RUMINANT NUTRITION II

0601 Using a dynamic metabolic model to investigate differences in metabolic patterns among lactating animals. L. Oliveira[1], H. Kimball[2], J. P. McNamara[*2], and A. Fix[2], *[1]Sao Paulo State University, Brazil, [2]Washington State University, Pullman, WA.*

In dairy cattle, the metabolic flux in body tissues, primarily in visceral, muscle, and adipose tissues make up a large contribution to variations in efficiency among animals housed and fed alike. Metabolic processes are affected by genotype, phenotype, and intake; genotypic differences eventually result in variation in patterns of metabolism that have different metabolic efficiencies. In continued work with the objective of identifying the patterns of metabolic flux in the most efficient dairy cattle, an existing mechanistic metabolic model (Molly, UC Davis) was used to describe differences in energetic and nitrogen efficiency among cows fed and housed alike. Data were from 42 high producing cows fed an alfalfa/corn/SBM based TMR. Data on genetic merit and DMI were input into the model, and milk component output, changes in adipose tissue lipid metabolism; visceral and body protein and lipid, nitrogen were output. Each cow was simulated separately. There was a range in metabolic processes from 27% (maintenance costs) to 93% (MUN) (Table 0601). Tissue metabolism rates (lipogenesis, lipolysis) varied by 48 to 74%; indicating a wide range in potential to metabolize nutrients. The intricate range of patterns of nutrient metabolism underlay the 21% range in net energy efficiency (milk energy/ME intake). A systems approach and model can be used, eventually, to improve selection of cows to reduce the variation in energy efficiency. Integrating all the biological processes with data on genomics and transcriptomics using systems models will help reduce variation in energy efficiency.

Key Words: efficiency, systems biology, metabolic model

Table 0601.

Item	Min	Max	SD	% range
DMI	19.8	31.5	3.2	159%
MILK, kg/d	28.7	49.8	5.1	174%
Lipolysis, M/d	8.1	12	1.3	148%
Lipogenesis, M/d	5.4	9.4	0.87	174%
MES, Mc/d	17.8	30.1	3.07	169%
Maint, Mc/d	25.4	32.4	3.5	127%
HI Main, kg/d	7.4	11.0	1.16	148%
Prot Intake, kg/d	1.3	2.0	0.21	159%
Aa to Milk, M/d	7.8	13.5	1.4	174%
MUN, mg/dl	5.5	10.6	1.3	193%
MES/MEI, %	34.0	41.0	1.7	121%

0602 A dynamic, mechanistic model of metabolism in adipose tissue of lactating dairy cattle. J. P. McNamara[*1], K. Huber[2], and A. Kenez[2], *[1]Washington State University, Pullman, [2]University of Hannover, Germany.*

Research in dairy cattle biology has resulted in a large body of knowledge on nutrition and metabolism supporting and underlying milk production and efficiency. The adipose tissues are an essential part of the overall efficiency of dairy cattle. Therefore we constructed a dynamic, mechanistic model of control of metabolism in the adipose tissues of dairy cattle. The model describes the biochemical interconversion of glucose, acetate, glycerol, fatty acids, and triacylglycerols. Data from our own research and published references were used to set equation forms and parameter values. Metabolites are absorbed from blood, and fatty acids are activated to the Acyl CoEnzymeA counterparts. Fatty acids are partitioned to palmitic, stearic, oleic and linoleic acids. Enzymatically catalyzed reactions are explicitly described with parameters including maximal velocity and substrate sensitivity. Energetic stoichiometry is maintained by the balance of ATP utilizing and generating reactions. Changes in gene transcription or post-translational modification of enzyme activity control nutrient metabolism, including control by insulin and norepinephrine. The model behavior to availability of nutrients and insulin or norepinephrine is in agreement with published data. For example, triacylglycerol synthesis when glucose is low (1 mM) is 17.82 + 1.9 X ln (Fatty Acyl CoA); when glucose is high (5 mM) it is 44.96 + 5.67 ln (Fatty Acyl CoA). Triacylglycerol lipolysis is -13.28- 4.33 ln (Fatty Acyl CoA) when norepinephrine is low, and is- 22.14- 7.22 ln (Fatty Acyl CoA) when it is high (25% more than basal). This model can form a basis for more sophisticated integration of existing knowledge and future studies on metabolic efficiency of dairy cattle.

