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C.R. Mullins

D. Weber

E. Block

See next page for additional authors

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Abstract

Ninety-six lactating Holstein cows were used to determine the effects of using commercial supplements to supply additional lysine and methionine in diets containing large proportions of corn by-products. Cows were assigned to 1 of 8 pens. Pens were offered rations formulated to differ in metabolizable lysine and methionine supply. The study was divided into 2 periods. During period 1, cows received similar diets, but the treatment diet supplied supplemental lysine and methionine. During period 2, the treatment diet was modified to reduce dietary crude protein. Feed intake and production were monitored daily, and milk components were analyzed 3 days per week for 4 weeks. Diet did not alter feed intake or milk production. During period 2, dietary crude protein and milk urea nitrogen (MUN) were decreased without sacrificing performance.; Dairy Day, 2011, Kansas State University, Manhattan, KS, 2011; Dairy Research, 2011 is known as Dairy Day, 2011

Keywords

Dairy Day, 2011; Kansas Agricultural Experiment Station contribution; no. 12-176-S; Report of progress (Kansas Agricultural Experiment Station and Cooperative Extension Service); 1057; Dairy; By-product; Lysine; Methionine; Milk yield

Authors

C.R. Mullins, D. Weber, E. Block, and John F. Smith

Effects of Supplementing Methionine and Lysine in a Lactation Diet Containing High Concentrations of Corn By-products

C. R. Mullins, D. Weber, E. Block, J. F. Smith, M. J. Brouk, and B. J. Bradford

Summary
Ninety-six lactating Holstein cows were used to determine the effects of using commercial supplements to supply additional lysine and methionine in diets containing large proportions of corn by-products. Cows were assigned to 1 of 8 pens. Pens were offered rations formulated to differ in metabolizable lysine and methionine supply. The study was divided into 2 periods. During period 1, cows received similar diets, but the treatment diet supplied supplemental lysine and methionine. During period 2, the treatment diet was modified to reduce dietary crude protein. Feed intake and production were monitored daily, and milk components were analyzed 3 days per week for 4 weeks. Diet did not alter feed intake or milk production. During period 2, dietary crude protein and milk urea nitrogen (**MUN**) were decreased without sacrificing performance.

Key words: by-product, lysine, methionine, milk yield

Introduction
Cost of protein sources combined with environmental regulations demands more efficient use of dietary protein. Formulating for metabolizable protein (**MP**) has provided some progress in this area while possibly improving production. Formulating for an adequate MP supply may, however, still fail to meet the requirements of the cow if the dietary amino acid profile is not considered.

By-products from corn biofuel production are often used to provide protein and energy in lactation diets. In 2010, of the nutritionists and veterinarians who formulate rations and completed a survey, 92% used distillers grains or considered using them. Many other by-products of corn milling also are fed to dairy cattle, including corn germ meal, corn bran, corn meal, and corn gluten feed. Like corn grain, these by-products are low in lysine, so it is not surprising when nutrition models predict that diets containing large concentrations of corn by-products do not supply enough lysine to support the demands of high milk production. Many lactation diets also do not supply adequate methionine; thus, lysine and methionine are often the first-limiting amino acids in lactating cow diets.

The objective of this study was to evaluate the effects of supplementing commercial rumen-protected amino acids in a diet that was predicted to have marginally deficient lysine and methionine supply. The products used to provide the additional amino acids contained lysine embedded within calcium salts of fatty acids (Megamine-L, Arm & Hammer Animal Nutrition, Princeton, NJ) and the isopropyl ester of 2-hydroxy-4-methylthio-butanoic acid (HMBi; MetaSmart, Adisseo Inc., Antony, France), a methionine precursor.

Experimental Procedures

Ninety-six lactating Holstein cows (33 first lactation; 63 second or greater lactation) that averaged 186 days in milk were enrolled in this study. Cows were assigned to 1 of 8 identical pens with 12 free stalls in each pen. Cows were divided into pens evenly based on milk production, parity, and pregnancy status. Cows were moved into pens on May 3, 2010, and the study began on May 10, 2010, allowing for a 1-week adaptation period. During the adaption period, all pens received a common diet.

The study consisted of two 28-day treatment periods. During period 1, cows were offered either of 2 rations that were formulated to differ in metabolizable amino acid supply (Table 1). During period 2, the treatment diet was modified to decrease dietary crude protein and further increase lysine and methionine supply. Treatment diets were assigned randomly to pens. Cows were fed once daily at 110% of the expected intake. Amounts of feed delivered and refused were recorded on days 19, 20, 21, 26, 27, and 28 of each period. The total mixed rations were analyzed for dry matter (DM) on those days. Samples of all dietary ingredients were collected on days 19, 21, 26, and 28 and composited into 1 sample per period for wet chemistry analysis.

Cows were milked 3 times daily in a milking parlor, and milk yields were recorded at each milking. Milk samples were collected from every milking on each Monday, Wednesday, and Friday throughout the experiment. Milk samples were analyzed for component concentrations.

