to 18% CP from SBM can support a moderate to high growth rate in Holstein heifers without changes in viscera, liver, peripheral tissue, or mammary glands weights when moderate levels of energy are fed.

**Key Words:** Dairy Heifer, Protein, Growth

**1232 Phytase addition to diets deficient in amino acids for grow-finish pigs.** S. L. Johnston\*, L. L. Southern, T. D. Bidner, and D. F. Coombs, *Louisiana State University Agricultural Center, Baton Rouge.*

One-hundred fifty gilts (initial weight = 20 kg) were used in a 106-d experiment to determine the effect on growth performance and carcass traits of phytase addition to diets deficient in amino acids, Ca, and P. The treatments were: 1) positive control (NRC adequate in amino acids, ME, Ca, and P), 2) a diet with 85% of the amino acids of Diet 1, but adequate in Ca and P, 3) a diet with 85% amino acids formulated with phytase expected to supply amino acids, ME, Ca, and P with added phytase, 4) Diet 3 but with no added phytase, 5) Diet 4 but adequate in Ca and P. The nutrient matrix values that were used for the phytase addition were: Ca 144%, aP 144%, ME 15,246 kcal/kg, Lys 12%, Met 5%, Thr 5%, and Trp 2%. The phytase was provided at 0.083% of the diet, and therefore was expected to provide the following nutrients: Ca 0.12%, aP 0.12%, ME 12.7 kcal/kg, Lys 0.01%, Met 0.004%, Thr 0.004%, and Trp 0.002%. Each treatment was replicated five times with six gilts each. Pigs fed diets with reduced amino acid concentrations (Diets 2 to 5) had lower daily gain ( $P < 0.01$ ) than pigs fed the positive control diet adequate in amino acids and other nutrients (Diet 1). Pigs fed Diet 3 (added phytase) had gain:feed (G:F) equal to, or slightly greater, than pigs fed Diets 1 or 2, but they had greater G:F than pigs fed Diet 4 ( $P < 0.05$ ) or Diet 5 ( $P = 0.15$ ). Phytase addition to a diet with reduced levels of amino acids, Ca, aP, and ME had G:F slightly higher than pigs fed Diets 1 or 2. However, G:F was reduced in the diet without phytase and formulated to be deficient in amino acids, Ca, P, and ME (Diet 4). Feed efficiency was also lower in pigs fed the diet without added phytase but which had adequate Ca and P (Diet 5). In addition, pigs fed the diet containing phytase (Diet 3) had more muscle and fat than pigs fed the diet without phytase (Diet 2). In conclusion, phytase improved utilization of amino acids and ME, as well as Ca and P in diets for pigs.

**Key Words:** Pigs, Phytase, Amino Acids

**1233 Effect of NDF from corn silage in diets of lactating dairy cows.** D.M. Allen\*<sup>1</sup>, C.S. Kuehn<sup>1</sup>, J.G. Linn<sup>1</sup>, W.P. Hansen<sup>1</sup>, H.G. Jung<sup>1,2</sup>, and M.I. Endres<sup>3</sup>, <sup>1</sup>University of Minnesota, St. Paul, MN, <sup>2</sup>USDA-ARS, St. Paul, MN, <sup>3</sup>Mycogen Plant Sciences, Eagan, MN.

Two studies were conducted to evaluate the effect of NDF from corn silage on lactation performance. In year 1, fifty-one Holstein cows (22 primiparous (P) and 29 multiparous (M)) were assigned randomly to one of five dietary levels (18, 20, 22, 24, and 26% of total dietary DM), of forage NDF (NDF<sub>F</sub>). Source of NDF<sub>F</sub> was corn silage and alfalfa hay, with hay constant at 13% of the diet DM. As NDF<sub>F</sub> increased, corn grain decreased and corn silage increased. Rumen inert fat was fed to maintain isocaloric diets. Cows received a standardized diet (22% NDF<sub>F</sub>) from calving until 20 to 26 d post calving when dietary treatments were initiated and remained on their respective diets for 17 weeks. Dry matter intake of M cows was affected ( $P < 0.05$ ) by diet with a decreasing DMI as NDF<sub>F</sub> increased except at 26% NDF<sub>F</sub>. Dietary treatment did not affect milk production, 3.5% FCM, BW, BCS, or DM digestibility within parity. Time spent chewing tended to increase linearly with increasing NDF<sub>F</sub> in the diet. Year 2, seventy-four Holstein cows (21 P and 53 M) were assigned randomly to one of six dietary treatments. Three dietary levels of NDF<sub>F</sub>, as contributed by corn silage and alfalfa hay (17, 20, and 22.5% of total dietary DM), with either an undegradable protein supplement (U; RUP 48.6% of CP; calculated) or a degradable protein supplement (D; RUP 32.5% of CP; calculated) were fed. Dietary NDF<sub>F</sub> was varied as in year 1 except alfalfa hay was held constant at 10% of dietary DM. All cows were fed 20% NDF<sub>F</sub>; D diet from calving until 20 to 26 d post-calving and then switched to their respective dietary treatment for 21 weeks. There was a numerical trend for decreasing DM intake as NDF<sub>F</sub> increased for both protein supplements within parity. Milk yield was not different across treatments within parity. Various levels of NDF<sub>F</sub> from corn silage can be fed as a total mixed ration when good feeding management practices are implemented without adverse health effects or compromising milk yield.

**Key Words:** corn silage, forage NDF, dairy cows

**1234 Effects of brown midrib-3 mutation in corn silage on lactational performance of dairy cows.** R. A. Longuski\*, M. S. Allen, and R. J. Tempelman, *Michigan State University, East Lansing.*

Effects of brown midrib-3 (*bm3*) mutation in corn silage on lactational performance were evaluated using eighty Holstein cows (30 primiparous and 50 multiparous) in a full lactation experiment with a randomized complete block design. Corn hybrids (*bm3* or its isogenic normal equivalent) were grown in both 1997 and 1998 and ensiled for the study. In vitro NDF digestibility (30 h) was greater for *bm3* corn silage compared to control in both 1997 (57.0% vs 47.6%) and 1998 (62.1% vs 49.9%). Cows were offered diets containing a forage mix of 67% corn silage treatments and 33% alfalfa silage on a DM basis. Diets offered at calving were formulated to 30% NDF and 18% CP and cows were switched to diets with higher NDF and lower CP contents if body condition and daily milk production criteria were met past 84±3 DIM. Animals were housed in a freestall facility grouped by treatment and diet energy density, fed 1X/d and milked 3X/d. Body weight and body condition score were measured within 72 hours of calving, at 14±3 DIM, at 28±3 DIM and at 28 day intervals thereafter. Milk was sampled monthly (3X/d) for each cow and analyzed for CP and fat content. Data from ten test days at 30-d intervals were analyzed using mixed effects models including effects of hybrid, DIM or stage of lactation, parity, silage year and diet energy density. A significant treatment by stage of lactation interaction ( $P=0.05$ ) was observed for solids corrected milk (SCM) yield. Yield of SCM was numerically lower for *bm3* treatment at test month 1 but higher for test months 2 (2.4 kg/d,  $P=0.07$ ), 3 (3.5 kg/d,  $P=0.01$ ) and 5 (2.6 kg/d,  $P=0.05$ ) compared to control treatment. Cumulative SCM from 50 to 150 DIM was greater for *bm3* treatment compared to control (3282 vs. 2990 kg,  $P<0.01$ ). Milk CP content was greater for *bm3* treatment than control (3.02 vs 2.87%;  $P<0.01$ ). No differences were observed between treatments for milk fat content, body weight, or body condition score. These results suggest that milk yield response for dairy cows fed *bm3* corn silage compared to control is greatest at peak lactation.

**Key Words:** Corn silage, Brown midrib, Full lactation

**1235 Effect of hybrid, maturity, and mechanical processing of corn silage on intake and digestibility by beef cattle.** J. G. Andrae<sup>\*1</sup>, C. W. Hunt<sup>1</sup>, L. R. Kennington<sup>1</sup>, G. T. Pritchard<sup>1</sup>, W. Kezar<sup>2</sup>, and W. Mahanna<sup>2</sup>, <sup>1</sup>University of Idaho, Moscow, <sup>2</sup>Pioneer HiBred International, Johnston, IA.

A study involving a 2 x 2 x 2 factorial arrangement of treatments was conducted to evaluate the effects of hybrid (Pioneer 3335 and 3489), maturity (half milkline and blacklayer), and mechanical processing (field chopper with and without on-board rollers engaged) on intake and digestibility of corn silage. Forty beef steers (322 kg BW) were stratified by weight groups, randomly assigned to silage treatments, and individually fed using electronic feeding gates. Diets consisted of 60 percent corn silage and 40 percent alfalfa hay (DM basis). Following a 5-d adaptation period, intake was measured for 7 d and fecal samples were collected for 5 d. Chromic oxide (5 g/d) was fed beginning 7 d prior to fecal collection and digestibility was determined by the ratio of Cr in the feed and feces. Steers were reallocated and these procedures were repeated providing 10 observations per treatment. At full maturity 3489 produced drier silage that phenotypically had coarser stover and harder cob fragments than 3335. Processing increased DMI of 3489 but did not affect DMI of 3335 (hybrid x processing; P < .06). Total tract digestibility of DM, starch, NDF, and ADF decreased (P < .01) as plant maturity increased. Maturity decreased starch digestibility more for 3489 than 3335 (hybrid x maturity; P < .10). Processing increased (P < .01) starch digestibility, but decreased (P < .01) NDF and ADF digestibility resulting in no processing effect for DM digestibility. Processing numerically increased starch digestibility more for late than early maturity corn silage (maturity x processing; P = .11). These data indicate that hybrid, maturity, and processing all affect corn silage digestibility. Mechanical processing of corn silage increased starch digestibility which may have disrupted ruminal fermentation resulting in decreased fiber digestibility.

**Key Words:** Corn Silage, Maturity, Processing

**1236 Influence of the particle size of barley silage on the effective fiber characteristics.** H.W. Soita<sup>\*</sup>, D.A. Christensen, and J.J. McKinnon, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

The aim of this study was to examine the influence of forage particle size on the effective fiber characteristics. Six steers (435 kg) equipped with ruminal cannulas were used in a 2 x 2 Latin square design to test two theoretical length of cut of barley silage (short SS = 4.85 mm and long LS = 18.0 mm). The diets were straight silage with a salt and trace mineral supplement. Dry matter intake was higher (P < .05) for the steers fed SS diets. Feeding LS diets sharply reduced DM and cell wall constituents digestibilities (P < .05). Feeding SS diets reduced mean rumen pH, ammonia, acetate: propionate ratio, molar proportion of acetic acid and increased the molar proportions of propionic acid and total VFA. The range of pH during the day and the time when pH and ammonia concentration were low (< 6.2 and 5.0 mg/dL, respectively) were increased. Eating rate average 38.3 g/min, however saliva production was higher (P < .05) for LS diets. Ingestive mastication reduced (P < .05) feed particle size retained on the first and second screen (>18 mm) of the LS as compared with SS. Rumen mean retention time was higher for LS as compared with SS. It is concluded that reduced barley silage particle size can influence the quantity and nature of digestive end products by altering chemical and physical conditions in the rumen.

**Key Words:** Barley Silage, Particle Size, Metabolic responses

**1237 Effects of feeding pea silage on milk yield and composition of dairy cows.** A. F. Mustafa<sup>\*</sup>, D. A. Christensen, and J. J. McKinnon, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Six Holstein cows in early lactation were used in a double 3 x 3 Latin square design to determine the effects of feeding pea silage (PS) as forage source relative to barley (BS) and alfalfa (AS) silage. Cows were fed rations formulated to contain 50:50 forage to concentrate ratio. Two Ruminally fistulated cows were used in a randomized complete block design to determine ruminal nutrient degradability for PS relative to BS and AS. Pea silage contained a lower (P < .05) NDF, ADF and starch but a higher (P < .05) CP level than BS. When compared with AS, PS had a higher (P < .05) starch and NDF but a lower (P < .05) CP content. Rate of degradation and effective ruminal degradability of NDF

was highest for AS, intermediate for PS and lowest for BS (P < .05). Dry matter intake and milk yield were not affected by forage source. However, cows fed PS or AS tended to produce more milk (2 kg/d) than cows fed BS. Milk composition was similar for cows fed PS or BS. However, Cows fed PS produced milk with a higher (P < .05) fat and a lower (P < .05) protein percentage than cows fed AS. It was concluded that PS can replace BS and AS as a forage source for dairy cows in early lactation.

**Key Words:** Pea silage, Milk yield and composition, Dairy cows

**1238 Comparative timed intakes of grain supplements for lactating Jerseys and Holsteins on pasture.** S.L. White<sup>\*1</sup>, S.P. Washburn<sup>1</sup>, C. Arellano<sup>1</sup>, and J.T. Green, Jr.<sup>1</sup>, <sup>1</sup>North Carolina State University, Raleigh.

