

Ruminant Nutrition: Dairy—Behavior, Modeling, and Production

697 Effect of stocking density and fence line barrier on the behavior of dairy cattle. J. M. Huzzey*, P. Valois, T. J. DeVries, M. A. G. von Keyserlingk, and D. M. Weary, *University of British Columbia, Vancouver, British Columbia, Canada.*

The objectives of this study were to evaluate the effect of using a headlock (HL) or a post-and-rail (PR) barrier on the behavior of dairy cows, and to determine how this effect interacts with stocking density. Thirty-six lactating Holstein cows were divided into four groups, two assigned to each barrier design. Groups were followed for 40 d and then switched to the alternate barrier for a subsequent 40 d. Within each 40 d period, each of the four groups were tested at four stocking densities (see Table), each lasting 10 d, with densities assigned to the groups using a 4x4 Latin square. Time-lapse video was used to quantify feeding, standing and competitive behavior at the feed bunk. Data were analyzed using a general linear model with group as the observational unit. Daily feeding times were higher ($P=0.001$) and duration of inactive standing in the feeding area was lower ($P<0.001$) when using a PR barrier compared to a HL barrier (Table). Feeding time increased ($P<0.001$) and inactive standing decreased ($P<0.001$) for both barrier designs as cows were given more space to feed. Cows were displaced more often from the feeding area ($P=0.005$) when the stocking density was increased, but this effect was greater ($P=0.002$) for cows using the PR barrier. In summary, regardless of feed barrier, increasing stocking density reduced feeding time and increased inactive standing time. The PR barrier allowed for increased feeding time and reduced inactive standing time, but also increased the frequency of competitive displacements especially when cows were overstocked.

Feed Barrier	Stocking Density	Feeding Time (min/d \pm SE)	Inactive Standing Time (min/d \pm SE)
HL	1.33 HL/cow	276.13 \pm 6.45	96.80 \pm 4.77
HL	1.00	264.79 \pm 6.45	103.21 \pm 4.77
HL	0.67	249.91 \pm 6.45	106.82 \pm 4.77
HL	0.33	218.68 \pm 6.45	119.83 \pm 4.77
PR	0.81 m/cow	290.68 \pm 6.45	81.23 \pm 4.77
PR	0.61	287.01 \pm 6.45	88.56 \pm 4.77
PR	0.41	268.00 \pm 6.45	93.20 \pm 4.77
PR	0.21	234.44 \pm 6.45	111.65 \pm 4.77

Key Words: Feed Barrier, Stocking Density, Feeding Behavior

698 Effect of feeding frequency on the behavior of lactating dairy cows. T. J. DeVries* and M. A. G. von Keyserlingk, *The University of British Columbia, Canada.*

The time of feed delivery alters the time of peak activity at the feed bunk, indicating that dairy cows respond strongly to the delivery of fresh feed. It follows that the frequency of feed delivery should also affect cow behavior. To date, few researchers have investigated the effects of feeding frequency on the behavior of group-housed dairy cows. The objective of this study was to examine the effects of frequency of feed delivery on the feeding and lying behavior of group-housed dairy cows. This objective was tested in two experiments. In each experiment, 48 lactating Holstein cows, split into groups of 12, were subjected to each of two treatments in a cross-over design. The treatments for the first experiment were: 1) delivery of feed once per day (1x), and 2) delivery of feed twice per day (2x). The treatments for the second experiment were: 1) delivery of feed 2x, and 2) delivery of feed four times per day (4x). In each experiment, cows were milked twice daily and fed a TMR containing 49% forage and 51% concentrate (DM basis). For both experiments, time-lapse video was used to quantify the feeding and lying behavior of the cows. Using the pen as the experimental unit, treatment effects were tested by paired *t*-tests. Cows fed 2x increased ($P = 0.04$) their daily feeding time by 10 min compared to

when they were fed 1x. Cows further increased ($P = 0.04$) their daily feeding time by 14 min when they were fed 4x compared to when they were fed 2x. Frequency of feed delivery had no effect ($P = 0.9$) on the daily lying time of the cows. Despite this, there were changes in the daily distribution of lying time. Cows fed 1x took 13 min longer ($P = 0.01$) to lie down after the return from the morning milking compared to when they were fed 2x. When cows received feed 4x, they lay down 11 min sooner ($P = 0.03$) after milking than when fed 2x. These results indicate that increasing the frequency of feed delivery increases the amount of time that cows spend feeding. These results also indicate that the feeding and lying patterns of dairy cows are affected by the frequency of feed delivery.