Key Words: adipose, metabolism, mechanistic model, lactation

0603 Total volatile fatty acid concentrations are unreliable estimates of treatment effects on in vivo ruminal fermentation. M. B. Hall[*1], T. D. Nennich[2], and P. H. Doane[3], *[1]U. S. Dairy Forage Research Center, USDA-ARS, Madison, WI, [2]Purdue University, West Lafayette, IN, [3]ADM Research, Decatur, IL.*

The sum of ruminal acetate, propionate, butyrate, and valerate concentrations ([VFA], m*M*) are used to assess impact of dietary treatments on pattern of carbohydrate fermentation, typically with intent to indirectly relate microbial products to nutrient supply to the cow. However, discrepancies in statistical results of treatment effects between [VFA] and VFA pool size (VFAmol) within one study suggested there were problems with this approach. We investigated relationships among [VFA], VFAmol, and rumen digesta liquid kg (LIQ) measured

2 h post-feeding using individual lactating cow data (175 observations) measured in seven separate feeding trials. Regression analyses were performed using mixed models with "trial" as a discrete random variable; dependent (Y) and independent (X) variables are in Table 0603. Correlations (*r*) are the mean of individual trial values. Across studies, [VFA] had a numerically smaller within-study coefficient of variation (13%) than did VFAmol (23%). Rumen liquid increased with VFAmol. Change in LIQ was likely a function of water flux in the rumen based on the osmotic gradient of rumen liquid and blood; VFAmol represents a large ruminal pool of solute. Rumen liquid and [VFA] were poorly correlated. Concentration of VFA increased with VFAmol. The ratio of [VFA]/VFAmol ranged from 9.0 to 24.1 and changed as a function of 1000/LIQ. The equation reflects the inherent relationship among the three variables, and that [VFA] at differing LIQ differ in their relationship to VFAmol. Mean within-trial LIQ was 73 kg (standard deviation = 11.2), with an average within-study range of 43 kg. Assumption of equivalent ruminal liquid volumes is incorrect. Occupying variable LIQ, [VFA] are not on the equivalent basis needed for comparison of treatments. Alternate approaches must be developed to appropriately use [VFA] to assess treatment effects.

Key Words: rumen, VFA, liquid

Table 0603. Relationships between rumen measures[1]

Y	X	Intercept (SE)	Slope (SE)	p-value of X	Average r
[VFA]	VFAmol	83.9 (5.1)	5.83 (0.38)	< 0.01	0.74
LIQ	VFAmol	32.8 (2.15)	3.68 (0.18)	< 0.01	0.83
[VFA]	LIQ	113 (10.9)	0.473 (0.124)	< 0.01	0.26

[1] Y = dependent variable, X = independent variable, SE = standard error, r = correlation coefficient, [VFA] = VFA concentration, mM, VFAmol = moles of VFA, LIQ = rumen liquid, kg.

0604 Effects of diets differing in starch, fiber, and fatty acid concentrations on milk production and energy partitioning.