This experiment compared intakes of grain supplement between Jerseys (J; n=9) and Holsteins (H; n=9) managed on pasture. Cows calved in September and were offered supplement twice a day before each milking. Supplement consisted primarily of ground corn, whole cottonseed, and soybean meal (42, 27, and 15 % of DM, respectively). Intake measurements were taken for six consecutive days in January (Period 1), March (Period 2), and May (Period 3). Amounts offered each cow at each feeding were 6.83 kg, 4.55 kg, and 2.27 kg for Periods 1, 2, and 3, respectively. Supplements were reduced in spring because of greater availability of pasture. The experiment was a Latin square with two squares within each period. During the first 3 days (square 1) intakes were measured at 2.5, 7.5, and 12.5 min and during the next 3 days (square 2) intakes were measured at 5, 10, and 15 min. Sets of 3 cows of each breed were assigned within each square such that each cow was allowed access to the grain supplement for each of the six time intervals over each 6-day period. Cows were fed individually before the afternoon milking and intakes determined by measuring orts at appropriate time intervals. The General Linear Models procedure in SAS was used for statistical analyses within period. Cow within breed was used as the error term for testing breed effects. Amounts of feed eaten increased with time but did not differ significantly between the two breeds. Numerically, Holsteins averaged eating at least 0.3 kg more supplement several times, particularly during January when more feed was offered and less pasture was available.

	Period 1 (6.83 kg offered)		Period 2 (4.55 kg offered)		Period 3 (2.27 kg offered)	
	H	J	H	J	H	J
Eating Time (minutes)						
2.5	1.07	0.96	0.81	0.81	1.02	1.01
5	2.22	1.88	1.73	1.61	1.89	1.74
7.5	2.97	2.50	2.29	2.15	2.13	2.04
10	4.15	3.66	2.79	3.02	2.23	2.26
12.5	4.49	3.97	3.28	3.05	2.24	2.27
15	5.39	5.02	3.78	3.48	2.23	2.27
S. E.	± .13		kg eaten ± .18		kg eaten ± .04	

**Key Words:** Breeds, Pasture, Intake

**1239 Short periods of sub-optimal pH reduce digestibility of pasture *in vitro*.** M.J. de Veth<sup>\*</sup> and E.S. Kolver, Dairying Research Corporation Ltd, Hamilton, New Zealand.

Four dual flow continuous culture fermenters were used in a 4x4 Latin square design to establish the effect of diurnal variation in ruminal pH on pasture digestion and microbial protein synthesis. Fermentation of high quality pasture (22% CP, 43% NDF) was controlled at pH 5.4 (sub-optimal) for four different intervals of each day (0, 4, 8, 12 h). During the remainder of each day pH was controlled at 6.3 (optimal). Automatic infusion of 5 N NaOH and 5 N HCl controlled pH to ±0.05. Samples were collected during the last 3d of each of the four 9-d experimental periods. Increasing the period of time at sub-optimal pH from 0 to 12 h/d reduced OM and DM digestibility by 8 percentage units, NDF digestibility by 15 percentage units and microbial N flow by 23%, but had no effect on total non-structural carbohydrate (TNC) digestion or efficiency of microbial protein synthesis. A negative linear relationship was observed between time at sub-optimal pH and digestibility of OM, DM, NDF, and microbial N flow. Digestibility of OM, DM, and NDF was reduced after exposure to sub-optimal pH for 4 h, but microbial

N flow was only significantly reduced after 8 h. These results indicate that short periods of sub-optimal pH inhibited the activity of the rumen microbial population, but longer periods of sub-optimal pH (>8 h) were required before ruminal flow of microbial N was significantly impaired. This experiment confirmed that the microbial population was able to adapt to a ruminal pH below 6.0 and exhibit high levels of digestion when an all-pasture diet was fed.

	Time at sub-optimal pH (hours)				SED	P <sup>1</sup>
	0	4	8	12		
True ruminal digestibility (%)						
OM	65.9 <sup>a</sup>	61.8 <sup>b</sup>	59.4 <sup>bc</sup>	58.2 <sup>c</sup>	1.03	0.001
DM	65.5 <sup>a</sup>	61.2 <sup>b</sup>	59.0 <sup>bc</sup>	57.6 <sup>c</sup>	1.05	0.001
Apparent ruminal digestibility (%)						
TNC	66.8	63.5	61.9	60.0	2.32	0.025
NDF	76.0 <sup>a</sup>	72.0 <sup>b</sup>	68.7 <sup>c</sup>	67.4 <sup>c</sup>	1.08	0.001
Microbial N flow (g N/d)	0.39 <sup>a</sup>	0.37 <sup>a</sup>	0.34 <sup>a</sup>	0.30 <sup>b</sup>	0.02	0.002
Efficiency of microbial protein synthesis (g N/kg OM digested)	10.9	11.1	10.8	9.4	0.52	0.029

<sup>1</sup> Linear relationship between pH treatments; <sup>a,b,c</sup>Means in a row with a different subscript differ (P<0.05)

**Key Words:** Pasture, pH, Rumen

**1240 Digestibility of diets containing whole linted cottonseed as a forage substitute when fed with ground or steam-flaked corn.** D.I. Harvatine\* and J.L. Firkins, *The Ohio State University, Columbus.*

Six mid-lactation primiparous Holstein cows (517 kg), fitted with ruminal and duodenal cannulas, were used in a 6 x 6 Latin Square with 3-wk periods. The objective was to quantify the site and extent of digestion when NDF from whole linted cottonseed (WCS) replaced alfalfa silage NDF and corn varied in ruminal starch availability (ground (G) or steam-flaked (SF)). Treatments were: forage control with G [FCG] (21% forage NDF (fNDF)); low (5%) WCS with G [LG] or SF [LSF] (18% fNDF); medium (10%) WCS with G [MG] or SF [MSF] (15% fNDF); and high (15%) WCS with G [HG] (12% fNDF). Diets had similar total NDF, CP and fat. DMI increased quadratically (P<0.05) with increasing substitution of fNDF with NDF from WCS (17.8, 20.0, 20.5, 20.3 kg DM for FCG, LG, MG, and HG). DMI decreased for cows fed SF (P<0.05) compared to G (19.2 and 18.2 kg for LSF and MSF vs. 20.0 and 20.5 kg for LG and MG). No difference was detected in ruminal NDF digestibility (39.4, 38.8, 37.5, 38.8% for FCG, LG, MG and HG), although there was a linear decrease (P<0.01) in total tract NDF digestibility (58.5, 55.3, 54.8, 48.3% for FCG, LG, MG and HG) with increasing level of WCS substitution. No effect of corn source was detected for NDF digestibility. NSC intake increased linearly (P<0.01) with increasing level of WCS inclusion (4.0, 5.0, 5.1, 5.7 kg for FCG, LG, MG, and HG). Apparent ruminal NSC digestibility increased linearly (P<0.05) (49.5, 55.3, 54.1, 66.4% for FCG, LG, MG and HG), although there was no difference in total tract NSC digestibility (95.1, 96.7, 97.0, 96.5% for FCG, LG, MG and HG) with increasing WCS substitution. SF increased (P<0.01) apparent ruminal NSC digestibility (75.8 and 79.4% for LSF and MSF vs. 55.3 and 54.1% for LG and MG) and increased (P<0.01) total tract NSC digestibility (99.4 and 99.8% for LSF and MSF vs. 96.7 and 97.0% for LG and MG) as compared to G. No interactions of corn source and WCS level were detected for NDF and NSC digestibility.

**Key Words:** Corn processing, Whole Cottonseed, Digestion

**1241 Effects of cottonseed hulls in the diets of dairy cows.** A. M. Akinyode\*<sup>1</sup>, M. B. Hall<sup>1</sup>, C. R. Staples<sup>1</sup>, H. H. Head<sup>1</sup>, and W. E. Kunkle<sup>2</sup>, <sup>1</sup>Dept. of Dairy & Poultry Sciences, <sup>2</sup>Dept. of Animal Science, University of Florida, Gainesville.

Our study evaluated the effect of providing a portion of dietary roughage as cottonseed hulls (CSH). Ten Holstein cows in mid-lactation, of which five were ruminally cannulated, were randomly assigned to dietary treatments in a 4x4 Latin square design. The isonitrogenous total mixed ration contained 40% roughage (sorghum silage and/or CSH) and 60% concentrate (corn meal, soybean meal, whole cottonseed, distillers grains, citrus pulp and minerals). Cows were fed individually twice daily. Treatment diets contained 0, 8, 16 and 24 percent of diet dry matter (DM) as CSH replacing sorghum silage. The experimental periods were 21d long with the last 7d for sampling. Cr-mordanted NDF (30g) was pulse-dosed orally or intraruminally on day 15 and fecal samples (n=28) were collected over an 82 h period for calculation of rate of passage (kp). Fecal pH was measured. Ruminal pH was measured for 12 h on d 21. Values reported are least squares means. Significance was declared at P<0.05. Dry matter intake (DMI), intake of concentrate DM, and DMI as a percentage of body weight (DM%BW) differed among treatments. DMI increased linearly with increasing CSH. Fecal pH decreased with increasing CSH, suggesting increased fermentation in the large intestine. Total tract kp, daily milk production, feed efficiency and ruminal pH did not differ among treatments. In conclusion, increasing dietary concentration of CSH increased DMI and maintained ruminal pH, although estimated kp was not affected. However, the reduction in fecal pH implies a partial shifting of nutrient digestion to the lower gut.

CSH % of diet DM	0	8	16	24	SEM
DMI, kg/d	20.7	22.9	24.3	25.3	0.81
DMI%BW	3.00	3.50	3.70	3.90	0.002
Ruminal pH	6.20	6.20	6.20	6.17	0.52
Fecal pH	6.50	6.43	6.44	6.36	0.04
Kp, h <sup>-1</sup>	0.051	0.054	0.056	0.053	0.002
Milk, kg/d	20.7	19.5	20.7	20.7	2.42
Milk/DMI, kg/kg	0.86	0.87	0.84	0.81	0.08

**Key Words:** Dairy Cattle, Cottonseed Hulls, By-product Feeds

**1242 Altering diurnal pH and *in situ* digestion in dairy cows with ruminal supplementation of direct fed microbials (DFM) and yeast.** J.E. Nocek\*<sup>1</sup>, W.P. Kautz<sup>2</sup>, J.A.Z. Leedle<sup>2</sup>, and J.G. Allman<sup>2</sup>, <sup>1</sup>Spruce Haven Farm and Research Ctr, <sup>2</sup>Chr. Hansen BioSystems.

Three ruminally-cannulated cows(70 DIM)were used to evaluate the effects of DFM and yeast supplementation on diurnal rumen pH profiles and *in situ* digestibility. Treatments were: a)control, b)DFM(*Enterococcus faecium*and *Lactobacillus plantarum* at 1x10<sup>5</sup>), c)10g Biomate Yeast-Plus, and d) combination of b and c. All treatments were directly incorporated into the rumen via fistula once daily. Cows were fitted with indwelling rumen pH probes connected to data-loggers. Rumen pH values were summarized hourly. The experimental period was 21d: 7d adjustment, 4d *in situ*, 10d pH monitoring. *In situ* digestion rates were conducted on high moisture ear corn(HMEC), haylage and corn silage (CS). Cows fed DFM had higher mean daily lowest(MDL) pH values compared to other treatments. Cows fed yeast or DFM/yeast tended to have higher rumen pH values. Area under the curve(AUC) for pH <5.5 was lowest for cows receiving DFM compared to other treatments. Rate of haylage DM digestion was highest for cows receiving DFM. Rate of HMEC and CS DM digestion tended to be higher for cows receiving DFM/Yeast. These data demonstrate that addition of a specific DFM aids in reducing ruminal acidity and affects DM digestion rates of some forages.

Parameter	Control	DFM	Yeast	DFM/Yeast	SEM
MDL pH	5.33 <sup>b</sup>	5.58 <sup>a</sup>	5.43 <sup>b</sup>	5.44 <sup>b</sup>	.04
AUC, <5.5	54.1 <sup>a</sup>	41.3 <sup>b</sup>	57.1 <sup>a</sup>	63.3 <sup>a</sup>	3.2
KdB, %/h					
HMEC	4.65	5.27	4.85	5.55	.53
Haylage	5.41 <sup>b</sup>	7.13 <sup>a</sup>	4.94 <sup>b</sup>	4.81 <sup>b</sup>	1.05
CS	4.33	4.98	3.58	4.75	.71

<sup>a,b</sup>means in the same row are different, P<.05

**Key Words:** DFM, rumen, pH

**1243 The effect of various combinations of fibrolytic enzymes on the feeding value of a TMR fed to lactating cows.** L. Kung, Jr.<sup>1</sup>, J. A. Lazartic\*<sup>1</sup>, R. L. Wuelfel<sup>2</sup>, L. M. Rode<sup>2</sup>, K. A. Beauchemin<sup>2</sup>, and R. J. Treacher<sup>3</sup>, <sup>1</sup>University of Delaware, Newark, <sup>2</sup>Agriculture and Agri-Food Canada, Lethbridge, <sup>3</sup>Finnfeeds Intl., Marlborough, UK.