Key Words: Feeding Frequency, Feeding Behavior, Dairy Cow

699 The Cornell Net Carbohydrate and Protein System: An evolving model. T. Tytlutki* and D. Fox, *Cornell University, Ithaca, NY.*

The Cornell Net Carbohydrate and Protein System (CNCPS), a cattle nutrition model, has been under continuous development since the early 1980s. The upcoming version (CNCPSv6) has undergone a comprehensive review with the addition of recent biological advances. This review highlighted several critical areas requiring corrective actions including: partitioning ash to microbes, NFC bacterial peptide uptake, NFC bacterial nitrogen requirements, FC microbial growth at different rumen pHs, efficiency of energy utilization for maintenance, the calculation of heat production, and others. Heat production and the efficiency of energy utilization for maintenance are now based upon diet characteristics. The review also resulted in different implementation strategies for growth and body reserves. Body reserves now encompass energy and protein (versus only energy) and can desired end points inputted to force either reserves mobilization or replenishment. Biological principles updated include: expanded carbohydrate pools, new passage rate equations, and updating energy conversions (ME to NE) and incorporating lactose in milk energy calculations according to the 2001 Dairy NRC. An additional change is in the NFC calculation where NDIN is no longer included. This change is based upon the AOFC NDF method that utilizes sodium sulfite (which removes the nitrogen from the NDF fraction). As CNCPSv6 was re-engineered, new programming techniques utilizing object-oriented methods and optimization procedures have been implemented. A shift from least cost formulation to maximizing income over feed costs has also occurred. An initial comparison with CPM version 3.0 for a diet formulated for 45.4 kg milk shows: ME supply, 6% lower in CNCPSv6; ME required, 4% higher; MP supply, 5% lower; MP required, 2% lower. Total microbial flow is predicted to be 2% lower in CNCPSv6. Model predictions, utilizing data from controlled studies, will be presented illustrating the impact of these changes on: predicted bacterial yield; ME, MP, and amino acid supply and requirements; whole animal performance; and herd nutrient excretion.

Key Words: Models, Systems

700 Impact of the level of aggregation of feed carbohydrate (CHO) fractions on predictions of the Cornell Net Carbohydrate and Protein System (CNCPS). C. Lanzas*, L. O. Tedeschi, and D. G. Fox, *Cornell University, Ithaca, NY.*

The CNCPS model accounts for the effect of variation in feed CHO fractions in predicting nutrient requirements and animal performance. However, current fractionation schemes aggregate VFA and organic acids (OA) with sugars and soluble fiber with starch in predicting microbial growth and CHO digestion, which may limit the accuracy of the model. A Monte Carlo analysis was conducted with a typical lactating dairy cow ration to compare the current CHO scheme (A = sugars and OA, B1 = starch and soluble fiber, B2 = available NDF, C = unavailable NDF) with the expanded CHO scheme developed for CPM

Dairy (**A1** = acetic, propionic and butyric acids, **A2** = lactic acid, **A3** = OA, **A4** = sugars, **B1** = starch, **B2** = soluble fiber, **B3** = available NDF, **C** = unavailable NDF). A database provided by Dairy One lab was used to obtain the distributions of these CHO fractions for the ingredients used, which are commonly used in the northeast US (corn, alfalfa silages, high moisture corn, soybean meal, and distillers grains). CNCPS predicted values for these two levels of aggregation are summarized below. The mean of Met allowable milk and MP from bacteria was lower with the expanded scheme. The model presented similar robustness as indicated by the SD for both schemes. For both levels, the SD for MP and Met milk was mainly due to variations in rates of fiber digestion ($r = 0.45$), NDF and starch in corn silage ($r = 0.41$), and silage OA and sugars ($r = -0.20$). We conclude the expanded CHO fractions can be added to the CNCPS model with little risk of use. However, to fully account for differences in feed CHO utilization, further modifications in the structure of the current model will be needed.