Results and Discussion

In formulating experimental diets, the strategy was to maintain large concentrations of corn by-products within diets; therefore, the control diet (Table 1) contained 26.7% wet corn gluten feed (**WCGF**) on a DM basis. The period 1 treatment diet was similar to the control; the primary differences were replacement of 190 g/cow of the calcium salts of fatty acids (Megalac-R, Arm & Hammer Animal Nutrition) with a source of calcium salts of fatty acids embedded with lysine (Megamine-L), and addition of 14 g/cow of HMBi. As expected, most nutrient concentrations were similar across treatments (Table 1); however, predicted supplies of metabolizable lysine and methionine were slightly elevated in the amino acid-supplemented group (Table 2).

Period 1 feed intake and production responses for both diets are shown in Table 3. Mean DM intake was 58.6 lb/day and mean milk yield was 88.4 lb/day, with means of 3.10% fat and 3.06% protein. No treatment effects were observed for any of the traits measured. Milk protein yield, the variable of greatest interest, was numerically smaller ($P = 0.54$) for the amino acid-supplemented diet compared with the control (2.67 vs. 2.71 ± 0.04 lb/day).

For period 2, the treatment diet was modified such that 3.6% WCGF was replaced with corn silage, expeller soybean meal was decreased from 4.9 to 2.2% of diet DM, and more Megamine-L and HMBi were added. These changes resulted in a decrease in dietary crude protein from 17.9% to 17.1%, with similar predicted lysine and methionine supply compared with the period 1 treatment diet (Table2).

Performance of cows fed the 2 diets during period 2 is shown in Table 4. Consistent with the decrease in dietary crude protein, milk urea nitrogen (**MUN**) was decreased ($P < 0.001$) in the amino acid-supplemented group (10.8 vs. 12.5 ± 0.2 mg/dL) without affecting milk production. During this period, mean DM intake was 53.8 lb/day and mean milk yield was 78.9 lb/day, with means of 3.18% fat and 3.04% protein. Beyond dietary treatment effects on MUN, no effects were observed for any production traits measured. As in period 1, milk protein yield was numerically smaller ($P = 0.20$) for the amino acid-supplemented diet compared with the control (2.18 vs. 2.25 ± 0.04 lb/day).

Results from this study did not support the hypothesis that increasing lysine and methionine supply would increase production of cows fed a corn by-product-based diet. A number of possible explanations could explain the lack of a response. One possibility is that the products used to provide supplemental methionine and lysine did not increase post-ruminal supply of these amino acids. Past research, however, has indicated that the amino acid sources used in this study are partially protected from ruminal degradation. The efficacy of HMBi to deliver metabolizable methionine is further supported by production responses showing HMBi supplementation increases milk protein when production seems to be limited by metabolizable methionine supply.

Another possibility accounting for why lysine and methionine supplementation did not increase production is that something else was first-limiting in this scenario. Our study narrowly focused on lysine and methionine because substantial research has supported the focus on a lysine and methionine deficiency in diets similar to those fed in our study. Energy intake also could have been limiting even though all nutrition model predictions indicated a positive energy balance.

A third possibility is that the model predictions, which were used to suggest a lysine limitation in the control diet, were wrong. From these results, determining whether this was because of inaccurate predictions of metabolizable lysine supply and/or lysine requirements is impossible.

Results from this study demonstrated little response to supplementing the rumen-protected amino acids lysine and methionine. Given the results, the diet fed to control cows likely was not deficient in these amino acids, or the supplemental amino acid products that were used did not efficiently escape ruminal degradation.

Table 1. Ingredient and nutrient composition of diets fed to lactating Holstein cows

	Dietary treatment		
Item	Control	Amino acid supplemented (period 1)	Amino acid supplemented (period 2)
Ingredient, % of dry matter			
Corn silage	23.4	23.4	27.8
WCGF[1]	26.7	26.6	23.0
Alfalfa hay	18.5	18.7	19.0
Cottonseed	5.4	5.3	5.6
Ground corn grain	14.2	14.2	14.7
Ground milo	2.7	2.7	2.8
Expeller soybean meal[2]	4.9	4.9	2.2
Fish meal, Menhaden	0.3	0.3	0.3
Calcium salts of fatty acids[3]	0.7	…	…
Megamine-L[4]	…	0.7	1.2
HMBi[5]	…	0.04	0.18
Micronutrient premix[6]	3.3	3.3	3.4
Nutrient			
Dry matter, % as-fed	55.6	55.6	52.9
Crude protein	17.8	17.9	17.1
Neutral detergent fiber	33.3	32.9	30.6
Crude fat	4.7	4.5	4.7
Starch	24.0	23.5	25.6
NFC[7]	37.6	37.9	41.1
Ash	6.9	6.8	6.7
NE_L, Mcal/lb[8]	0.76	0.76	0.79
Calcium	0.83	0.79	0.94
Phosphorus	0.54	0.53	0.50
Magnesium	0.35	0.33	0.33
Potassium	1.41	1.42	1.30
Sodium	0.42	0.44	0.44