We tested the effect of feeding cows TMR that had their forage component treated with fibrolytic enzymes prior to feeding. Twenty seven multiparous and 3 primiparous Holstein cows averaging 93 DIM and 38 kg of milk/d were fed a TMR of 30% corn silage, 15% alfalfa hay, and 55% concentrate (DM basis). After a 14-d pretreatment period, cows were blocked on parity and milk yield before being randomly allocated to one of the three treatments. During a 12-wk treatment period the forage portion of the TMR was treated with: 1) no enzymes, 2) cellulase complex D and hemicellulase complex B (3400 CMCase units and 10,450 xylanase units/kg forage DM), or 3) cellulase complex D and hemicellulase complex C (3350 CMCase units and 10,500 xylanase units/kg forage DM). Enzymes were diluted in water and applied to forages with in 30 min (10 l/1000 kg fresh forage) before mixing into the TMR. A similar amount of water was added to untreated forage in treatment 1. Diets were fed to cows within 30 to 60 min of enzyme treatment. Dry matter intake (kg), milk production (kg), milk fat (%) and milk protein (%) for treatments 1, 2, and 3 were not affected by treatment and were: 26.9, 27.8, 27.2; 37.2, 39.0, 36.8; 3.33, 3.44, 3.29; and 3.10, 3.14, 3.09, respectively. However, cows fed treatment 2 produced 2.5 kg ( $P < 0.12$ ) and 2.8 kg ( $P < 0.08$ ) more 3.5% FCM than cows fed treatment 1 and 3, respectively. In vitro gas production of the treated forage portions of the diets was greater ( $P < 0.05$ ) from enzyme treated forages than from untreated forage, but 96 h VFA production was not different among treatments. Enzyme activity at pH above 6.0 was similar for both hemicellulase enzymes. However, activity was greater at lower pH for hemicellulase complex B. These data show that in vitro gas production does not accurately predict in vivo response to various fibrolytic enzymes. The apparent discrepancy may be related to differences in enzyme activity at low pH.

**Key Words:** Enzymes, Lactation, Forage

**1244 Effects of Tween 60 and Tween 80 on protease activity, thiol group reactivity, protein adsorption and cellulose degradation by rumen microbial enzymes.** G. M. Kamande<sup>1</sup>, J. Baah\*<sup>2</sup>, K.-J. Cheng<sup>3</sup>, T. A. McAllister<sup>2</sup>, and J. A. Shelford<sup>3</sup>, <sup>1</sup>PMT Inc. (Prairie Microtech), Regina, SK, <sup>2</sup>Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, <sup>3</sup>University of British Columbia, Vancouver, BC.

Microbial enzymes extracted from mixed ruminal microorganisms were incubated for 2 h with casein and Tween 60 or Tween 80 at 10 concentrations ranging from 0 to 2.0% (vol/vol) to determine the effects of these nonionic surfactants on protease activation and thiol reactivity (unmasking of thiol groups). Rate and extent of protein adsorption to cellulosic substrate (barley straw) was measured in the presence of 0, .05, .10, .25, and .50% (vol/vol) Tween 80. Degradation of cellulose by a rumen bacterial fraction was measured over 48 h of incubation with and without Tween 60 or Tween 80 at .25% (vol/vol). Maximum accelerations of protease activity achievable with Tween 60 and Tween 80 (calculated from a Michaelis-Menten kinetics model) were 99.2 and 166.8%, respectively. Concentrations of Tween 60 and Tween 80 at which half the maximal velocities were attained were .28 and .20% (vol/vol), respectively. Tween 80 increased ( $P < .05$ ) the rate and extent of adsorption of microbial protein to barley straw, and the effect was related to concentration of Tween 80 up to .10% (vol/vol). Initial rates of cellulose degradation with no surfactant, .25% Tween 60, or .25% Tween 80 were .60, .87, and 1.04  $\mu\text{g}/\text{mL}$  per h, respectively. These nonionic surfactants were effective for enhancing rumen microbial protease and cellulase activities. Thus, further study is warranted to determine their potential for improving ruminant feeding.

**Key Words:** Ruminal proteases, Surfactants, Cellulose degradation

**1245 Protein value of wet brewers grain for dairy cattle.** A. M. van Vuuren\*<sup>1</sup>, A. Klop<sup>1</sup>, G.A.L. Meijer<sup>1</sup>, J. Kogut<sup>1</sup>, and E. de Koning<sup>2</sup>, <sup>1</sup>ID-Lelystad, <sup>2</sup>Bonda's Veevoederbureau, Hillegom, The Netherlands.

Fluxes of amino acids in the portal vein suggested that the protein value of wet brewers grain (WBG) is higher than predicted from in situ incubations (van Vuuren et al., 1998, J. Dairy Sci. 81, Suppl. 1: 343). Therefore, we compared the duodenal N fluxes in dairy cows, provided with a ruminal cannula and a duodenal cannula, fed total mixed diets containing either WBG or solvent soybean meal. In a Latin square designed experiment (4 cows x 4 periods), 3 diets were tested: 1) a control diet containing grass silage, corn silage, and a concentrate mixture (26, 40 and 33 % of total DM, respectively); 2) a WBG diet in which 3.5 kg of DM of the control diet was replaced by 4.4 kg of ensiled WBG (DM: 25.3%; CP: 24.2% of DM); 3) a SOY diet in which 3.5 kg of DM of the control diet was replaced by 1.4 kg of solvent soybean meal (CP: 47.4% of DM) and 1.9 kg of soybean hulls. Duodenal fluxes were calculated using Cr-NDF and Co-EDTA as markers. The highest duodenal fluxes of AA N were observed for the WBG diet (Table). The duodenal AA N flux was approximately 60 g higher than for the control and SOY diets. Microbial N fluxes were not different between treatments. For WBG, the calculated value for available protein at the duodenum (DVE; Tamminga et al., 1994, Livest. Prod. Sci. 40:139-155) in vivo was 177 g DVE/kg of DM, whereas the calculated value from in situ results was 92 g DVE/kg of DM. The difference between both estimates could be due to a low rate of rumen degradation of the washout fraction. These observations agree with the portal AA fluxes (van Vuuren, 1998).

Parameter	Diet			SE of difference	P level
	Control	WBG	SOY		
Intake					
OM, kg/d	16.8	18.0	16.9	0.4	0.053
N, g/d	475	561	538	13	0.001
Duodenal flux					
AA N, g/d	330	392	334	16	0.008
Micr. N, g/d	365	358	333	24	0.410
DVE <sup>1</sup> in vivo, g/kg DM	89	177 <sup>2</sup>	100 <sup>2</sup>		
DVE in situ, g/kg DM	84	92	160		

<sup>1</sup>DVE: available protein at duodenum; <sup>2</sup>DVE value for supplemental WBG and solvent soybean meal.

**Key Words:** Wet brewers grain, Protein, Dairy Cattle

**1246 Effect of increasing ruminally degraded protein on ruminal and total tract digestion of nutrients in dairy cows.** K. F. Kalscheur\*<sup>1,2</sup>, B. P. Glenn<sup>2</sup>, R. L. Baldwin VI<sup>2</sup>, and R. A. Kohn<sup>1</sup>, <sup>1</sup>University of Maryland, College Park, <sup>2</sup>USDA, Agricultural Research Service, Beltsville, MD.

The objective of this experiment was to determine the effects of increasing ruminally degraded protein (RDP) on nitrogen metabolism and nutrient digestion in lactating dairy cows. Three ruminally and duodenally cannulated multiparous Holstein cows were assigned one of four diets in a 3 x 4 incomplete Latin square design with 3-wk periods. Diets were formulated to provide four concentrations of RDP (% of DM) while rumen undegraded protein remained constant: 1) 7.3% RDP; 2) 8.8% RDP; 3) 10.3% RDP; and 4) 11.7% RDP. Diets contained 50% corn silage and 50% concentrate (DM basis). Ingredients of the diets were equal across treatments except for the change in ground corn, soybean meal and protected soybean meal (Soypass<sup>®</sup>). DMI increased as dietary RDP increased (18.2 to 19.4 kg/d;  $P < 0.04$ ). Milk yield tended to increase linearly with increasing RDP in the diet (22.3 to 25.9 kg/d;  $P < 0.07$ ). 3.5% FCM (20.7 to 24.4 kg/d;  $P < 0.02$ ), fat yield (0.68 to 0.81 kg/d;  $P < 0.03$ ), protein yield (0.63 to 0.75 kg/d;  $P < 0.04$ ), and milk urea nitrogen (6.8 to 13.3 mg/dl;  $P < 0.007$ ) increased linearly with increasing RDP in the diet. Total N flow to the small intestine increased ( $P < 0.03$ ), nonbacterial N tended to increase ( $P < 0.10$ ), and urinary N increased ( $P < 0.003$ ) linearly as cows were fed an increasing amount of RDP. Bacterial N flow to the duodenum and microbial synthesis were unaffected by treatment. Although bacterial protein synthesis appeared unaffected by treatment, increases in RDP resulted in higher N flow to the small intestine and increased milk yield, fat yield, and protein yield.

	Treatment				SEM	P <sup>1</sup>
	1	2	3	4		
N intake, g/d	383.0	449.6	486.1	553.1	38.4	0.001
Duodenal flow, g/d						
Total N	376.6	417.4	437.8	487.5	65.4	0.03
Nonbacterial N	220.0	255.2	257.0	315.2	45.4	0.10
Bacterial N	156.7	162.2	180.8	172.2	27.8	NS
Bacterial synthesis						
g of N/kg of OMTD	15.7	15.3	17.5	16.7	1.9	NS
Urinary N, g/d	99.2	138.6	167.5	217.2	21.0	0.003
Fecal N, g/d	163.2	164.7	172.1	169.3	23.8	NS
N digestibility, %	57.9	63.0	64.4	69.0	2.1	0.009

<sup>1</sup>Linear effect.

**Key Words:** Ruminally degraded protein, ruminal nitrogen metabolism

**1247 Influence of ruminally degradable carbohydrates and nitrogen on microbial crude protein supply and N efficiency of lactating Holstein cows.** R.A. Sannes\*<sup>1</sup>, D.B. Vagnoni<sup>2</sup>, and M.A. Messman<sup>2</sup>, <sup>1</sup>Utah State University, Logan, <sup>2</sup>Cargill Animal Nutrition Center, Elk River, MN.

Sixteen multiparous lactating Holstein cows (4 with rumen cannulae) were fed diets varying in the content of ruminally degradable carbohydrates and N to examine dietary effects on microbial CP flow, whole animal N efficiency, and to evaluate the model of Jonker et al. (J. Dairy Sci. 81:2681) for predicting urinary N excretion and N efficiency from milk urea N concentrations. A replicated Latin square design (consisting of diet and experimental period) was employed. The four diets consisted of a low protein diet with 20% ground corn (LP corn), LP with 3% sucrose (LP sucrose), a high protein diet containing 3% sucrose and 0.8% urea (HP urea), and a high protein diet containing 3% sucrose and 5.4% soybean meal (HP SBM). Dietary means were separated using 3 single df contrasts to evaluate carbohydrate source (LP corn vs LP sucrose), CP level (LP sucrose vs HP urea and HP SBM) and CP source (HP urea vs HP SBM). The intakes of DM and N were increased (P < .05) by increasing dietary CP level. However, the yields of milk and milk protein were not affected (P > .2) by CP level. Microbial CP flow was reduced (P = .03) by sucrose and was increased (P = .03) by CP level. There was no effect (P > .18) of CP source on DM intake, milk yield, or microbial CP flow. Urinary N excretion (mean = 252 g/d) was underestimated (P < .01) by 55 g/d using the equations of Jonker et al. and was overestimated (P = .02) by 25 g/d using a modified equation of Kauffman and St-Pierre (J. Dairy Sci. 82 (Suppl. 1): 95). Nitrogen efficiency (mean = 22.4%) was underestimated (P < .01) by 7.5% and 3.2% using the equations of Jonker et al. and Kauffman and St-Pierre, respectively. The magnitude of the error of these predictions using the latter equations (10% and 14% for urinary N excretion and N efficiency, respectively) suggest that milk urea N is a useful tool for evaluating N losses and N efficiency in lactating Holsteins.

**Key Words:** Dairy Cattle, Milk Urea Nitrogen, Dietary Carbohydrate

**1248 Effect of each amino acid on growth efficiency of ruminal bacteria.** H. Kajikawa\*<sup>1</sup>, <sup>1</sup>National Institute of Animal Industry, Tsukuba, Japan.

Estimation of microbial synthesis in the rumen is a crucial factor for the absorbed protein system. Ruminal bacteria can grow with NPN as sole N source, but their growth efficiency is known to be improved in the presence of amino acids. This study was done to investigate effect of each amino acid on the growth rate and efficiency of mixed ruminal bacteria since the effect has not been well clarified yet. Ruminal bacteria were harvested from the mixture of solid and fluid portions taken from a ruminally fistulated Holstein cow having timothy hay at maintenance level. Protozoa were removed by centrifugation. After washed once with Na-K phosphate buffer, the bacterial cells were anaerobically and isonitrogenously (100 mgN/L) incubated with glucose, xylose and cellobiose (4, 4 and 2 mM, respectively). Amino acid-N was replaced with 25% (=25 mgN/L) of nitrogen in the control treatment which had ammonium-N as sole N source. Growth efficiency was estimated from ratio of cell protein increased to amount of sugars consumed at exponentially growing stage. Sugars were analyzed by a capillary electrophoresis. Growth rate and efficiency were significantly improved in the presence of twenty amino acids in equal amounts, but no specific sole amino acid improved them. When whole amino acids lacking only one amino acid were added, the

improvement of growth rate and efficiency was suppressed in the absence of tryptophane, tyrosine, glutamate or methionine. Isoleucine had an inhibitory effect on bacterial growth rate and efficiency. Growth rate and efficiency were highly correlated with each other, which suggesting that ratio of energy consumed for maintenance and growth would be the decisive factor for the efficiency.