	Current CHO fractions	Expanded CHO fractions
Mean±SD	Mean±SD	
ME allowable milk (kg/day)	34.2±1.06	34.2±1.05
MP allowable milk(kg/day)	33.7±1.24	33.1±1.22
MP from bacteria (g/day)	1304±46.4	1273±44.6
Met allowable milk(kg/day)	32.7±1.72	31.8±1.68
Fecal N excretion	228±3.7	226±3.6
Urinary N excretion (g/day)	212±3.7	215±3.6

Key Words: Feed Carbohydrate, Simulation, Nutritional Models

701 The energy system of the 2001 Dairy NRC: Challenges for a ration formulation program. M. VandeHaar*, *Michigan State University, East Lansing.*

The energy system of the 2001 Dairy NRC is considerably more complicated than that of the 1989 NRC. The 2001 NRC was developed to be a retrospective evaluation program. The objective of this simulation study was to determine how the new system works as a prospective formulation program. Whereas a retrospective program examines a diet that has already been consumed by a cow and thus is at least reasonable, the prospective ration formulation program must be able to develop a new diet without prior knowledge of how the cow will eat it. Estimation of feed energy values using the composition of ingredients is likely an improvement over the previous system of book NEL values. However, protein is overvalued in the model, with an energy value of 5.6 kcal/g of digested protein but with the same constant conversion of DE to ME as in 1989. More importantly, the digestibility discount is now adjusted for level of intake, and, although feed factors are not used in predicting feed intake, they are used in predicting digestibility. Nonfat feeds with the highest TDN values at 1X maintenance are discounted the most with increasing intake. As an evaluation program, this may work well. However, as a formulation program for high producing cows, the new system predicts nearly the same energy-allowable milk with a high grain diet as with a high forage diet. Because the feed intake equation does not use feed factors, the implicit assumption is that a cow can eat as much of a high forage diet as a high grain diet. Thus, least-cost formulation programs would be unjustly biased toward high forage diets for high-producing cows (>54 kg of milk per day). As a diet formulator, the 2001 NRC model favors diets for high producing cows that are higher in fat, protein, and fiber than are optimal for high production. Possible solutions are to lower the energy value of digested protein to 4.8 kcal/g and to remove feed factors from the equation for predicting the digestibility discount, or to add feed factors to the equation for predicting feed intake.

Key Words: Ration Software, 2001 Dairy NRC

702 Corn grain endosperm type and brown midrib 3 corn silage: ruminal fermentation and microbial N efficiency in lactating dairy cows. C. C. Taylor* and M. S. Allen, *Michigan State University, East Lansing.*

Interactions of endosperm type of corn grain and the brown midrib 3 (*bm3*) mutation in corn silage on ruminal fermentation and microbial N efficiency of lactating dairy cows were evaluated. Eight ruminally and duodenally cannulated cows (72 ± 8 d in milk; mean ± SD) were used in a duplicated 4 × 4 Latin square design experiment with a 2 × 2 factorial arrangement of treatments. Grain treatments were dry corn grain from hybrids with floury or vitreous endosperm; silage treatments were corn silage from a hybrid with the *bm3* mutation or its isogenic control hybrid without the *bm3* mutation. Diets contained 26% neutral detergent fiber and 17% crude protein. Treatment corn grain and silage supplied 23% and 38% of the diet DM, respectively. Data were analyzed by a mixed effects model and orthogonal contrasts were determined for main effects of corn grain endosperm type and corn silage hybrid and their interaction. Mean and minimum ruminal pH was reduced by floury corn grain and *bm3* corn silage ($P < 0.05$). Non-ammonia N (NAN) and non-ammonia non-microbial N (NANMN) flow to the duodenum did not differ among treatments. Microbial N flow was similar among endosperm types in *bm3* silage diets but in control silage diets vitreous grain numerically increased microbial N flow 185 g/d compared to floury grain (interaction $P < 0.17$). There were no interactions of main treatment effects for microbial N efficiency (MNE) and type of silage did not affect MNE, but MNE was numerically higher for diets containing vitreous compared to floury corn grain (41.3 versus 34.5 g/kg truly ruminally degraded organic matter; $P < 0.12$). MNE was negatively correlated with ruminal starch digestibility ($r = -0.47$; $P < 0.01$) and positively correlated with mean ruminal pH ($r = 0.53$; $P < 0.006$) and rate of starch passage from the rumen ($r = 0.46$; $P < 0.01$) across cow period means. Microbial N efficiency and ruminal pH are affected by starch digestion kinetics, which varies according to corn endosperm type.