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Effects of feeding diets similar in energy composition, yet differing in starch, fiber, and fatty acid (FA) concentrations, on yield of milk and milk components and energy partitioning were evaluated in a crossover design experiment. Holstein cows (*n* = 32; 102 ± 22 DIM) were randomly assigned to treatment sequence. Treatments were a high starch diet containing 34% corn grain (mixture of dry ground and high moisture corn; HS) or a high FA diet containing 2.5% palmitic acid-enriched FA supplement (HF). Diets contained corn silage, alfalfa silage, and wheat straw as forage sources and contained 34 or 18% starch, 3.2 or 6.3% FA, and 26 or 34% NDF for HS and HF, respectively. Treatment periods were 28 d with the final 5 d used for data and sample collection. The statistical model included the random effect of cow and fixed effects of treatment and period. DMI was 27.4 and 26.9 kg/d for HS and HF, respectively ($P = 0.11$). Compared with HF, HS increased milk yield (47.1 vs. 45.8 kg/d; $P = 0.02$), milk protein concentration (3.07 vs. 2.93%; $P < 0.01$), and milk protein yield (1.44 vs. 1.34 kg/d; $P < 0.01$), did not alter ECM ($P = 0.47$), but reduced milk fat concentration (3.58 vs. 3.95% kg/d; $P < 0.01$), milk fat yield (1.68 vs. 1.81 kg/d; $P < 0.01$), and milk to feed ratio (ECM/DMI, 1.73 vs. 1.78; $P = 0.03$). HS increased the yield of de novo synthesized (< 16-carbon) milk FA (58 g/d; $P < 0.01$) and reduced the yield of 16-carbon milk FA (179 g/d; $P < 0.01$). Yield of preformed (> 16-carbon) milk FA was not affected ($P = 0.80$). HS increased plasma concentration of insulin by 27% ($P < 0.01$) but decreased triglycerides by 10% ($P < 0.01$) and NEFA by 28% ($P < 0.01$). Compared with HF, HS increased BW gain by 14 kg/28 d ($P < 0.01$), change in BCS by 0.25 pt/28 d ($P < 0.01$), and fat thickness over the rump by 0.79 mm/28 d and between the 12th and 13th rib by 0.23 mm/28 d (both $P = 0.04$). Calculated body energy gain as a fraction of NE_L use was greater for HS (10 vs. 3%; $P < 0.01$), whereas milk energy as a fraction of NE_L use was decreased for HS (68 vs. 74%; $P < 0.01$). We conclude that the two diets resulted in similar NE_L intake but the HS diet partitioned more energy toward body gain, whereas the HF diet partitioned more energy toward milk. A high fiber and FA diet might diminish the incidence of over conditioning in mid-lactation cows.

Key Words: starch concentration, fatty acid concentration, energy partitioning

0605 Propionic acid decreased meal size and feed intake compared with glycerol when infused abomasally in cows in the postpartum period.

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Our objective was to evaluate effects of propionic acid (P) and glycerol (G) on dry matter intake (DMI) and feeding behavior for cows in the immediate postpartum period. We hypothesized that propionic acid will decrease DMI and meal size compared to glycerol because of differences in their hepatic metabolism. Isoenergetic infusions of P or G were administered abomasally to eight ruminally cannulated multiparous Holstein cows (4.8 ± 2.3 DIM) in a double crossover design with four, 2-d infusion periods. Treatment sequences (P-G-P-G or G-P-G-P) were assigned alternately to cows based on date of parturition. Treatments were propionic acid (99.5%, 1.00 M) and glycerol (99.7%, 0.92 M) infused at 483 mL/h, which provided 4.26 Mcal/d. Feeding behavior was recorded by a computerized data acquisition system. Data were averaged within period, and period means were analyzed by analysis of variance; the model included the random effect of cow, the fixed effects of period and treatment, and interactions between treatment and period and between treatment and cow. No difference was detected for the amount of each treatment infused (11.6 L/d). Propionic acid decreased DMI

16.7% compared with glycerol (12.5 vs. 15.0 kg/d, $P = 0.04$) by decreasing meal size (1.04 vs. 1.18 kg DM, $P < 0.05$). No interaction was observed between treatment and period indicating a sustained treatment effect over time. Propionic acid tended to increase the time between meals 35 min (114 vs. 79 min, $P = 0.11$) but did not affect meal frequency (12.3 meals per d; $P = 0.48$) compared with glycerol. Propionic acid decreased the hunger ratio (meal size to time since the previous meal) by 25% compared with glycerol (20.3 vs. 27.1 g/min, $P = 0.05$) as well as the satiety ratio (meal size to time until the next meal) by 27% compared with glycerol (24.6 vs. 33.6 g/min, $P < 0.02$). Consistent with our hypothesis, propionic acid decreased meal size and DMI compared with glycerol possibly because of differences in their metabolism in the liver.