[1] Wet corn gluten feed (Sweet Bran, Cargill, Inc., Blair, NE).
[2] Soybest (Grain States Soya, Inc., West Point, NE).
[3] Megalac-R (Arm & Hammer Animal Nutrition, Princeton, NJ).
[4] Calcium salts of long-chain fatty acids plus lysine monohydrochloride (Arm & Hammer Animal Nutrition).
[5] Isopropyl ester of 2-hydroxy-4-methylthio-butanoic acid, MetaSmart (Adisseo Inc., Antony, France).
[6] The premix consisted of 41.6% limestone, 32.5% sodium bicarbonate, 6.50% Diamond V XP (Diamond V Mills, Inc.), 5.40% trace mineral salt, 5.40% magnesium oxide, 5.20% vitamin E premix, 1.66% 4-plex, 0.93% Se premix, 0.36% vitamin A premix, 0.16% vitamin D premix, 0.05% EDDI, and 0.21% Rumensin 80 (Elanco Animal Health, Greenfield, IN).
[7] Nonfiber carbohydrates; calculated as dry matter − (crude protein + NDF + crude fat + ash).
[8] Estimated according to NRC (2001). Nutrient Requirements of Dairy Cattle, 7th rev. ed., National Research Council. Natl. Acad. Sci., Washington, DC.

Table 2. Predicted metabolizable lysine and methionine supplies as a percentage of predicted metabolizable protein supply by 3 different models and predicted metabolizable lysine:methionine ratio

	Dietary treatment					
	Control		Amino acid supplemented (period 1)		Amino acid supplemented (period 2)	
Item	Lysine	Methionine	Lysine	Methionine	Lysine	Methionine
Predicted supply (g/day)						
NRC (2001)	191	65	206	67	200	69
CNCPS 5.0	181	64	197	66	197	70
CNCPS 6.1	165	62	194	67	188	68
% of metabolizable protein						
NRC (2001)	6.3	2.2	6.8	2.2	7.2	2.5
CNCPS 5.0	6.1	2.1	6.6	2.2	7.1	2.5
CNCPS 6.1	5.3	2.0	6.0	2.1	6.5	2.3
Lysine:methionine[1]						
NRC (2001)	2.92		3.07		2.90	
CNCPS 5.0	2.84		2.99		2.81	
CNCPS 6.1	2.66		2.89		2.77	

[1] Calculated based on g of predicted amino acid supply.

Table 3. Effects of supplementing lysine embedded within calcium salts of fatty acids[1] and HMBi[2] on performance of lactating Holstein cows in period 1

	Dietary treatment			
Item	Control	Amino acid supplemented (period 1)	SEM	*P*-value
Dry matter intake, lb/day	58.2	58.9	1.10	0.65
Yield, lb/day				
Milk	88.2	88.2	1.5	0.98
Milk fat	2.68	2.75	0.07	0.59
Milk protein	2.71	2.66	0.04	0.54
Milk lactose	4.29	4.31	0.09	0.96
Energy-corrected milk[3]	84.0	84.7	1.5	0.81
Milk fat, %	3.07	3.12	0.06	0.59
Milk protein, %	3.08	3.04	0.04	0.51
Milk lactose, %	4.88	4.88	0.03	0.97
MUN, mg/dL	13.9	14.3	0.2	0.25

[1] Megamine-L, Arm & Hammer Animal Nutrition, Princeton, NJ.
[2] The methionine precursor isopropyl ester of 2-hydroxy-4-methylthio-butanoic acid (MetaSmart, Adisseo Inc., Antony, France).
[3] Energy-corrected milk = (0.327 × milk yield) + (12.86 × fat yield) + (7.65 × protein yield).

Table 4. Effects of supplementing lysine embedded within calcium salts of fatty acids[1] and HMBi[2] on performance of lactating Holstein cows in period 2

	Dietary treatment			
Item	Control	Amino acid supplemented (period 2)	SEM	*P*-value
Dry matter intake, lb/day	53.9	53.5	0.9	0.91
Yield, lb/day				
Milk	79.2	78.1	1.3	0.51
Milk fat	2.29	2.33	0.07	0.65
Milk protein	2.24	2.18	0.04	0.20
Milk lactose	3.59	3.52	0.07	0.36
Energy-corrected milk[3]	84.0	84.7	1.5	0.81
Milk fat, %	3.12	3.23	0.06	0.59
Milk protein, %	3.05	3.02	0.04	0.59
Milk lactose, %	4.85	4.84	0.04	0.87
Milk urea nitrogen, mg/dL	12.5	10.8	0.2	<0.001

[1] Megamine-L, Arm & Hammer Animal Nutrition, Princeton, NJ.
[2] The methionine precursor isopropyl ester of 2-hydroxy-4-methylthio-butanoic acid (MetaSmart, Adisseo Inc., Antony, France).
[3] Energy-corrected milk = (0.327 × milk yield) + (12.86 × fat yield) + (7.65 × protein yield).