Key Words: Endosperm, Microbial Efficiency, Ruminal pH

703 Effects of corn grain endosperm type and conservation method on site of digestion, ruminal digestion kinetics and microbial nitrogen production of lactating dairy cows. Y. Ying* and M. S. Allen, *Michigan State University, East Lansing.*

Eight ruminally and duodenally cannulated Holstein cows (73 ± 39 DIM; mean ± SD) were used in a duplicated 4 × 4 Latin square design. A 2 × 2 factorial arrangement of treatments was used with main effects of corn grain endosperm type (floury or vitreous) and conservation method (dry or high-moisture, HM). Diets were formulated to 26.6% neutral detergent fiber and 16.5% crude protein. Corn grain treatments supplied 86.6% of dietary starch. True ruminal starch digestibility was increased by HM compared to dry (87.2 vs. 64.3%, $P < 0.001$) and for floury compared to vitreous (83.7 vs. 67.7%, $P < 0.001$) treatments. The increase for HM compared to dry corn was because of an increase in digestion rate (31.4 vs. 24.4 %/h, $P < 0.05$) and a decrease in passage rate (7.1 vs. 16.3 %/h, $P < 0.001$) of starch. Rate of starch digestion was not affected by endosperm type; the increase in ruminal starch digestibility for floury compared to vitreous was because of a 53% decrease in rate of starch passage from the rumen (7.5 vs. 16.0 %/h, $P < 0.001$). Total tract digestibility of starch was similar across treatments exceeding 95% because of compensatory post-ruminal digestion. Ruminal pH was increased (6.22 vs. 6.10, $P = 0.002$) by dry compared to HM corn. Dry corn treatment tended to increase non-ammonia N flow to the duodenum (466 vs. 431 g/d, $P = 0.08$) by increasing flow of non-ammonia non-microbial N (211 vs. 111 g/d, $P < 0.001$) despite a decrease in microbial N flow (255 vs. 320 g/d, $P < 0.01$) compared to HM treatment. Vitreous corn increased non-ammonia non-microbial N flow to the duodenum (187 vs. 135 g/d, $P < 0.05$) compared to floury corn treatment but microbial N flow to the duodenum was not affected by endosperm type. Efficiency of microbial N production was not affected by treatment. Endosperm type and conservation method of corn grain greatly affect digestion kinetics and ruminal digestibility of starch as well as flow of N fractions to the duodenum.

Key Words: Corn Endosperm, Conservation, Ruminal Digestion Kinetics

704 Evaluation of near infrared calibrations for corn kernel hardness parameters and relationship to degradabilities. D. Ngonyamo-Majee^{*1}, R. Shaver¹, J. Coors¹, D. Sapienza², J. Lauer¹, and P. Flannery¹, ¹University of Wisconsin, Madison, ²Sapienza Analytica, Johnston, IA.