Key Words: fresh cows, feed intake, hepatic metabolism

0606 Responses to starch infusion on milk synthesis in low yield lactating dairy cows. Y. Zou*, Z. Yang, Y. Guo, S. Li, and Z. J. Cao, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing.*

The effect of starch infusion on production and metabolic parameters was investigated in low yield lactating cows from 86 d in lactation. Six Holstein cows fitted with permanent ruminal cannulas were arranged into two complete 3 × 3 Latin squares, infused a starch solution containing 800 g starch for 16 d. The three treatments were: 1) ruminal and abomasal infusion with water (Control); 2) ruminal infusion with cornstarch solution and abomasal infusion with water (Rumen); 3) ruminal infusion with water and abomasal infusion with cornstarch solution (Abomasum). There was no significant difference ($P > 0.05$) among the three treatments with low yield lactating cows in dry matter intake, body condition and milk yield, and milk component concentrations. However, cows receiving starch through rumen performed better than through abomasum directly during the glucose tolerance test procedure with higher area under the curve (AUC; $P = 0.08$) and shorter half-time ($t^{1/2}$; $P = 0.11$) of plasma insulin, therefore, it increased glucose disposal, which stated a lipid anabolism other than mobilization after energy supplementation. In conclusion, extra starch infusion at concentration of 800 g/d did not ameliorate energy supplies to mammary gland and improve the lactating performance as we expected but resulted in a tendency of shifting metabolic event toward the pathway of subcutaneous adipose accumulation at low yield lactating cows.

Key Words: starch infusion, lactation performance, glucose tolerance test

0607 The effect of starch digestibility of two corn silage varieties on lactation performance in dairy cows. E. E. Klingensmith*, L. Harthan, and M. D. Hanigan*, Virginia Polytechnic Institute and State University, Blacksburg.*

The objective of this study was to investigate the effect of storage on two corn silage varieties with varying amounts of floury and vitreous endosperm. Floury endosperm is expected to have faster rates of ruminal starch digestion at harvest, resulting in increased overall starch digestibility. However it is unclear if these differences persist during storage. Two multiparous, ruminally cannulated dry cows were used to assess ruminal degradability of starch in ensiled corn silage derived from a floury and vitreous varieties of corn. Cows were fed lactating high cow TMR twice daily ad libitum. Ruminal degradability characteristics were determined as described by NRC (2001). Approximately 10 g of dried and ground corn silage stored for 54 and 80 d sealed in duplicate polyester bags and suspended in the rumen in a large nylon mesh bag for 2, 4, 8, 12, 24, and 36 h. Samples were placed in the rumen in reverse order at varying times and removed simultaneously at the end

Table 0606. Effects of starch infusion with 800 g/d on performance, production and glucose tolerance test in lactation dairy cows