**Key Words:** Ruminal bacteria, Growth efficiency, Amino acid

**1249 Effect of feeding protein supplements with differing ruminal degradabilities on milk production and rumen metabolites in dairy cows.** S. M. Reynal\*<sup>1</sup>, G. A. Broderick<sup>2</sup>, and S. Ahvenjarvi<sup>3</sup>, <sup>1</sup>University of Wisconsin, Madison, <sup>2</sup>U.S. Dairy Forage Research Center, Madison, WI, <sup>3</sup>Agricultural Research Center of Finland, Jokioinen.

Nineteen multiparous and 6 primiparous (ten ruminally fistulated) Holstein cows in early-mid lactation (82 ± 34 DIM) were assigned to 5x5 Latin squares (21-d periods) and fed diets with different protein supplements to determine the effect of ruminal protein degradation on milk production and composition and on rumen variables. Total mixed rations were (DM basis): 43.5% corn silage, 22% alfalfa silage, 2% urea, and 31% concentrate (protein supplement plus rolled high moisture shelled corn, RHMSC). Diets were: Control (31% RHMSC); SSBM (22% RHMSC, 9% solvent soybean meal); ESBM [21% RHMSC, 10% expeller soybean meal (Soy Plus<sup>®</sup>)], BM (25.5% RHMSC, 5.5% blood meal); and CGM (24% RHMSC, 7% corn gluten meal). Crude protein content of the diets was, respectively, 15.7, 19.1, 19.7, 20.3 and 19.3%. Rates and extents of ruminal protein degradation, estimated by the inhibitor in vitro method, were 0.17, 0.04, 0.01 and 0.01/h and 74, 42, 15 and 14% of total CP, for SSBM, ESBM, BM and CGM, respectively. Rumen and omasal samples also were collected to determine the rates and extents of protein degradation in vivo. Yield of milk and milk components and DMI all were increased compared to the Control. Milk yield was higher for cows fed ESBM and CGM, milk fat yield was higher on SSBM and CGM, but milk protein yield was not significantly different among cows fed SSBM, ESBM, BM and CGM. Digestibility of NDF was higher on SSBM and BM.

Item	Control	SSBM	ESBM	BM	CGM	SEM
DMI, kg/d	21.7 <sup>a</sup>	23.5 <sup>bc</sup>	23.8 <sup>c</sup>	22.8 <sup>b</sup>	23.6 <sup>bc</sup>	0.6
BW gain, kg/d	0.39 <sup>ab</sup>	0.55 <sup>ab</sup>	0.16 <sup>a</sup>	0.59 <sup>b</sup>	0.36 <sup>ab</sup>	0.15
Milk Yield, kg/d	32.9 <sup>a</sup>	36.5 <sup>b</sup>	37.9 <sup>c</sup>	37.7 <sup>bc</sup>	38.5 <sup>c</sup>	1.2
Milk fat, kg/d	1.18 <sup>a</sup>	1.36 <sup>b</sup>	1.28 <sup>c</sup>	1.28 <sup>c</sup>	1.35 <sup>bc</sup>	0.04
Milk protein, kg/d	0.95 <sup>a</sup>	1.11 <sup>b</sup>	1.11 <sup>b</sup>	1.10 <sup>b</sup>	1.14 <sup>b</sup>	0.03
Rumen pH	6.18 <sup>a</sup>	6.09 <sup>ab</sup>	6.16 <sup>a</sup>	6.00 <sup>b</sup>	6.16 <sup>a</sup>	0.05
Rumen NH <sub>3</sub> , mM	8.0 <sup>a</sup>	11.2 <sup>b</sup>	10.3 <sup>bc</sup>	9.9 <sup>c</sup>	9.1 <sup>ac</sup>	0.4
Rumen TAA, mM	3.11	3.47	2.98	3.20	2.81	0.25
NDF intake, kg/d	6.25 <sup>a</sup>	6.71 <sup>bc</sup>	6.89 <sup>c</sup>	6.54 <sup>b</sup>	6.58 <sup>b</sup>	0.16
NDF digestibility, %	40.9 <sup>a</sup>	48.2 <sup>b</sup>	43.7 <sup>a</sup>	45.8 <sup>b</sup>	43.9 <sup>a</sup>	1.2

<sup>a,b,c</sup>Means with different superscripts differ (P<0.05). NH<sub>3</sub>= Ammonia, TAA= Total Amino Acids

**Key Words:** Dairy cows, Ruminal protein degradation, Protein supplements

**1250 Effects of diet protein level and abomasal amino acid infusion on phenylalanine and tyrosine metabolism in lactating dairy cows.** C. K. Reynolds\*<sup>1</sup>, L. A. Crompton<sup>1</sup>, B. J. Bequette<sup>2</sup>, J. France<sup>1</sup>, D. E. Beever<sup>1</sup>, and J. C. MacRae<sup>2</sup>, <sup>1</sup>University of Reading, UK, <sup>2</sup>Rovett Research Institute, Aberdeen, UK.

The objective was to measure effects of diet protein level and abomasal amino acid infusion on kinetic transfer of Phe and Tyr across splanchnic tissues in 6 multiparous, catheterized, rumen cannulated, mid-lactation Holstein x Friesian cows (667 kg BW). Measurements were made on the last day of 4-d abomasal water (18 L/d) and 6-d abomasal essential amino acid (EAA equal to 800 g milk protein/d) infusions. Cows were fed one of 2 concentrates (109 g [LO] or 203 g [HI] crude protein/kg DM) in a split-plot design with 5-wk periods. Dehydrated lucerne, grass silage and concentrate (330, 170 and 500 g/kg DM, respectively) were fed hourly at 95 % of ad libitum DMI. 1-<sup>13</sup>C-Phe and <sup>2</sup>H<sub>4</sub>-Tyr were infused into a jugular vein beginning 3.5 h before hourly measurements (4) of portal-drained viscera (PDV) and liver (LIV) blood flow and kinetic

flux (mmol/h) of Phe, Tyr and CO<sub>2</sub> were obtained. Intake of DM was lower ( $P < 0.04$ ) for LO (21.5 vs. 22.4 kg/d), but milk yield was not affected (30.3 kg/d,  $P > 0.11$ ). Body irreversible loss of Phe (48 vs. 63) and Tyr (38 vs. 43) and Phe hydroxylation (2.5 vs. 5.0) were increased ( $P < 0.01$ ) by E800. Gross PDV Phe uptake was increased ( $P < 0.02$ ) by HI (12 vs. 14) and E800 (11 vs. 15). Gross PDV Phe release was increased by E800 (44 vs. 63,  $P < 0.01$ ) and tended to increase for HI (51 vs. 57,  $P < 0.10$ ). There was no measurable PDV Phe oxidation or hydroxylation. Gross LIV Phe uptake (35 vs. 50) and oxidation (15 vs. 27) were increased ( $P < 0.01$ ) by E800, whilst LIV Phe hydroxylation ( $P < 0.03$ ) was increased by E800 for LO (1.7 vs. 4.0) and decreased by E800 for HI (7.2 vs. 4.4). Gross LIV Phe release (12) was not affected ( $P > 0.73$ ). Gross Tyr uptake (10 and 29) and release (37 and 12) by PDV and LIV, respectively were not affected ( $P > 0.08$ ). Increased gross PDV release of Phe accounted for 99 % of Phe in E800, whilst on a net basis the recovery was 77 %. This illustrates the extent to which net PDV flux underestimated Phe absorption and suggests little loss of Phe during absorption.

**Key Words:** Splanchnic, Cows, Phenylalanine

**1251 Effects of diet protein level and abomasal amino acid infusions on splanchnic metabolism in lactating dairy cows.** C. K. Reynolds<sup>\*1</sup>, B. Lupoli<sup>1</sup>, P. C. Aikman<sup>1</sup>, J. A. Benson<sup>1</sup>, D. J. Humphries<sup>1</sup>, L. A. Crompton<sup>1</sup>, J. France<sup>1</sup>, D. E. Beever<sup>1</sup>, and J. C. MacRae<sup>2</sup>, <sup>1</sup>University of Reading, UK, <sup>2</sup>Rowett Research Institute, Aberdeen, UK.

The objective was to measure effects of diet protein level and abomasal amino acid infusion on splanchnic metabolism in 6 multiparous, catheterized, rumen cannulated, mid-lactation Holstein x Friesian cows (667 kg BW) fed one of 2 concentrates (109 [LO] or 203 [HI] g crude protein/kg DM). Cows received 4-d abomasal infusions (18 L/d) of water followed by essential amino acids (EAA) equal to 800 g milk protein/d for 6 d in a switch-back experiment with 5-wk periods. Dehydrated lucerne, grass silage and concentrates (33, 17 and 50 %, respectively, on a DM basis) were fed hourly at 95 % of ad libitum DMI. Hourly measurements (6) of splanchnic (portal-drained viscera [PDV] and liver [LIV]) blood flow and net nutrient flux (mmol/h) were obtained on the last day of water and treatment infusions. Intake of DM was decreased ( $P < 0.04$ ) by LO (21.5 vs. 22.4 kg/d), but milk yield was not affected (30.3 kg/d,  $P < 0.11$ ). Milk protein (g/kg) was increased ( $P < 0.01$ ) by EAA (35.4 vs. 36.3). Blood flow for PDV and LIV (1897 and 2377 L/h, respectively) were not affected by diet ( $P > 0.12$ ) or EAA ( $P > 0.06$ ). Net PDV release of ammonia was increased by HI (636 vs. 770,  $P < 0.01$ ). Net LIV release of acetate was decreased by EAA (1055 vs. 391,  $P < 0.02$ ). Net LIV removal of ammonia (663 vs. 824,  $P < 0.02$ ) and release of urea (390 vs. 575,  $P < 0.04$ ) were increased by HI. Infusion of EAA increased net PDV release of total EAA (265 vs. 327,  $P < 0.03$ ). The recovery of infused EAA as increased net PDV release averaged 48 % and ranged from 16 (Val) to 83 (Arg) %. Increased splanchnic release was 6 (LO) and 35 (HI) % of total EAA infused. Net PDV release (308 vs. 344) and LIV removal (217 vs. 261) of total nonessential amino acids (NEAA) was increased by HI ( $P < 0.05$ ). The net recovery of infused EAA as increased PDV release was not affected by diet protein level and was relatively low, but net flux does not account for increased EAA removal from arterial blood.

**Key Words:** Splanchnic, Cows, Amino acids

**1252 Splanchnic metabolism of gut peptides in dairy cows abomasally infused with long chain fatty acids at two stages of lactation.** J. A. Benson<sup>\*</sup> and C. K. Reynolds, University of Reading, UK.

Effects of a 7 d abomasal infusion of long chain unsaturated fatty acids (LCFA) on arterial concentration (pmol/ml) and splanchnic metabolism (portal-drained viscera [PDV] and liver [LIV]; nmol/h) of hormones were measured in 6 Holstein x Friesian cows (673 kg BW) at a mean of 55 (ELAC) and 100 (MLAC) d lactation. Pancreatic glucagon (PAN), gut glucagon (GUT), glucagon-like peptide-1 (7-36) amide (GLP-1) and cholecystokinin-8 (CCK) were measured by RIA. Daily DMI was decreased by LCFA (22.8 vs 21.5 kg/d,  $P < 0.01$ ) but was unchanged between lactation stage ( $P > 0.6$ ). Milk yield was unaffected by LCFA infusion ( $P > 0.13$ ) but was greater in ELAC (40.0 vs 35.1 kg/d,  $P < 0.01$ ). Arterial PAN concentration was greater in MLAC (0.113 vs 0.090,  $P < 0.01$ ), the result of increased PDV PAN release (38.8 vs 28.3,  $P <$

0.04) and reduced LIV PAN uptake (5.8 vs 11.1,  $P < 0.07$ ) in MLAC. Arterial concentration and PDV PAN release were unaffected ( $P > 0.2$ ) by LCFA but LIV uptake of PAN was increased (11.6 vs 5.3,  $P < 0.03$ ). Neither PDV or LIV GUT metabolism was affected by LCFA or stage of lactation ( $P > 0.23$ ) but arterial concentration (0.36 vs 0.30,  $P < 0.09$ ) and total splanchnic (TSP) output (42.7 vs 24.9,  $P < 0.10$ ) of GUT were increased by LCFA. Arterial concentration (0.057 vs 0.051,  $P < 0.01$ ) and PDV release (5.6 vs 2.8,  $P < 0.03$ ) of GLP-1 were also increased by LCFA. There was no significant net GLP-1 flux across LIV but periods of uptake or release were evident. Arterial concentration (0.057 vs 0.052,  $P < 0.02$ ) and TSP release (6.5 vs 4.7,  $P < 0.1$ ) of GLP-1 were greater in ELAC. Arterial CCK concentration was greater in ELAC (0.025 vs 0.019,  $P < 0.01$ ) due to less LIV CCK uptake (1.2 vs 5.3,  $P < 0.1$ ). Net TSP release and arterial CCK concentration were unaffected by LCFA infusion ( $P > 0.31$ ). The results show the liver's important role in determining circulating hormone concentrations and suggest unsaturated fatty acids stimulate the release of GUT and GLP-1 by splanchnic tissues, but not CCK.