We previously evaluated kernel hardness parameters and degradabilities of 33 inbreds and developed near infrared (NIR) calibrations. For this study we developed 13 hybrids from crosses of selected inbreds covering low (0-30%), medium (30-70%) and high (70-100%) vitreousness (V) classifications and test lines (Mo17Ht and B73) for evaluation of the NIR calibrations. Six check hybrids, W64AxOh43 carrying opaque-2 (o2), floury-2 (fl2), sugary-2 (su2) and amylose-extender (ae1) mutant genes, straight W64AxOh43, and B73xMo17Ht were included. The hybrids were grown at the West Madison Research Station during 2003 in 3*5m row plots in a randomized complete block design with three replicates. Harvesting was at three maturity stages (HS1=½ milk line; HS2=black layer; HS3=21d post black layer). Dried kernels were ground through a 1mm Wiley mill screen for NIRS prediction of V, density (D) and stentvert hardness measures of grinding time (T) and height in collection receptacle (CH). In-situ ruminal (RDMD) and total (TDMD; Pioneer Hi-bred Int. in vitro enzymatic method on ruminal residue) DM degradabilities were determined on 6mm ground samples and correlated with NIRS predicted hardness parameters. Correlations (r) are presented in the table. All NIRS-predicted hardness parameters were correlated (P<0.001) with degradability measurements. Stentvert CH correlations were better than T. NIRS density correlations were better than NIRS V correlations from either manual dissection or visual rating. Correlations for stentvert CH gave similar correlations as both V calibrations.

Parameter	NIRS calibration	0-hr	RDMD	TDMD
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Key Words: Corn, Vitreousness, Degradability

705 Long term feeding of wet corn distillers grains and lactation performance of dairy cows. G. S. Mpapho^{*}, A. R. Hippen, K. F. Kalscheur, and D. J. Schingoethe, *South Dakota State University, Brookings.*

The objectives of this study were to evaluate milk production, dry matter intake, and milk composition of dairy cows fed wet corn distillers (WDG) at 15% of diet dry matter. Sixteen multiparous and fourteen primiparous Holstein, and eight multiparous Brown Swiss cows were randomly assigned to one of the two treatments. Cows were blocked by parity, breed, and expected calving date. Experimental diets contained 35% corn silage and 15% alfalfa hay (DM basis) and were fed from 22 to 105 DIM. The treatment group was fed WDG at 15% of diet DM. In the control diet (CTL), WDG was replaced by corn grain, soybean meal, and extruded and expeller soybean meals. Diets were balanced (DM basis) at 17% CP, 21.7% forage NDF, 5.5% ether extract, and 1.63 Mcal NEL/kg. The diet was offered for ad libitum intake. Dry matter intake of cows fed WDG and CTL (19.0 and 20.5 kg; P > 0.20) did not differ between treatments. Milk production (35.4 and 33.7 kg/d) and 4% FCM (33.4 and 32.1 kg/d) were not different (P > 0.40). Concentrations of milk components and milk component yields were also not affected by diet, although milk lactose percentage tended to be higher for WDG than CTL (4.97 and 4.89%; P < 0.07). Cows fed WDG had higher MUN (15.6 and 13.3 mg/dL; P < 0.02). Diet was found to interact with parity as primiparous cows had greater DMI on CTL than for WDG (19.3 vs 15.3 kg/d) whereas diet did not affect DMI of multiparous cows (P < 0.03 for diet*parity). Other effects observed included parity and breed. Multiparous cows produced more milk than primiparous cows (22.2 and 17.3 kg/d; P < 0.001) and Holstein cows produced more milk than Brown Swiss cows (39.3 and 29.5 kg/d; P < 0.01). Milk fat (4.05 and 3.38%; P < 0.01) and milk protein (3.10 and 2.86%; P < 0.02) were greater for Brown Swiss than Holstein cows. Results from this experiment showed that feeding WDG at 15% of diet dry matter does not affect lactation performance.

Key Words: Wet Distillers Grains, Milk Production, Dairy Cows

706 Feed intake and lactation performance of Holstein cows fed graded amounts of a poultry-based protein and fat supplement (PRO*CAL). S. J. Freeman^{*1}, P. J. Myers¹, C. J. Sniffen², and T. C. Jenkins¹, ¹Clemson University, Clemson, SC, ²Fencrest, LLC, Holderness, NH.