Items	Treatment			Pooled SEM	Contrast	
	Control	Rumen	Abomasum		Infusion	Site
Dry matter intake, kg/d	18.58	17.96	17.67	0.30	0.26	0.70
Body weight, kg	584.5	590.5	600.7	8.35	0.55	0.63
Body condition score	2.71	2.75	2.79	0.06	0.64	0.79
Backfat thickness, mm	17.50	19.33	19.87	0.61	0.37	0.83
Milk yield, kg/d	21.05	21.02	21.07	0.28	0.99	0.93
Milk fat, %	3.43	3.42	3.35	0.03	0.43	0.25
Milk protein, %	2.88	2.91	2.88	0.02	0.71	0.56
Milk lactose, %	4.93	4.98	4.94	0.03	0.70	0.62
Insulin resistance						
Basal concentration, μIU/mL	18.4	16.5	18.7	1.88	0.83	0.79
Peak concentration, μIU/mL	30.3	27.7	41.4	1.36	0.91	0.62
Clearance rate, %/min	3.64	2.59	5.83	0.65	0.90	0.83
Area under the curve, μIU × min/mL	347.8	333.8	374.5	17.59	0.81	0.08
$t^{1/2}$, min	19.1	26.7	13.6	3.14	0.97	0.11

of the experiment. A 0-h sample was immersed in 39°C water for 20 min. Residues were submitted to Agri Analysis for fiber and starch content determination. Starch disappearance was calculated as the difference between the original starch mass and the mass remaining after ruminal fermentation and expressed as a percentage of the original starch mass. The two varieties of corn silage did not differ for soluble starch (24.10 vs. 26.41%; $P = 0.99$), degradation rate (0.35 vs. 0.24%/hr; $P = 0.79$), slowly digestible starch (67.65 vs. 68.22%; $P = 1.00$), and resistant starch (8.24 vs. 5.36%; $P = 0.70$) after 54 d storage. There were also no differences after 80 d of storage for rapidly digestible starch (19.06 vs. 36.71%; $P = 0.28$), degradation rate (0.23 vs. 0.24 $P = 1.00$%/h), slowly digestible starch (78.49 vs. 59.11%; $P = 0.11$), and resistant starch (2.45 vs. 4.18%; $P = 0.90$). Thus, any differences amount corn varieties did not persist by 54 d of storage. References: (1) National Research Council. 2001. Nutrient Requirements of Dairy Cattle. Natl. Acad. Sci., Washington, DC.

Key Words: starch digestibility, corn silage

0608 Effects of calcium oxide treated corn stover as a partial replacement for corn silage, Chinese wildrye or concentrate on milk yield and composition of dairy cows. H. T. Shi*, S. L. Li, Z. J. Cao, and Y. Q. Wu, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing.*

The utilization of corn stover was limited by its poor digestibility for ruminants. Studies showed that the nutritive value of corn stover can be improved by calcium oxide (CaO) treatment. The objective of this experiment was to determine the effect of replacing a portion of corn silage (CS), Chinese wildrye (CW), or concentrate (CT) in the diets with CaO-treated corn stover on milk yield and milk composition of dairy cows. Sixty-four Holstein cows in mid to late lactation were assigned to one of the four treatments in a randomized block design (16 cows/group): 1) control treatment (CON), diets included 15% Chinese wildrye, 25% corn silage, 10% alfalfa hay, and 50% concentrate; 2) replacing 15% Chinese wildrye with treated stover (RCW); 3) replacing 12.5% corn silage with treated stover (RCS); 4) replacing 7% concentrate with treated stover (RCT). Cows were offered the total mixed ration (TMR) thrice daily and the experiment was lasted for 90 d. The inclusion of treated stover in treatment diets as a substitute for CW, CS, and CT had no effects ($P > 0.05$) on lactose percentage, 4% fat-corrected milk yield, milk fat yield, and milk protein yield. Cows in RCW and RCT treatments had similar milk yield ($P > 0.05$) compared with that in CON treatment. Cows in CON treatment had higher ($P < 0.05$) milk protein percentage than that in other treatments. Cows in RCS treatment had higher ($P < 0.05$) milk yield and milk lactose yield than that in CON treatment. Milk fat percentage was decreased ($P > 0.05$) for the RCW treatment compared with the CON treatment. The CON treatment had higher ($P < 0.05$) total solids percentage and MUN concentration than other treatments. The RCS treatment had lower ($P < 0.05$) somatic cell count than other treatments. These results suggest that a portion of corn silage, Chinese wildrye, or concentrate can be replaced by CaO-treated corn stover without negative effects on 4% FCM, milk fat, milk protein, and milk lactose yields of dairy cows.