**Key Words:** Gut peptides, Splanchnic, Fatty acids

**1253 Evaluation of Molly, a dynamic, metabolic model of a dairy cow for predicting milk production.** H.A. Johnson<sup>\*</sup>, R.L. Baldwin, and D. Meyer, University of California, Davis.

Data from 3 cows in a nitrogen (N) balance study were used to evaluate estimates of N intake and excretion by MOLLY. MOLLY is a dynamic, mechanistic model of dairy cow metabolism and digestion written in the advanced continuous simulation language (ACSL). Cows were fed two diets in a crossover design. The first diet was 21.7% beet pulp, 18.3% whole cottonseed, 13.3% rolled barley, 10.3% molasses, 8.4% almond hulls, 3.3% soybean meal 3% mineral mix 1.7% fat and 20% flaked corn. Diet 2 was the same except flaked corn was replaced with rolled corn. Cows were adjusted to the diets for 7 days and then feed intake, milk production and total urine and feces data were collected for 5 days for a total of two collection periods per cow (one for each diet). The model was calibrated to replicate total milk and total N intake for each cow for the first 5 day period. Then the model was used to predict N excretion in the first and second periods. Average N intake of observed data were 0.541 kg/d (SE=0.030) and average N excretion of observed data were 0.206 kg/d in urine (SE=0.013), 0.201 kg/d in feces (SE=0.016) and 0.143 kg/d in milk (SE=0.0063). Predicted parameters were regressed on observed data to determine correlation coefficients for an index of goodness of fit of model predictions to the data. The model was able to predict N excretion in urine ( $R^2$ )=0.70, mean bias=0.015 kg/d) and milk ( $R^2$ )=0.75, mean bias=-0.0080 kg/d) but over predicted N in feces ( $R^2$ )=0.22, mean bias=0.015 kg/d).

**Key Words:** Nitrogen Balance, Model Evaluation, Metabolic Dairy Cow Model

**1254 Effect of duodenal infusion of  $\alpha$ -ketoglutarate ( $\alpha$ -KG) on nitrogen metabolism of dairy cows.** F. Rossi<sup>1</sup>, L. Fiorentini<sup>1</sup>, H.G. Jungvid<sup>2</sup>, and G. Piva<sup>\*1</sup>, <sup>1</sup>Istituto di Scienze degli Alimenti e della Nutrizione, Facoltà di Agraria, Piacenza, Italy, <sup>2</sup>Gramineer International AB, Lund, Sweden.

Two dry Friesian cows were duodenally infused alternatively with: sterile water (control);  $\alpha$ -KG (60g/d); lysine (27.6 g/d) plus methionine (9.20 g/d). The animal received a diet made up with (as fed): grass hay 7 kg, corn silage 5 kg, barley straw 2 kg.  $\alpha$ -KG was prepared as stock solution (100 ml of water, 30 g of  $\alpha$ -KG, 9.6 g of NaOH) and given as a 5% water solution continuously infused for 9 hours. Blood samples were taken every hours starting before morning meal and analyzed for urea, glucose and amino acids content. Compared to control the infusion of  $\alpha$ -KG reduces the amino acids catabolism as indicated by the lowering of the average urea plasma level (-24.7%,  $P < .01$ ), the effect is similar to the one obtained when infusing lysine and methionine (- 21.7%,  $P < .01$ ), suggesting that  $\alpha$ -KG supplementation can improve the amino acids balance. No effect was detected on the glucose level, probably due to the strong homeostatic regulation of this parameter. By infusing  $\alpha$ -KG the plasma EAA concentration was increased (22.4%) 6 hours from feeding compared to the 0 hour sample, whereas there was a decrease of the ratio (9.1%) when infusing distilled water. The plasma EAA concentration was also increased when infusing lys+met (30%). The increments of the single amino acids 6 hours after the infusion were higher, compared to the control, either when infusing  $\alpha$ -KG or lys+met. When  $\alpha$ -KG was

administered the major increments were observed for Thr (35.9%), Lys (31.0%). Arginine concentration also increased (15.7%) probably because it is a precursor of urea. When infusing  $\alpha$ -KG there is a decrease of urea excretion and, as the arginine is involved in the urea cycle, this could reduce the need for the amino acid. The increased lysine and threonine plasma concentrations could partially be accounted for by a reduction of amino acids catabolism.

**Key Words:** Cow, Urea,  $\alpha$ -ketoglutarate

**1255 Estimating the undegradability of intake protein using duodenal flows: a literature study.** R. A. Patton\*<sup>1</sup> and M. J. Stevenson<sup>2</sup>, <sup>1</sup>Nittany Dairy Nutrition, Mifflinburg, PA, <sup>2</sup>Degussa Hüls Canada, Burlington, ON, Canada.

The amount of protein that escapes rumen degradation and is delivered to the intestine for absorption is important if amino acids are to be accurately evaluated in dairy cattle diets. One way to estimate the UIP of feedstuffs is to measure the amount of feed protein flowing to the duodenum and then back calculate the degradability of each protein. We reviewed 44 studies representing 177 diets (104 lactating dairy cow and 73 growing beef cattle diets) in which feed intake and duodenal flow of dietary and microbial protein were reported. We assumed feedstuff UIP values were relative and computed a diet UIP factor (=measured duodenal feed protein / UIP calculated from standard values). Degradability estimate=standard UIP %CP \* diet UIP factor. Mean UIP predictions are presented, as reported and corrected for endogenous protein flow. All degradability estimates had high SE. Degradability of the diet was unrelated to DMI or DMI as a % of BW. Steer diets had significantly lower undegradability factors (1.00 and 0.64) than dairy diets (1.50 and 1.34) for unadjusted and adjusted factors respectively (P<.10 and P<.01). Adjusted UIP estimates were slightly greater than those in the Mepron model. Although SE is high, this work generally supports published UIP values.

Feed	No	Std Estimate		Corrected		
		UIP	Estimate	SE	UIP	SE
Alfalfa hay	62	28	35.4	11.9	30.1	11.6
Alfalfa silage	45	23	28.9	8.2	26.3	8.0
Grass hay	15	30	39.1	12.5	36.4	11.8
Corn silage	91	30	45.4	11.3	39.9	11.7
Grd shell corn	86	50	71.7	20.9	61.7	22.4
Cracked corn	25	55	64.1	19.8	54.8	21.4
Corn glut meal	19	65	74.3	20.3	65.4	20.2
Blood meal	28	80	108.7	32.7	98.5	32.8
Canola meal	10	30	32.1	6.0	27.9	7.2
Fish meal	18	60	81.3	21.0	73.4	21.5
Soybean ml 48	95	30	42.7	12.0	37.5	11.9
Raw soybean	6	25	47.0	5.6	42.1	7.7
Roast soybean	12	50	47.2	16.5	38.5	5.9
Whole cotton	18	40	54.3	19.3	43.9	18.3

**Key Words:** rumen undegradable protein, feed degradability, DMI

**1256 Molecular cloning, in vitro expression, and functional characterization of an ovine gastrointestinal peptide transporter (oPepT1).** Y. Pan\*, E. A. Wong, J. R. Bloomquist, and K. E. Webb, Jr., Virginia Tech, Blacksburg.

We have determined the primary structure, tissue distribution, and in vitro functional characteristics of a peptide transporter, oPepT1, from ovine intestine. The ovine intestinal oPepT1 cDNA was 2,829 bp long encoding a protein of 707 amino acid residues with an estimated molecular size of 79 kDa, and a pI of 6.57. The cDNA contained a 79-bp 5' untranslated sequence and a 630-bp 3' untranslated sequence. The proposed oPepT1 protein was 77.9, 81.3, and 82.6 percent identical to PepT1 from rabbit, rat, and human, respectively. High stringency northern blot analysis demonstrated that oPepT1 is expressed strongly in the small intestine, at lower levels in the omasum, and at much lower levels in the rumen, and is not expressed in liver or kidney. The presence of the peptide transporter in the forestomach at such levels could provide amino acid nitrogen in the form of short peptides for the ruminant in a nutritionally significant manner. Transport function of oPepT1 was assessed by expressing oPepT1 in *Xenopus* oocytes using a two-electrode voltage-clamp technique. Overall, the in vitro transport characteristics of oPepT1 expressed in oocytes were similar to those of PepT1 from

other species. The transport process is electrogenic and pH-dependent, but independent of Na<sup>+</sup>, Cl<sup>-</sup>, and Ca<sup>2+</sup>. It displayed a broad substrate specificity that transported neutral and charged dipeptides and tripeptides. All dipeptides (10) and tripeptides (4) examined evoked inward currents in a saturable manner, with an affinity constant (K<sub>t</sub>) ranging from 20 mM to 3.0 mM for peptides. No responses were detected from tetrapeptides (4) or free amino acids.

**Key Words:** Peptide, Transport, Sheep

**1257 Transport of peptides in CHO cells expressing the cloned ovine gastrointestinal peptide transporter (oPepT1).** H. Chen, Y. Pan, E. A. Wong, J. R. Bloomquist, and K. E. Webb, Jr., Virginia Tech, Blacksburg.

Chinese hamster ovary cells (CHO) expressing our cloned ovine gastrointestinal peptide transporter (oPepT1) were used to investigate oPepT1-mediated absorption of peptides in mammalian cells. The CHO cells were transfected with an expression vector containing the oPepT1 cDNA. Transport was assessed by uptake studies using the radiolabeled dipeptide, [<sup>3</sup>H]-Gly-Sar. Expression of oPepT1 was detected by 8 h post-transfection with maximum expression occurring by 16 h. Uptake of [<sup>3</sup>H]-Gly-Sar showed that the transport process is pH-dependent with an optimal pH of 5.5. Gly-Sar uptake is also concentration-dependent and saturable with an apparent K<sub>m</sub> of 3.8±0.8 mM and a maximum velocity of 1,350 pmol · 2x10<sup>5</sup> cells<sup>-1</sup> · 20 min<sup>-1</sup>. These results were similar with those obtained from *Xenopus* oocytes expressing oPepT1. Competition studies with three non-radiolabeled dipeptides (Met-Gly, Met-Met, and Lys-Lys) and two non-radiolabeled tripeptides (Leu-Gly-Gly and Lys-Trp-Lys) with [<sup>3</sup>H]-Gly-Sar showed that all these peptides inhibited the uptake of [<sup>3</sup>H]-Gly-Sar. Substrate affinities of these peptides were similar to those observed in *Xenopus* oocytes expressing oPepT1. In addition, two tetrapeptides (Met-Gly-Met-Met and Pro-Phe-Gly-Lys) inhibited the uptake of [<sup>3</sup>H]-Gly-Sar, whereas these two tetrapeptides were not transported in oocytes expressing oPepT1. The reason for this difference is under investigation. There was no inhibition of [<sup>3</sup>H]-Gly-Sar uptake when non-radiolabeled free amino acids were used as a competitor.

**Key Words:** Peptide, Transport, CHO

**1258 Determination of enzyme secretion from bovine pancreas using an in vitro tissue model.** K. C. Swanson\*, J. C. Matthews, C. J. Richards, and D. L. Harmon, University of Kentucky, Lexington.

An in vitro pancreatic tissue model was developed to evaluate the relative sensitivity of bovine pancreatic tissue to neurohormonal mimics and substrates. Steers (150 to 200 kg BW) fed a hay-based diet were overdosed on sodium pentobarbital and the pancreata removed and rinsed with and transported to the lab in ice-cold saline (.9% NaCl). A portion from the central region was cut into small pieces (approximately 2 × 2 mm) with scissors in ice-cold Krebs's Ringer Bicarbonate buffer (KRB). Tissue pieces (100 to 200 mg) were incubated in capped 25-mL flasks containing 3 mL of oxygenated KRB in a 39C shaking water bath. After incubation, flasks were placed on ice and the buffer removed and stored at -30C until analysis for  $\alpha$ -amylase and trypsin (after activation with 200 U/L enterokinase) activities. Preliminary experiments indicated that secretion of  $\alpha$ -amylase increases (P<.01) linearly with incubation time from 30 to 180 min. Tissues were challenged for 60 min, following a 60-min pre-incubation (in the presence of substrates), with control (KRB), 100 nM caerulein (CCK mimic), or 10  $\mu$ M carbachol (acetylcholine analog) to determine if substrate addition interacts with neurohormonal challenge to influence  $\alpha$ -amylase and trypsinogen secretion (experiment replicated 3 times). Substrate treatments were: 1) control (no additions), 2) 3.3 mM glucose and 5 mU insulin, 3) minimal essential amino acid mixture (Gibco), .26 mM glutamine, and 5 mU insulin, and 4) VFA (2 mM acetate, .5 mM propionate, .2 mM isobutyrate, .4 mM butyrate, .05 mM 2-methyl butyrate, .10 mM 3-methyl butyrate, and .15 mM valerate).  $\alpha$ -Amylase and trypsin secretion increased (P<.01) with caerulein and carbachol challenge. Trypsin secretion increased (P<.06) when amino acids or VFA were included as a substrate. These data indicate that pancreatic tissue prepared as described will respond to neurohormonal or substrate challenge. This procedure may prove useful for evaluating factors mediating nutritional adaptation of pancreatic enzyme secretion in cattle.