PRO*CAL has recently been introduced as a new dairy feed supplement, which consists of nutrients from poultry processing plants reacted to yield a dry, free-flowing product high in both protein and fat. A previous continuous culture study with mixed ruminal microorganisms demonstrated that PRO*CAL, despite its high fat content, did not have negative effects on fermentation and that unsaturated fatty acid components were more resistant to biohydrogenation than fatty acids in soybean oil. This study was done to determine the effects of PRO*CAL on feed intake and lactation performance. Four levels of PRO*CAL were fed to 24 Holstein cows (50 ± 15 DIM) for 6 weeks in a randomized block design. Target concentrations of PRO*CAL in the blended ration were designed to keep diets isonitrogenous but replace 0 (diet0), 33 (diet33), 67 (diet67), or 100% (diet100) of the bypass protein supplied. The data were analyzed using the mixed procedure of SAS with α=0.05. Diet had no effect on dry matter intake, milk yield, or milk composition. When averaged across all weeks, milk yield averaged 41.9 kg/d, and milk fat and protein percentages averaged 3.29 and 2.55, respectively. A diet by week interaction (P < 0.05) occurred because milk yields were similar for all diets through week 2, but from weeks 3 through 6, milk yields were higher (P < 0.05) for diet67 and diet100. As PRO*CAL increased in the diet, milk concentrations of C18:0, trans C18:1, C18:1, and C18:2 increased (P < 0.05). The results show that PRO*CAL can be fed to lactating dairy cows as a poultry-based source of bypass protein and fat without negative effects on feed intake or milk production. Also, PRO*CAL has the added advantage over other bypass protein supplements of enhancing milk yield, presumably due to its higher fat and energy values.

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Key Words: PRO*CAL, Dry Matter Intake, Milk Yield and Composition

707 Effects of feeding whole cottonseed coated with starch, urea, or yeast on performance of lactating dairy cows. K. M. Cooke^{*} and J. K. Bernard, *The University of Georgia, Tifton.*

Thirty Holstein cows were used in an 8-wk randomized block trial to test the viability of select additives included in the gelatinized starch coating applied to whole cottonseed (WCS) on nutrient intake and digestibility and milk yield and composition. Treatments included WCS coated with 2.5% gelatinized corn starch (CONTROL); control plus 0.5% urea included in the coating (UREA); or control plus 2.0% yeast culture in the coating (YEAST). The diets were fed once daily behind Calan doors. Dry matter intake, milk yield and composition were similar for cows fed CONTROL and UREA. There was a tendency for increased milk fat yield (P = 0.09) in cows fed UREA compared with CONTROL. Energy corrected milk yield (ECM) increased 6.5 % and efficiency of milk production (ECM per unit of DMI) increased 5.3% when cows were fed UREA compared with CONTROL, but the differences were not significantly different (P = 0.16 and P = 0.15, respectively). Percentage lactose was numerically lower (4.89 vs. 4.77 %) for cows fed UREA compared with CONTROL. Intake (P < 0.0001) and whole tract apparent digestibility of fat ether extract (P = 0.07) were higher, but the apparent digestibility of dry matter (P = 0.005), crude protein (P = 0.01), NDF (P = 0.003) and ADF (P = 0.001) was lower for cows fed UREA compared with the control. Inclusion of yeast culture in the coating tended to decrease the percentage of milk protein and solids-not-fat (2.8 and 2.0% respectively) in milk and increased the efficiency of milk production (P = 0.06), but no differences were observed for milk yield or other milk components. Intake of crude protein was lower (P = 0.04) and apparent digestibility of acid detergent fiber was higher (P = 0.03) for cows fed diets containing YEAST compared with control. The results of this trial indicate that the inclusion of urea or yeast culture in the gelatinized starch coating applied to whole cottonseed may potentially improve the efficiency of milk production and numerically increase yield of ECM.