Key Words: dairy cow; performance; treated corn stover

0609 Effects of dried sugar beet pulp as a replacement for corn silage on performance of dairy cows. G. R. Ghorbani*, N. Naderi, A. Sadeghism, and I. Sadrearhami, *Isfahan University of Technology, Isfahan, Iran.*

This study investigated the effects of feeding dried beet pulp (BP) as a replacement for corn silage (CS) on performance of dairy cows. Four multiparous (126 ± 13 d in milk) and four primiparous (121 ± 11 d in milk) Holstein cows were used in a replicated 4 × 4 Latin square design with four 21-d periods. Dry matter intake was not affected by treatments. Nonetheless,

Table 0609. Effects of treatments on dry matter intake, milk, and digestibility

	Treatment[1] (CS:SBP)					*P*-value[2]		
Item	A (100:0)	B (50:50)	C (25:75)	D (0:100)	SEM	Trt	L	Q
DM intake, kg/d	22.58	22.60	23.09	22.43	0.23	0.772	0.978	0.477
Milk yield, kg/d	38.49	39.33	40.94	39.64	0.26	0.026	0.041	0.052
3.5% FCM[3]	37.71	38.45	38.88	35.86	0.46	0.142	0.232	0.058
FCM/DMI	1.67	1.71	1.69	1.61	0.02	0.468	0.349	0.209
Milk fat, %	3.46	3.47	3.27	3.00	0.05	0.021	0.004	0.204
Milk protein, %	3.03	3.10	3.11	3.12	0.02	0.203	0.062	0.392
Milk lactose, %	5.62	5.63	5.69	5.68	0.01	0.360	0.111	0.773
MUN, mg/dl	12.20	11.08	10.48	10.73	0.19	0.03	0.01	0.09
DM digestibility, %	69.25	62.93	72.59	69.23	1.29	0.100	0.418	0.574
OM digestibility, %	71.06	64.95	74.14	71.02	1.27	0.113	0.435	0.564

[1]Treatments were four different ratios of corn silage to beet pulp: 100:0 (A), 50:50 (B), 25:75 (C), or 0:100 (D).
[2]Trt: treatment effect, L: linear effect, Q: quadratic effect.
[3]3.5% fat-corrected milk.

as corn silage was replaced with dried beet pulp, milk yield increased in a curvilinear manner (Table 0609), which led to a trend ($P = 0.058$) for increasing 3.5% yield quadratically. Milk fat percentage linearly decreased ($P = 0.004$) as corn silage was replaced with dried sugar beet pulp. However, milk protein percentage tended ($P = 0.062$) to increase linearly as corn silage was replaced with dried beet pulp. As beet pulp was increasingly substituted for corn silage milk urea nitrogen (MUN) was decreased linearly ($P < 0.001$). Replacing corn silage with dried sugar beet pulp tended ($P = 0.100$) to have an effect on DM digestibility, which led to a trend ($P = 0.113$) for OM digestibility. The results of this experiment indicate that replacing of dried sugar beet pulp for 75% of corn silage can increase actual milk, 3.5% FCM and protein yields and decrease MUN.