**Key Words:** pancreas, in vitro, bovine

**1259 Estimating the uptake of circulating free and peptide-bound Methionine and Leucine by the udder of goats at two stages of lactation.** S. J. Mabweesh<sup>\*1</sup>, C. E. Kyle<sup>2</sup>, J. C. MacRae<sup>2</sup>, and B. J. Bequette<sup>2</sup>, <sup>1</sup>Hebrew University of Jerusalem, Israel, <sup>2</sup>Rowett Research Institute, Scotland.

An arterio-venous (A-V) kinetic technique was used to monitor mammary amino acid (AA) metabolism in goats (n=4) at two stages of lactation (80 ± 17 vs. 233 ± 14 DIM) in response to an i.v. infusion of Lys plus Met. At both stages, [5-<sup>13</sup>CH<sub>3</sub>]Met and [5,5,5-<sup>2</sup>H]Leu A-V kinetics were performed on the last day of 5-d i.v. infusions of saline followed by Lys (9 g/d) plus Met (2 g/d; LM). At both stages of lactation, there was sufficient net uptake of blood free Met and Leu by the udder to account for their secretion in milk. It was estimated from isotope dilution, however, that circulating peptides contributed 8 and 17% of Met and 12 and 27% of Leu used for casein synthesis in early vs. late lactation, respectively. And, for both AA, the contribution of peptides was highest ( $P < 0.001$ ) in late lactation. Thus, when both free AA and peptides are considered, there appears to be considerable excess (up to 65%) uptake by the udder of Met and Leu. Depending upon treatment and stage of lactation, net uptake of free AA from blood differed ( $P < 0.05$ ) from plasma for Met, Lys and Thr. And, for Ala and Lys, the ratio of mammary net uptake to output in milk was higher ( $P < 0.05$ ) in late lactation. These data provide the first systematic comparisons of circulating free AA and peptide removals by the udder of goats at different stages of lactation.

**Key Words:** mammary gland, amino acid, peptide

**1260 Effect of ruminally protected betaine on the productivity of Angora goats.** T. Shenkoru<sup>\*1</sup>, F.N. Owens<sup>2</sup>, R. Puchala<sup>1</sup>, T. Sahlul<sup>1</sup>, and E. Virtanen<sup>3</sup>, <sup>1</sup>E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, <sup>2</sup>Animal Science Department, Oklahoma State University, Stillwater, <sup>3</sup>Cultor, Helsinki, Finland.

Twenty-five Angora wethers (20 ± 2 kg initial BW and 7 mo of age) were used to evaluate effects of ruminally protected betaine (PB) on ADG, ruminal fermentation endproducts, and mohair quality and production. Animals were randomly allocated to five treatments and had ad libitum access to a 53% concentrate diet (15% CP) for 90 d beginning in September. Treatments were no added betaine (C), 6 g/d of unprotected betaine (UPB), and 2, 4, and 6 g/d of PB (2PB, 4PB, and 6PB, respectively). In a separate experiment, ruminal disappearance of UPB was complete at 2 h of incubation and total tract digestibility of PB was 76%. Dry matter intake and feed efficiency were similar among treatments ( $P > .10$ ). Average daily gain was greatest ( $P < .06$ ) among treatments for 6PB (45, 46, 29, 56, and 82 g/d for C, UPB, 2PB, 4PB, and 6PB, respectively; SE = 8.8). No differences were observed in greasy and clean fleece weights ( $P > .10$ ). There was a treatment x 4-wk period interaction in mohair length. Mohair length at first harvest in October was similar among treatments. In November length was greater ( $P < .02$ ) for 6PB than for C and UPB (25, 25, 27, 28, and 29 mm; SE = .06); whereas, December mohair tended ( $P < .06$ ) to be longer for 6PB than for C and UPB (21, 21, 21, 24, and 26 mm for C, UPB, 2PB, 4PB, and 6PB, respectively; SE = .07). Ruminal concentration of total VFA and the acetate to propionate ratio were similar among treatments ( $P > .10$ ). In conclusion, these results suggest that dietary supplementation with 6 g/d ruminally protected betaine may enhance ADG and mohair length of Angora goats.

**Key Words:** Betaine, Mohair, Angora goats

**1261 Influence of raw and dry roasted whole lupin seeds (*lupinus angustifolius*) and whole faba beans (*vicia faba*) as protein supplements on performance of growing lambs.** P. Yu<sup>\*</sup>, B.L. Leury, M. Sprague, L. Boon-ek, and A.R. Egan, University of Melbourne, Australia.

Forty second-cross growing female lambs ([Border Leicester (M) × Merino (F)] → F1 (F) × Poll Dorset (M)); 6 months; 34.9 ± 2.1 kg liveweight) were used to study the effects of dry roasting of whole lupin seeds (WLS) and whole faba beans (WFB) on performance and carcass quality. Lambs were fed a fixed quantity of oaten and lucerne chaff plus a daily supplement of either: (1) no legume seeds; (2) raw WLS; (3) roasted WLS; (4) raw WFB; (5) roasted WFB. Seeds were dry roasted at 150°C for 45 min. All diets were isonitrogenous (15.9% CP). Diets in

supplement group, about 55% of protein was supplied by WLS or WFB protein. Diets with roasted seeds and diets with raw seeds were isoen-ergetic. Supplementation improved lambs performance: ADG ( $p < 0.05$ ) and gain:feed ratio ( $p < 0.05$ ) and the effect was greater in the lambs fed WFB than that fed WLS. The major reasons could be attributed to different intakes on the net truly absorbable protein in the small intestine (DVE), ME and/or absorbable bypass starch (ABSt). Dry roasting of WLS and WFB tended to increase ADG ( $p < 0.1$ ) and gain:feed ratio ( $p < 0.1$ ) of lambs fed moderate quality roughage and this effect seemed to be mainly mediated through a decrease in ruminal CP and/or starch degradability of the roasted seeds and increased intestinally absorbed protein (DVE values) and starch (ABSt). The predicted live-weight changes ( $\Delta W$ ) from known intakes of DM and ME were all higher than the observed ADG. This could be because supplies of the truly absorbed intestinal protein in diets (total DVE intakes) did not meet predicted requirements for support of the predicted/target  $\Delta W$  values. However, in terms of the purpose in this study, which was not to obtain a maximum growth rate but to detect effectiveness of dry roasting on animal performance, probable limiting in DVE supplies might play an important role in detecting the effectiveness of dry roasting on animal performance.

**Key Words:** Lamb Performance, Legume Seeds, Dry Roasting

**1262 Using the DVE/OEB model to determine optimal conditions of pressure toasting on horse beans (*vicia faba*) for dairy feed industry.** P. Yu<sup>\*</sup>, J.O. Goelema, and S. Tamminga, Department of Animal Nutrition, Wageningen Agricultural University, The Netherlands.

The effects of pressure toasting (100, 118 and 136°C for 3, 7, 15 and 30 min) on potential ruminant protein nutritional values in terms of: a), rumen bypass protein (BCP); b), rumen bypass starch (BSt); c), fermented organic matter (FOM); d), true absorbed BCP (ABCP); e), microbial protein synthesized in the rumen based on available energy (E<sub>MP</sub>); f), microbial protein synthesized in the rumen based on available N (N<sub>MP</sub>); g), true protein supplied to the small intestine (TPSI); h), true absorbed rumen synthesized microbial protein (AMP); i), endogenous protein losses (ENDP); j), true digested protein in the small intestine (DVE); k), degraded protein balance (OEB) of horse beans were evaluated by the new Dutch protein evaluation system: the DVE/OEB model. Pressure toasting significantly increased BCP, BSt, TPSI, ABCP, DVE ( $P < 0.001$ ) and decreased FOM, E<sub>MP</sub>, AMP, N<sub>MP</sub> and OEB ( $P < 0.001$ ) with increasing temperatures and times. The values of BCP, BSt, TPSI, ABCP and DVE at 136°C/15 min were highly increased 3.1, 1.9, 1.7, 3.3 and 1.9 times and the values of FOM, E<sub>MP</sub>, AMP, N<sub>MP</sub> and OEB at 136°C/15 min were greatly decreased by 28.7, 30.9, 29.0, 49.0 and 69.0%, respectively, over the raw horse beans. The OEB values were significantly reduced ( $P < 0.001$ ) but not to the level of negative, which indicated that microbial protein synthesis might not be impaired due to the sufficient N supplied in the rumen, but the high positive OEB values in the most treatments except of 136°C for 15 min (The OEB values: 31.9 g/kg DM) indicated that there were the large amounts of N loss in the rumen. It was concluded that pressure toasting at high temperature was effective in shifting protein degradation from rumen to intestines and it increased the DVE values without reaching the negative OEB values. The treatments of 100°C/7, 15 or 30 min, 118°C/3, 7, 15 or 30 min and 136°C/3 or 7 min were not sufficient to reduce N-loss in the rumen due to the too high OEB values. But pressure toasting at 136°C/15 min might be optimal treatments for horse beans due to its high DVE and very low OEB values.

**Key Words:** DVE/OEB Model, Horse Bean, Pressure Toasting

**1263 Effect of the substitution of safflower meal by chickpeas on organic matter digestibility and digestible energy value of finishing diets for sheep.** R. Barajas<sup>\*</sup>, J.F. Obregon, and A. Estrada, Universidad Autonoma de Sinaloa.

A crossover experiment was conducted to determine the effect of substituting safflower meal with chickpeas on total tract digestibility of organic matter, crude protein, and energy of finishing diets for sheep. Four Pelibuey sheep (30.8 kg) were assigned to dietary treatments: 1) Control: 15.7% CP and 2.81 Mcal DE/kg, containing (DM basis) 30% of safflower meal, 38% ground sorghum grain, 20% alfalfa hay, 10% sugarcane molasses, 0.6% of urea and 1.4% of mineral premix; and 2) Diet similar to control diet but substituting safflower meal with ground chickpeas. The dry matter (DM) and organic matter (OM) intake were not



affected ( $P > 0.60$ ) by treatments. Mean DM intake was 1.04 kg/day (3.38% of initial body weight). Fecal excretion decreased ( $P < 0.01$ ) by 47% for DM (346 vs 183 g/d) and by 50% for OM (314 vs 156 g/d) for the chickpea diet. The inclusion of chickpeas, increased ( $P < 0.01$ ) total tract digestibility of DM (66.8 vs 82.6%) by 23.6%, and total tract digestibility of OM (67.6 vs 83.9%) by 24.1%. Fecal excretion of CP and digestibility of CP were not affected ( $P > 0.10$ ) by treatments. Chickpeas increased ( $P < 0.01$ ) digestible energy content of the diet (2.76 vs 3.54 Mcal/kg) by 28%. Using the reference the value of 84% for true digestibility for safflower meal CP, the true digestibility of CP for chickpeas was 95%. Chickpeas are a better crude protein supplement than safflower meal in finishing diets for sheep.

**Key Words:** Chickpeas, Safflower meal, Sheep

**1264 The substitution of canola meal by chickpeas as protein supplement in finishing diets for sheep: effect on apparent digestibility.** J.F. Obregon\*, R. Barajas, and A. Estrada, *Universidad Autonoma de Sinaloa*.

The objective was to determine the effect of substituting canola meal with chickpeas on total tract digestibility of organic matter, crude protein and energy of finishing diets for sheep. Four Pelibuey sheep (22.5 kg) were used in a digestion trial with a crossover design. The dietary treatments were: 1) Control: 20.4% CP and 3.25 Mcal DE/kg, containing (DM basis) 30% canola meal, 36% ground sorghum grain, 20% alfalfa hay, 12% of sugarcane molasses, 0.6% of urea and 1.4% of mineral premix; and 2) Diet similar to control except substitution of canola meal with ground chickpeas. The dry matter (DM) and organic matter (OM) intake were not affected ( $P > 0.60$ ) by treatments. Mean DM intake was 0.829 kg/d and represented 3.69% of initial weight of sheep. Fecal excretion of DM, OM, and CP decreased ( $P < 0.05$ ) 21% with chickpeas compared to control. Mean values for fecal output of DM, OM, and CP were 176 vs 139 g/d; 150 vs 119 g/d; and 42 vs 33 g/d for control or chickpeas respectively. The inclusion of chickpeas, increased ( $P < 0.01$ ) total tract digestibility of DM by 6.4% (78.23 vs 82.3%); improved total tract digestibility of OM by 6.6% (79.8 vs 85.1%); and enhanced ( $P = 0.02$ ) the apparent crude protein digestibility in diets by 2.2% (76.82 vs 78.47%). The digestible energy content (DE) of the diet increased ( $P < 0.01$ ) by 7.6% with chickpeas (3.35 vs 3.60 Mcal/kg). Taken as reference the value of 88% of true digestibility for canola meal-CP, the true digestibility of CP of chickpeas was 97%, and its value of digestible energy content was calculated as 4.11 Mcal/kg. It is concluded, that chickpeas have a better nutritional value as a crude protein supplement than canola meal in finishing diets for sheep.