Key Words: Cottonseed, Starch, Urea

708 Mammary use of glucose when milk yield is reduced by once daily milking and/or feed restriction in dairy cows. J. Guinard-Flament*, E. Delamaire, S. Lemosquet, and Y. David, *UMR INRA-Agrocampus Rennes Production du Lait, Rennes, France.*

A decrease in milk yield may alter mammary use of plasma glucose for lactose production through a modified mammary supply, uptake and/or metabolic fate of glucose. A study was conducted to better understand mammary glucose utilization following a decrease in milk yield induced by once daily milking (ODM) and/or feed restriction (FR). Five multiparous dairy cows (30 kg/d of milk) were fitted with an ultrasonic flow probe to measure mammary blood flow (MBF) and with two catheters to determine arteriovenous differences in glucose concentrations (AV). Mammary use of glucose was measured on d 7 of each experimental week according to a reversal design in which the cows were milked once or twice daily while fed a diet providing 98 or 70% of needs determined before the trial. Data were analyzed by Anova using PROC GLM of SAS. No interaction between ODM and FR was observed. The decrease in milk yield induced

by ODM was larger (-5.1 kg/d) than with FR (-2.9 kg/d) ($P < 0.01$). This difference was not due to a lower mammary supply of glucose with ODM because it was less reduced with ODM than with FR (-1.7 vs. -3.4 mmol/min, respectively). MBF decreased by about 0.8 L/min with ODM and FR ($P < 0.01$) but arterial concentration of glucose was higher with ODM ($P < 0.03$). The difference in milk response between ODM and FR was not also due to a different decline in the mammary uptake of glucose (MBF \times AV). It decreased by 0.75 mmol/min for ODM and FR ($P < 0.01$) in response to a reduced or unchanged glucose AV ($P < 0.06$ and 0.32, respectively). In fact, the difference in milk yield decrease, induced by the two treatments, was due to a more efficient intracellular use of glucose towards lactose synthesis with FR (80 vs. 72%). Thus, glucose supply, uptake and metabolic fate are differently involved in the regulation of milk yield by ODM and FR, implying a decrease in MBF and different intra-mammary regulations resulting in an altered glucose AV for ODM and an increased use of glucose towards lactose synthesis with FR.

Key Words: Glucose, Udder, Dairy Cow

Ruminant Nutrition: Beef and Small Ruminant—Nitrogen Metabolism

709 Metabolizable protein effects on ammonia emissions and nitrogen excretion of steers. D. Panetta*, W. Powers, and J. Russell, *Iowa State University of Science and Technology, Ames.*

Protein degradability effects on N metabolism and NH_3 emissions were evaluated. In Exp 1, eight steers (initial BW, 338 kg) were fed diets containing urea (D1: 10.6% CP), soybean meal (D2: 10.1% CP), or soybean meal and urea (D3: 16.9% CP). In Exp 2, nine steers (initial BW, 268 kg) were fed diets containing 0 (D0: 12.7% CP), 12 (D12: 10.7% CP), or 24% (D24: 12.9% CP) distillers dried grain with solubles (DDGs). Feces and urine collections and DMI determination occurred during one 4-d period in Exp 1 and three 3 to 6-d periods in Exp 2. An 800-g, as-excreted mixture of urine and feces from each steer was placed into duplicate plastic tubs. Air passed over the excreta at a rate of 3 L/min for 96 h and NH_3 was trapped in boric acid. In Exp 1, DMI (7.3 kg/d) and ADG (0.55 kg/d) did not differ ($P < 0.05$) between diets. Digestibility of DM (61.9%) did not differ with diet, but total Kjeldahl nitrogen (TKN) digestibility was greater in steers fed D3 (65.7 vs. 50.7 and 41.5% on D1 and D2). Daily fecal DM, $\text{NH}_4^+\text{-N}$, and TKN mass did not differ between diets. Steers fed D1 excreted less urinary $\text{NH}_4^+\text{-N}$ (4.8 vs. 8.7 and 9.1 g/d for D2 and D3). Steers fed D2 excreted less urinary TKN (32.3 vs. 42.5 and 49.5 g/d for D1 and D3). In Exp 2, steers fed D0 had lower DMI (4.0 vs. 5.5 and 5.4 kg/d for D12 and D24) and ADG (-0.80 vs. 0.32 and 0.24 kg/d for D12 and D24). Intake of TKN was greater for D24 (104.9 vs. 78.6 and 88.2 g/d for D0 and D12). Digestibility of DM (77.9%) and TKN (67.3%) were unaffected by diet. Steers fed D24 had greater fecal TKN (32.7 vs. 23.6 and 25.3 g/d for D0 and D12) and $\text{NH}_4^+\text{-N}$ (4.22 vs. 2.94 and 2.82 g/d for D0 and D12) but daily urinary TKN (12 g) was unaffected by diet. Urinary $\text{NH}_4^+\text{-N}$ was greater for steers fed D0 (9.1 g/d) than D12 (5.4 g/d). Daily $\text{NH}_3\text{-N}$ emissions were 170, 99, and 97 mg for D1, D2, and D3 and 70, 29, and 53 mg for D0, D12, and D24. The daily portion of total emitted NH_3 increased with time (18, 25, 28, 29% and 22, 23, 27, 28% for d 1, 2, 3, and 4 of Exp 1 and 2). Metabolizable protein fractions play a larger role than dietary CP in influencing N excretion and NH_3 emissions and DDGs, as a UIP source, contributes to reduced NH_3 emissions.