Key Words: corn silage, dried sugar beet pulp, dairy cows

0610 Effect of feeding different types of sugars on rumen fermentation and productivity of lactating dairy cows. X. Gao* and M. Oba, *University of Alberta, Edmonton, Canada.*

The objective of this study was to investigate the effect of feeding different types of sugar (sucrose or lactose) on rumen fermentation and milk production of lactating dairy cows. Our hypothesis was that sucrose diets have lower rumen pH and milk fat yield compared with diets supplement with lactose. Twenty-eight multiparous lactating Holstein cows (141 ± 50 DIM; 614 ± 53 kg of BW) including eight ruminally cannulated cows were used in this study. Cows were assigned to four dietary treatments in a 4 × 4 Latin square design. Two high sugar diets contained 27% starch and 9% sugar with sucrose (SUC) or lactose (LAC) as a supplemental sugar. In addition, high starch diet (STA) contained 32% starch and 4% sugar, and control diet (CON) contained 27% starch and 4% sugar. All diets were formulated to contain 17% crude protein. There was no significant difference in DMI between two high sugar diets, but it was higher for SUC than CON (27.8 vs. 26.2 kg/d; $P < 0.01$). In addition, both high sugar diets had higher DMI than STA diet (27.8 and 26.9 vs. 25.5 kg/d; $P < 0.01$). There was no difference in minimum rumen pH, duration and area of rumen pH < 5.8 among treatments, though LAC diet tended to have lower mean rumen pH than STA diet (6.17 vs. 6.32; $P = 0.08$). Milk yield and milk composition were not different between two high sugar diets, but STA diet had lower fat yield compared to CON, SUC, and LAC diets (1.26 vs. 1.36, 1.32 and 1.33 kg/d; $P < 0.01$). Milk CP yield tended to be higher for SUC diet than STA diet (1.32 vs. 1.26 kg/d; $P = 0.08$), and both high sugar diets had higher CP concentration than CON (3.51 and 3.50 vs. 3.46%; $P = 0.04$). However, all STA, SUC and LAC diets had lower MUN concentration compared with CON (13.2, 12.9 and 13.3 vs. 14.5 mg/dL; $P < 0.01$), which was probably due to more carbohydrate fermentation in the rumen for high-starch or high-sugar diets compared with CON diet, providing more energy for microbes to capture NH_3–N. These results suggested that feeding different type of sugar (sucrose or lactose) to lactating cows might not affect rumen fermentation and animal performance.

Key Words: sucrose, lactose, milk fat content

0611 Effects of alfalfa and cereal straw as a forage source on nutrient digestibility, rumen microbial protein synthesis, and lactation performance in lactating dairy cows. B. Wang*[1], S. Y. Mao[2], H. J. Yang[3], Y. M. Wu[1], J. K. Wang[1], S. L. Li[4], Z. M. Shen[2], and J. X. Liu[5], *[1]Institute of Dairy Science, Zhejiang University, Hangzhou, China, [2]Nanjing Agricultural University, China, [3]China Agricultural University, Beijing, [4]State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, [5]Zhejiang University, Hangzhou, China.*

This study was conducted to investigate nutrient digestibility, rumen microbial protein (MCP) synthesis, and lactation performance when alfalfa was replaced with cereal straw in the diet of lactating cows. Forty-five multiparous Holstein dairy cows were individually fed, blocked based on days in milk (164 ± 24.8 d) and milk yield (29.7 ± 4.7 kg), and randomly assigned into one of three treatments. Three isonitrogenous diets with a forage-to-concentrate ratio at 45:55 contained similar concentrate composed by ground corn grain, wheat bran, soybean meal, and cottonseed meal and 15% corn silage, with three forage sources (DM basis): 23% alfalfa hay and 7% Chinese wild rye hay (AH); 30% corn stover (CS); and 30% rice straw (RS). The trial lasted for 14 wk. The rumen MCP was estimated using purine derivatives and creatinine in urine, and metabolizable protein was the sum of the intestinally absorbable MCP plus intestinally absorbable dietary protein estimated by modified three-step procedure. Apparent nutrients digestibilities were measured with acid-insoluble ash as internal marker. The data of animal performance are summarized in Table 0611. Cows fed AH had higher MCP yield ($P < 0.05$) and metabolizable protein ($P < 0.01$) than those fed RS and CS, which may be attributed to the higher content of soluble carbohydrates in AH. Total volatile fatty acids concentration in ruminal fluid collected by an oral stomach tube was higher in AH than in CS and RS. Apparent digestibilities of nutrients were higher in AH than in CS and RS ($P < 0.05$). In summary, when cereal straw was used to replace alfalfa as a main forage source for lactating cows, the shortage of easily fermented energy may reduce the rumen MCP synthesis, resulting in lower milk protein yield, and lower nutrient digestibility may restrict milk production.