**Key Words:** Chickpeas, Canola meal, Sheep

**1265 Nitrogen metabolism of beef steers fed endophyte-free fescue hay: effects of rumen protected methionine supplementation.** S. L. Archibeque\*, J. C. Burns, and G. B. Huntington, *North Carolina State University, Raleigh*.

Level of nitrogen (N) intake and rumen protected methionine supplementation were evaluated in 8 Angus growing steers (initial weight 253  $\bar{n}$  21 kg, final weight 296  $\bar{n}$  21 kg). In a replicated, 4x4 latin square design, the steers were fed two endophyte-free fescue (*Festuca arundinacea*) hays that were either high (HI) (2.8% DM) or low (LO) in N (2.2% DM) and were either supplemented or not with rumen protected methionine<sup>1</sup> (10 g metabolizable methionine/d). Diets were fed to provide adequate energy for 0.5 kg ADG and sufficient protein for maintenance (LO), or 0.5 kg ADG (HI). Following at least 14 d of adjustment, N balance was measured for 6 d. Jugular blood was collected during the balance trial and serum was analyzed for blood urea N (BUN). By design, daily N intake was less ( $P < 0.05$ ) for LO (89 g) than HI (112 g). HI differed from LO ( $P < 0.05$ ) in daily DMI (4217 vs. 4151 g), urine N (48.3 vs. 37.5 g), fecal N (34.4 vs. 31.1 g), N retained (29.8 vs. 21.1 g), N digested (77.1 vs. 57.7 g), and urine urea N excretion (34.6 vs. 24.8 g). HI also differed ( $P < 0.05$ ) from LO in urine urea N concentration (276 vs. 219 mM), BUN (8.7 vs. 6.7 mM), N digestibility (69.1 vs. 64.9%), and percentage of urinary N present as urea (71.5 vs. 66.7%,  $P = 0.053$ ). Methionine supplementation tended to decrease daily urine N (44.6 vs. 41.2 g,  $P = 0.102$ ), and tended to increase both the amount of N retained daily (23.4 vs. 27.5 g,  $P = 0.089$ ) and the percentage of dietary N digested by the steers that was retained (34.6 vs. 40.4%,  $P = 0.094$ ). In summary, supplemental methionine met a specific dietary limitation by

increasing the amount of N retained within the steers by decreasing the amount of N lost in the urine.

**Key Words:** Beef Steers, Forage, Methionine

**1266 Effect of nitrogen source in high-concentrate diets on microbial fermentation in vitro.** M. Devant, A. Ferret\*, S. Calsamiglia, R. Casals, and J. Gasa, *Universitat Autonoma de Barcelona*.

Eight dual-flow continuous culture fermenters (1327 mL) were used in two consecutive periods to study the effects of nitrogen source on microbial fermentation. A 2 x 2 factorial arrangement of treatments was designed. Factors were protein source (soybean meal, S, or a mixture of fish meal and corn gluten meal, FC) and the partial substitution of protein source by urea (without vs with, U). Solid (5.9 %/h) and liquid (9.6 %/h) passage rates, and pH curve (average 6.25) obtained in a previous in vivo study conducted with the same diets were used. Fermenters were maintained at 39 ° C and were fed continuously a 12 to 88 barley straw to concentrate diet (12.3% CP). True OM digestion, total VFA concentration, molar percentage of acetate and ammonia N concentration were, 53, 51, 48, 49%; 183, 169, 152, 169 mM; 45, 40, 38, 41 mol/100 mol; .95, .62, .51, and .63 mg/100 mL, for S, SU, FC, and FCU, respectively. Total VFA concentration ( $P < .01$ ), molar percentage of acetate ( $P < .05$ ) and ammonia N concentration ( $P < .05$ ) were greater in S, followed by SU and FCU, and by FC. A significant protein source x urea interaction in these measurements was detected ( $P < .05$ ). True OM digestion tended to increase ( $P = .13$ ) in treatments containing soybean meal. Results suggest that amino N from soybean meal and ammonia N concentration stimulated nutrient digestion. Microbial protein synthesis was 1.31, 1.63, 1.18 and 1.38 g/d for S, SU, FC, and FCU, respectively. Microbial protein synthesis increased ( $P < .01$ ) in treatments containing soybean meal and urea, indicating that rapidly available N limited microbial growth. Efficiency of microbial protein synthesis was 26, 33, 25, 30 g microbial N/kg OM truly digested for S, SU, FC, and FCU, respectively. Efficiency of microbial protein synthesis increased ( $P < .001$ ) when treatments contained urea. Nitrogen degradability was 42, 54, 34 and 42% for S, SU, FC, and FCU, respectively. The low CP degradability may have limited aa and peptides supply for microbial growth.

**Key Words:** Microbial fermentation, Nitrogen source, Concentrate

**1267 Influence of dietary metabolizable protein on production rates and N use by steers fed high grain content diets.** R.H. Pritchard, C.J. Mueller\*, K.W. Bruns, and S.J. Bierman, *South Dakota State University, Brookings*.

This study evaluated the effects of manipulating metabolizable protein (MP) levels on yearling steer performance and N use in a feedlot situation. Steers ( $n = 120$ ; BW = 343  $\pm$  1.1 kg) were blocked into light (LBW; 323 kg) and heavy (HBW; 356 kg) BW groups, then allotted to one of three treatments for a 117d feeding period. Treatments were: LO) 11% CP fed throughout; HI) 13% CP fed throughout; and LHL) 11% CP fed from d 1 to 35, 13% CP fed from d 36 to 94 and 11% CP fed from d 95 to 117. Steers were fed a high grain diet (1.39 Mcal NEg/kg) throughout the trial and received an estradiol-trenbolone acetate implant on d 35. Metabolizable protein (estimated by NRC (1996)) allowed ADG were 1.5 and 1.8 kg for the LO and HI diets, respectively. Each treatment included 5 pens (2 LBW and 3 HBW replicates) with 8 steers per pen. When compared to the LO treatment the HI treatment improved gain efficiency (.163, .167 and .174 kg ;  $P < .10$ ) and cumulative ADG (1.62, 1.68 and 1.75 kg;  $P < .05$ ) for LO, LHL and HI, respectively. This resulted in heavier ( $P < .10$ ) and fatter ( $P < .05$ ) carcasses for HI vs LO. Interim growth performance was inconclusive. Serum urea-N concentrations were highest ( $P < .05$ ) for cattle receiving the HI treatment across all periods. All treatments had an increase in serum urea-N within 56d of implant administration. Calculated total N intake increased ( $P < .01$ ) from 18.8 to 21.3 to 23.1 kg per steer for LO, LHL and HI treatments, respectively. The N intake per 100 kg BW gain was higher ( $P < .01$ ) for HI than LO treatments ( 9.89, 10.90, and 11.33 kg , respectively,) indicating a reduction in efficiency of N use with higher dietary levels of MP. The results of this experiment indicate that an increase in dietary MP can improve growth rates and efficiency, but may not result in improved efficiency of N use by the animal.

**Key Words:** Feedlot, Steers, Metabolizable protein

**1268 Phosphorus balance throughout early lactation in dairy cows fed diets varying in phosphorus content.** K.F. Knowlton\*, W.A. Wark, and J.H. Herbein, *Virginia Polytechnic Institute and State University, Blacksburg.*

The effect of dietary phosphorus (P) on P balance throughout early lactation was evaluated in thirteen cows fed diets varying in dietary P content. All cows were fed a common TMR pre-partum (.28%P), followed by a common TMR for 7 days post-partum (.51%P). On day 7, cows were randomly assigned to one of three treatment diets containing .34 (no supplementary P), .52, or .67%P. Treatment diets differed only in dietary P content, and contained 18.3% CP, 15.8% ADF, 26.4% NDF, and .74% Ca. Total collections of milk, urine, and feces were conducted during weeks 3, 5, 7, 9, and 11 of lactation. Body weight (mean = 594.7 kg), milk yield (mean = 47.8 kg/d), and DMI (mean = 25.5 kg/d) were not affected by diet. With increasing dietary P, linear increases were observed in P intake (87.4, 133.7, and 171.7 g/d), fecal P (42.5, 86.3, and 113.0 g/d), urinary P (.32, 1.28, and 3.89 g/d), and total P excretion (42.8, 87.6, and 117.0 g/d). Apparent P digestibility decreased quadratically with increasing dietary P (51.1, 33.2, and 34.4% of P intake). Increasing dietary P did not affect P balance (-53.1, -50.1, -35.2 g/d). Increasing dietary P increased fecal and urinary P excretion in early lactation cows and did not improve P retention. We conclude that because bone mobilization in response to Ca needs in early lactation cows provides a readily available source of P, increasing dietary P content to meet the P needs of these cows may be redundant.

**Key Words:** Phosphorus Balance, Phosphorus Excretion, Early lactation cows

**1269 Milk production and bone characteristics of dairy cows fed different amounts of phosphorus for two or three lactations.** Z. Wu\*<sup>1</sup>, L. D. Satter<sup>1</sup>, A. J. Blohowiak<sup>1</sup>, R. H. Stauffacher<sup>1</sup>, and J. H. Wilson<sup>2</sup>, <sup>1</sup>*US Dairy Forage Research Center, USDA-ARS, and University Wisconsin, Madison*, <sup>2</sup>*Virginia Polytechnic Institute & State University, Blacksburg.*

Effects of feeding different amounts of P to lactating dairy cows in the third year of a 3-yr feeding experiment are reported. Treatments were .31, .39, and .47% dietary P (DM basis) fed to 10, 14, and 13 Holsteins. The 37 cows included 19 and 14 that had been fed similar amounts of P for 2 or 3 yr, respectively, upon completion of the lactation this year; the remaining 4 cows (3 in the .31% and 1 in the .39% P groups) completed just the one lactation of this trial. The 12th rib bone was surgically removed (20 cm) from 9, 9, and 11 cows that were still available at the end of the lactation from the three treatments. The nine cows sampled from the .31% P group included the three 1-yr cows. The bone samples were tested for strength and P content. Milk production averaged > 12,000 kg during the lactation, with no indication that feeding low P reduced milk production. No difference was determined among treatments in the force the bone endured before rupture (shear stress) or the energy required to deform the bone to the point of fracture (fracture energy). Ash content of the bone was slightly lower for the .31% P group, but P content of bone ash was similar among treatments. Feeding .31 or .39% P for 2 or 3 yr did not reduce milk production, bone strength, or bone P content.

Item	.31% P	.39% P	.47% P	SEM
Milk, kg/308-d	13038 <sup>a</sup>	11909 <sup>b</sup>	12126 <sup>ab</sup>	407
Bone shear stress, N/mm <sup>2</sup>	26.5	28.1	27.5	2.2
Bone fracture energy, N-mm	66552	60459	64952	4186
Bone ash, % of DM	53.9 <sup>c</sup>	56.2 <sup>a</sup>	55.6 <sup>ab</sup>	.8
Bone P, % of ash	17.7	17.3	17.9	.3
Bone thickness, mm	5.1	5.1	5.2	.1

<sup>a,b,c</sup> b < a ( $P < .05$ ) for milk yield, and c < a ( $P < .06$ ) and c < b ( $P < .13$ ) for bone ash.

**Key Words:** Milk, Phosphorus, Bone

**1270 Effect of dietary Vitamin D and phosphorous intake on mineral excretion in dairy cattle.** K.M. Dooley\*, J.A. Bertrand, R.J. Thurston, A.B. Bodine, and T. Gimenez, *Clemson University, Clemson, SC.*

Phosphorous (P) excretion in manure is recognized as an environmental concern in the United States. The objective of this study is to reduce P excretion via increased intestinal absorption with the utilization of

supplementary Vitamin D. Two levels of phosphorous representing adequate and low values per the National Research Council (.41% and .31% DMI, respectively) were fed in conjunction with two levels, adequate (18,000 IU/d) and high (180,000 IU/d), of Vitamin D supplement in a 2x2 Latin square design experiment. Four Holstein cows of similar age and lactation were fed the assigned, rotated rations for an adjustment period of 24 days of each of four 28 day periods. The last four days of each period involved a total collection balance, weighing and sampling of milk, urine, and feces. Additionally, four blood samples were taken on day 28. Cows consumed a daily average of 17 Kg DM of a corn silage/grain ration containing 15.3% crude protein and 31 Mcal of NEL. Phosphorous levels in feces were affected by dietary phosphorous intake ( $p < .05$ ) but not by Vitamin D ( $p > .05$ ). Neither phosphorous intake nor Vitamin D were a main effect for milk or blood P ( $p > .05$ ). Both phosphorous and Vitamin D indicated a trend in raising urine P ( $p = .1$ ) with a significant interaction effect ( $p < .05$ ). In feces, calcium levels were affected by Vitamin D ( $p < .05$ ) and the calcium:phosphorous ratio was significantly different due to both P intake and Vitamin D ( $p < .05$ ), while magnesium levels were not affected by either ( $p > .05$ ). Milk yield, composition, calcium level or calcium:phosphorous ratio was also not significantly different among treatments. Excess Vitamin D does not appear to alter P absorption in dairy cattle. Dietary P at .31% DM for 590 KG lactating Holsteins did not reduce milk yield or alter milk components.