Key Words: Ammonia, Protein

710 Effects of energy source on methionine utilization by growing steers. G. F. Schroeder*, E. C. Titgemeyer, M. S. Awawdeh, J. S. Smith, and D. P. Gnad, *Kansas State University, Manhattan.*

We evaluated the effects of different supplemental energy sources on methionine (Met) utilization in growing steers. Ruminally cannulated Holstein steers were used in two 6×6 Latin squares with data pooled for analyses. In Exp. 1, steers (148 kg) were fed 2.3 kg DM/d of a diet based on soybean hulls. Treat-

ments (2×3 factorial) were abomasal infusion of 0 or 3 g/d of L-Met, and supplementation with no energy or with glucose (360 g/d) or fat (150 g/d) continuously infused into the abomasum. In Exp. 2, steers (190 kg) received 2.6 kg DM/d diet and were provided in a 2×3 factorial with 0 or 3 g/d L-Met and with no supplemental energy or with acetate (385 g/d) or propionate (270 g/d) continuously infused into the rumen. Energy sources supplied 1.3 Mcal ME/d. In both trials, all steers received basal infusions of 400 g/d acetate into the rumen and a mixture (125 g/d) of all essential AA except Met into the abomasum. Nitrogen balance (23.6 vs 27.8 g/d, $P < 0.01$) and whole-body protein synthesis (2.1 vs 2.3 kg/d, $P < 0.07$) were increased by Met supplementation, indicating that Met limited protein deposition. Energy supply reduced ($P < 0.01$) urinary N excretion and increased ($P < 0.01$) N retention, without differences among energy sources. Increases in N retention in response to Met were numerically greater when energy was supplied. Efficiency of supplemental Met utilization was 11% when no energy was supplemented but averaged 21% when 1.3 Mcal ME/d was provided. Whole-body protein synthesis and degradation were not affected by energy supply. Serum insulin concentrations were increased by glucose and propionate supplementation. Serum IGF-I concentrations were increased by supplementation with Met or glucogenic sources of energy. In growing steers, N retention was increased by energy supplementation even though Met limited protein deposition, suggesting that energy supplementation improves the efficiency of AA utilization. These responses were independent of the source of energy supplemented.

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711 Ruminant fermentation of ^{15}N -labeled alfalfa hay N fractions *in vitro*. A. Melgar* and A. N. Hristov, *University of Idaho, Moscow.*

The objective of this study was to compare the ruminal *in vitro* rate and extent of bacterial utilization of ^{15}N -labeled alfalfa hay N fractions. Nitrogenous fractions from green house-grown alfalfa hay were isolated and incubated *in vitro* with mixed ruminal populations. The following N fractions were prepared: insoluble N (InsN), soluble protein N (SolPN), non-protein N (NPN), neutral-detergent insoluble N (NDFN), and acid-detergent insoluble N (ADFN). Casein labeled with ^{15}N (Cas) was used as a control. Incubation was repeated three times ($n=3$). All N fractions were incubated with ruminal inoculum/buffer media containing sugars, starch, and pectin as energy sources. Concentration of ^{15}N in the incubation media was 5.6 mg/L. Samples were taken at 0, 0.25, 0.5, 1, 2, 4, 6, and 8 h, fractionated into: ammonia N (NH₃N), bacterial N (BactN), N