Key Words: forage source, lactation performance, ruminal microbial protein

Table 0611. Dietary composition and lactation performance in dairy cows

Item	Treatment			SEM	*P*-value
	AH	CS	RS		
Composition, % of DM					
Crude protein	16.7	16.2	16.0		
Neutral detergent fiber	31.1	36.3	36.9		
Non-fibrous carbohydrate	40.6	36.0	34.6		
Dry matter intake, kg/d	18.0	18.2	18.0	0.18	0.64
Milk yield, kg/d	23.5[a]	19.4[b]	20.8[b]	0.52	< 0.01
Milk composition, %					
Protein	3.30[a]	3.20[ab]	3.10[b]	0.055	0.05
Fat	4.21	4.20	4.19	0.077	4.21
Lactose	4.89[a]	4.84[a]	4.70[b]	0.026	< 0.01
Total solid	13.7[a]	13.5[ab]	13.2[b]	0.15	0.13

[a,b]Values with different letters differ significantly ($P < 0.05$).

0612 Feeding lactating dairy cattle long hay separate from the TMR can maintain DMI during incidents of low rumen pH.

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The objective of this study was to investigate effects of orchardgrass hay (H) quality and feeding method on rumen pH and feed preference in lactating dairy cows. Eight rumen-cannulated Holstein cows (104 ± 34 DIM, 601 ± 116 kg, and parity of 2.38 ± 1.69; mean ± SD) were used in a replicated 4 × 4 Latin Square. Each period encompassed 21 d divided into five phases: adaptation, d 1 to 14, ad libitum TMR; baseline, d 15 to 17, ad libitum TMR; restricted feeding, d 18, cows fed for 75% of baseline DMI; challenge, d 19, 4 kg (as-fed) fine ground wheat mixed into the digesta of each cow via rumen cannula before feeding; and recovery, d 20 to 21, ad libitum TMR. Cows were assigned to squares by parity and randomly assigned to treatments. Treatments were: corn silage (CS) with coarse H TMR (CC), CS and fine H TMR (CF; both hays chopped and included in TMR), CS TMR with 5.2% supplemental long coarse H (TMR+C), and CS TMR with 5.2% supplemental long fine H (TMR+F; both hays fed separate from TMR). Coarse H was 8.6% CP and 67.1% NDF, fine H was 14.4% CP and 56.2% NDF. Animals were housed individually, milked 2x/d, and fed 1x/d for 10% refusal rate. Data was analyzed using PROC MIXED of SAS. Rumen challenge decreased weighted average rumen pH from 5.72 to 5.51. Cows fed TMR+C had higher rumen pH compared to CC and TMR+F on d 19. During d 20, cows fed H had higher rumen pH than cows fed supplemental long H. Cows fed supplemental long H had greater DMI during baseline and challenge d compared to TMR H treatments. Minimal differences among diets were found for TMR particle size selection during challenge d; however, cows had a greater preference for fine long H during recovery d. Milk production averaged 38.3 kg/d and did not differ among treatments. Fat, protein, and lactose yields were also not different among treatments. Milk fatty acid profile was altered by treatment. The TMR+C and CF treatments increased production of conjugated linoleic acid (CLA) *cis*-9, *trans*-11 ($P = 0.02$). Results of this study indicate that feeding TMR plus supplemental long H can maintain DMI during incidents of and recovery from periods of low ruminal pH.

Key Words: subacute ruminal acidosis, ruminal pH, particle size