**Key Words:** Phosphorous, Vitamin D, Cows

**1271 Effects of dietary iron on copper metabolism and milk production in Holstein and Jersey cattle.** P. D. French\*, R. E. James, M. E. Lissow, S. Nadir, and M. L. McGilliard, *Virginia Polytechnic Institute and State University, Blacksburg.*

An experiment was conducted to investigate the effects of dietary Fe on Cu status and milk production of Holstein and Jersey cows. Twelve Holstein and 12 Jersey multiparous cows ( $70 \pm 4$  days in milk) were assigned at random to diets containing 0 or 500 mg FeCO<sub>3</sub>/kg DM in a 2 x 2 factorial plan. Diets contained (DM basis) 31% corn, 26% corn silage, 16% soy hulls, 12% whole cottonseed, 10% soybean meal, 2% animal-marine protein blend, and 3% mineral-vitamin. Diets were supplemented with 10 mg CuSO<sub>4</sub>/kg DM and differed only in Fe supplementation. The basal diet contained 210 mg Fe and 9 mg Cu/kg DM. The experimental period was 90 d. Hepatic and plasma Cu, Fe, and Zn were determined on 0, 45, and 90 d samples. Holsteins receiving supplemental Fe consumed more DM and FeCO<sub>3</sub> than Jerseys receiving supplemental Fe, while breed intakes did not differ for cows receiving no supplemental Fe. Intake of Fe was similar for Holsteins and Jerseys receiving no supplemental Fe. Hepatic Cu did not differ for breeds (481 vs. 493 µg/g DM for Holstein and Jersey, respectively) or Fe supplementation (474 vs. 499 µg/g DM for 0 and 500 mg Fe/kg DM, respectively). For Jerseys, hepatic Fe was greater for cows receiving supplemental Fe (254 µg/g DM) compared to controls (184 µg/g DM). Hepatic Zn did not differ for breeds or Fe supplementation. Plasma Cu was greater for Jerseys (0.72 µg/ml) compared to Holsteins (0.61 µg/ml). Plasma Zn and Fe did not differ for breeds or Fe supplementation. Iron supplementation did not affect milk yield or milk fat percentage. Milk protein percentage was greater for cows receiving supplemental Fe. Dietary Fe did not affect Cu status or productivity of Holstein and Jersey cows in this experiment.

**Key Words:** Copper, Holstein, Jersey

**1272 Effect of feeding complexed zinc methionine, manganese methionine, copper lysine, and cobalt glucoheptonate on lactational and reproductive performances by lactating Holstein cows.** P. Mandevu\*<sup>1</sup>, K. C. Uchida<sup>2</sup>, C. J. Sniffen<sup>1</sup>, C. S. Ballard<sup>1</sup>, and M. P. Carter<sup>1</sup>, <sup>1</sup>*W. H. Miner Agricultural Research Institute, Chazy, NY*, <sup>2</sup>*Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan.*

This study was undertaken to determine the effect of feeding chelated trace minerals on performance of Holstein cows. The product used as a source of the chelated minerals was called Availa4<sup>®</sup> (Zinpro Corp., Eden Prairie, MN). Pregnant cows (n=40) were blocked by parity, previous milk production and predicted calving date, and randomly assigned to treatments at calving. After 48±30 d cows were moved within treatment, from the fresh group (FG) to the high producing (HP) group. Cows were housed in a free-stall barn and group-fed total mixed rations (TMR) containing inorganic minerals (control) or inorganic minerals

and Availa4<sup>®</sup> (Availa4) for ad libitum intake. Cows were kept on the study for a minimum of 80 d or until first breeding service. The TMR were formulated using the CPM Dairy<sup>®</sup> model to exceed NRC (1988) trace mineral requirements for lactating dairy cows. The TMR consisted of approximately 51% forage and 49% concentrate (DM basis) for both the FG and HP cows. The Availa4 TMR was formulated to supply each cow with 7 g of Availa4<sup>®</sup> (DM basis) daily by partially substituting the inorganic minerals in the concentrate mix. Each 7 g of Availa4<sup>®</sup> supplied 360 mg of zinc (Zn), 200 mg of manganese (Mn), 125 mg of copper (Cu), and 12 mg of cobalt (Co). The control TMR was formulated to supply each cow with an equivalent amount of additional Zn, Mn, Cu, and Co from inorganic sources. The control and Availa4 TMR had similar concentrations of CP: 17.5% for FG cows and 18.0% for HP cows, and NDF: 32.8% for FG cows and 32.2% for HP cows. The performance by cows fed the control TMR and Availa4 TMR, respectively were milk yield kg/d (wk 1-8): 44.9 and 44.4 (SE=0.44); milk fat % (wk 1-8): 4.05 and 4.23 (SE=0.062); milk crude protein % (wk 1-8): 3.18 and 3.25 (SE=0.19); linear somatic cell count (wk 1-8): 4.10 and 3.74 (SE=0.079); services per conception: 2.04 and 1.58 (SE=0.23); and days to conception: 101 and 77 (SE=11.45). Days to conception were lower for Availa4 cows ( $P < 0.002$ ). Conception rate at 150 days postpartum for the control cows was 61.1% while the Availa4 cows was 95.0%. Feeding Availa4<sup>®</sup> to lactating Holstein cows improved conception rate with fewer days open but had no significant effect on milk production, milk fat and protein content, linear somatic cell count, body condition score and lameness score.

**Key Words:** Key words: Dairy cow, Availa4<sup>®</sup>, Milk production, Reproductive performance

**1273 Zinc-methionine improves udder health and Zn metabolism in lactating dairy goats.** A. Salama, G. Caja\*, E. Albanell, X. Such, R. Casals, and R. Parés, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Lactation and metabolism trials were conducted to investigate the effects of supplementation with Zn-Methionine (Zn-Met) on milk yield, milk composition, milk SCC, udder health, N and Zn metabolism in 22 Murciano-Granadina dairy goats milked once-a-day from week 2 to 20 of lactation. Each half udder was studied separately. Goats were fed a diet based on a dehydrated mixture of maize-whole plant and alfalfa *ad libitum*, alfalfa pellets, barley grain and concentrate mixture. Treatments were: Control (C) and supplemented (S) with 1g/d Zn-Met (Biomet-10<sup>®</sup>, Norel SA, Madrid, Spain). For the S group, Zn-Met was included in the concentrate mixture. Average milk yield was not affected by Zn-Met supplementation (2.04 l/d;  $P > 0.05$ ), but percentage of milk fat tended to be lower (C: 5.12%; S: 4.67%;  $P < 0.06$ ). Percentages of total protein, true protein and casein were not significantly affected by treatments. Lower values ( $P < 0.05$ ) of milk whey protein (0.56 vs. 0.62 %) and milk NPN (0.29 vs. 0.34 %) were observed in S vs. C group. The geometric mean of milk SCC decreased by 24% as a result of supplementation (C:  $333 \times 10^3$ ; S:  $269 \times 10^3$ ;  $P < 0.11$ ) but C values were reduced to  $293 \times 10^3$  and differences were not significant ( $P > 0.05$ ) when halves with persistent infection were excluded from the analysis. Infection prevalence was 14% for C group vs. 5% for S group ( $P < 0.05$ ). For the metabolism trial, apparent absorption of N ( $P < 0.01$ ) and Zn ( $P < 0.12$ ) increased for the S goats, which also tended to retain more Zn than goats of the C group (52.5 vs. 21.4 mg/d;  $P < 0.08$ ). We conclude that Zn-Met supplementation seems to play a positive role on mastitis resistance. The N and Zn utilization in the whole animal body was also improved when Zn-Met was fed.

**Key Words:** Zinc Chelates, Somatic Cell Counts, Zn Metabolism

**1274 Comparison of the blood and urine acidifying activity of common dietary chloride and sulfate supplements.** J.P. Goff\* and R.L. Horst, *USDA-Agricultural Research Service, Ames, IA.*

Evidence suggests calcium homeostasis in the periparturient cow is impaired by metabolic alkalosis; common in cows fed diets high in cations such as potassium. When decreasing dietary potassium is insufficient to control hypocalcemia, anions are added to the diet to induce a mild

metabolic acidosis to reduce periparturient hypocalcemia and milk fever. Chloride and sulfate are commonly used for this purpose, though there may be differences in the blood acidifying activity of these anions. In each of the following trials 7 non-preg, non-lact Jersey cows received 7 treatments during one of 7 five day treatment periods in a crossover design. Treatment periods were separated by 5 days of feeding the basal alfalfa diet alone. Basal diet was limit fed (2X/d) to insure that all added anions were consumed. Treatments consisted of 0.75, 1.5, or 2.25 Eq/d of either a chloride or sulfate anion source dissolved in water, or water alone, added to the basal diet. Three trials were run to compare the effects of hydrochloric acid vs. sulfuric acid, Ca chloride vs. Ca sulfate, and Mg chloride vs. Mg sulfate. Three hr after the last feeding on day 5 of each treatment period, blood and mid-stream urine samples were obtained. Urine pH, and blood pH and standard base excess (SBE) were determined and plotted against the dose of each anion utilized. The slope of the regression line obtained for the anion sources in each trial were determined. Urine pH decreased as addition of anions to the diet increased, but there was no significant difference in the slopes of the lines determined for the different anion sources. Blood pH and SBE were negatively correlated with the dose of hydrochloric acid, Ca chloride, Mg chloride, and Ca sulfate. However blood pH and SBE were not significantly correlated with sulfuric acid or Mg sulfate dose, suggesting a weak effect of these anion sources on blood acidity. The slopes of the lines describing the effect of Ca chloride on SBE and blood pH were 1.7 and 1.6 fold greater respectively than the slopes describing the effect of Ca sulfate on SBE and blood pH. Chloride consistently decreased blood acidity more than the sulfate anions suggesting that chloride sources would be more effective for prevention of hypocalcemia in periparturient cows than sulfate sources.

**Key Words:** Anion, Milk fever, Metabolic Acidosis

**1275 Direct fed microbial and anionic salt supplementation to dairy cows fed 21 days pre- to 70 days postpartum.** E. Block<sup>1</sup>, J.E. Nocek<sup>2</sup>, W.P. Kautz<sup>\*3</sup>, and J.A.Z. Leedle<sup>3</sup>, <sup>1</sup>McGill University, <sup>2</sup>Spruce Haven Farm and Research Ctr, <sup>3</sup>Chr. Hansen BioSystems.

Sixty-four multiparous Holstein cows were used to evaluate the effect of anionic salts in combination with a direct fed microbial (DFM)/yeast(Y) in the prepartum period and DFM/Y on production performance during the postpartum period. Four close-up dry diets were fed to 4 groups of 16 cows each starting at 21-days precalving as follows: a) no anionic salts, no DFM/Y, b) anionic salts, no DFM/Y, c) no anionic salts, DFM/Y at 90g/d, and d) anionic salts, DFM/Y at 90g/d. After calving, eight cows from each prepartum group were fed a lactation ration with or without DFM/Y supplementation top dressed at rate 90g/d. The 90g of DFM contained approximately  $5 \times 10^9$  CFU yeast and  $5 \times 10^9$  CFU bacteria (*Lactobacillus plantarum*/*Enterococcus faecium*). There were no significant effects of prepartum treatments on prepartum DMI or postpartum DMI or milk production; therefore, postpartum performance data were pooled for cows which did or did not receive DFM/Y supplementation. DMI, milk yield, and milk protein were higher for cows receiving DFM/Y supplementation ( $P < .05$ ). Blood glucose and insulin were higher and NEFA lower for cows receiving DFM/Y in the lactation period ( $P < .05$ ). These data suggest that DFM/Y supplementation resulted in increased DMI and milk production. Blood metabolic indices suggest more glucose was made available with less fatty acid mobilization from lipid stores with DFM/Y supplementation.

Period	Trt	DMI (kg/d)	Milk (kg/d)	Protein (%)	Glucose (mg/dl)	Insulin (uIU/ml)	NEFA (uM/L)
1 to 7d	Control	12.9 <sup>b</sup>	22.1 <sup>b</sup>	3.98	51.1 <sup>b</sup>	8.9 <sup>b</sup>	598
	DFM/Y	15.3 <sup>a</sup>	22.4 <sup>a</sup>	4.01	59.3 <sup>a</sup>	12.2 <sup>a</sup>	488
8 to 21d	Control	18.4 <sup>b</sup>	34.5 <sup>b</sup>	3.21 <sup>b</sup>	49.7 <sup>b</sup>	10.6 <sup>b</sup>	624 <sup>d</sup>
	DFM/Y	21.2 <sup>a</sup>	36.1 <sup>a</sup>	3.35 <sup>a</sup>	55.7 <sup>a</sup>	16.8 <sup>a</sup>	570 <sup>c</sup>
22 to 70d	Control	24.6 <sup>d</sup>	48.2 <sup>d</sup>	3.01 <sup>b</sup>	52.1 <sup>b</sup>	23.7	658 <sup>b</sup>
	DFM/Y	25.1 <sup>c</sup>	49.1 <sup>c</sup>	3.27 <sup>a</sup>	58.1 <sup>a</sup>	24.7	525 <sup>a</sup>

<sup>a,b</sup> means in the same column within time differ  $P < .05$  <sup>c,d</sup> means in the same column within time differ  $P < .10$

**Key Words:** DFM, Anionic salt, Production