Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 2 *Dairy Research (1984-2014)*

Article 55

2011

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Recommended Citation

Brake, D.W.; Titgemeyer, Evan C.; Bradford, Barry J.; and Macgregor, C.A. (2011) "Evaluation of methionine availability to dairy cows when added to mechanically extracted soybean meal with soy gums," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 2. https://doi.org/10.4148/2378-5977.2980

Evaluation of methionine availability to dairy cows when added to mechanically extracted soybean meal with soy gums

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Evaluation of Methionine Availability to Dairy Cows When Added to Mechanically Extracted Soybean Meal with Soy Gums

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Summary

Twenty-five Holstein cows were fed 5 different diets to evaluate amounts of metabolizable methionine provided to dairy cows from a mechanically extracted soybean meal (**meSBM**) with methionine added during manufacture. The control diet was designed to be deficient in metabolizable methionine supply. Two amounts of methionine were added from either a commercially available ruminally protected product (**RPMet**) or from a meSBM with methionine added during manufacture (**meSBM-Met**). Average milk yield was 98.8 lb/day, average milk fat was 2.81%, and milk urea nitrogen (**MUN**) averaged 8.6 mg/dL. Milk protein yield was not responsive to metabolizable methionine supply, suggesting that milk protein yield was not an optimal criterion for assessing metabolizable methionine supply. Milk protein content was greater when methionine was provided as RPMet than meSBM-Met. In addition, RPMet linearly increased plasma free methionine, but meSBM-Met did not. Body condition score (**BCS**; 1=thin and 5 =fat) was increased linearly by meSBM-Met, but responses were quadratic to RPMet. Methionine added to meSBM during manufacture did not appear to be available to dairy cows, likely because of extensive ruminal degradation.

Key words: methionine, dairy cow, soybean meal

Introduction

Optimizing the efficiency with which dairy cows utilize feed protein is often a goal of dairy producers and nutritionists. Improving efficiency of protein utilization decreases the amount of ruminally undegraded protein (**RUP**) necessary to optimize lactation performance and milk protein concentration. In addition, more efficient use of feed protein would mitigate contributions of reactive nitrogen to the environment by the dairy industry.

A large portion of metabolizable protein (protein available to the dairy cow) is of microbial origin, and this is largely a result of ruminal fermentation of feed. Microbial protein is generally considered to have an adequate profile of amino acids (building blocks of proteins) to support optimum milk protein synthesis. The amino acids provided by microbial protein plus the RUP from basal dietary ingredients (i.e., forages and grains) are unfortunately not sufficient to support ideal levels of milk production. Thus, nutritionists typically include ingredients with high concentrations of RUP (e.g., heated soybean meal, blood meal) to increase the supply of metabolizable protein. Unless the RUP has an amino acid profile well suited to meet cow needs, it will yield a less than optimal response.

Methionine and lysine are the amino acids most likely to limit the efficiency of protein utilization for milk production in dairy cows fed diets based on corn, corn silage, and alfalfa. Additions of ruminally protected methionine can increase efficiency of milk protein production when lysine is not limiting. Indeed, a number of ruminally protected amino acid products are

[1] Grain States Soya, West Point, NE.

commercially available to dairy producers, but adding these products to a ration can increase complexity in generating daily rations. Improving the amino acid profile provided by mechanically extracted soybean meal (**meSBM**) and adding methionine directly to the meSBM during manufacture may be possible, particularly if the methionine was mixed with soy gums before the soy gums were applied to the meSBM.

We evaluated the availability of methionine to dairy cows when it was added to meSBM with soy gums during its manufacture. We hypothesized that the methionine would be protected from ruminal degradation and therefore provide metabolizable methionine to the dairy cows.

Experimental Procedures

Twenty-five Holstein cows were housed in tie stalls at the Kansas State University Dairy Teaching and Research Center and fed 5 different diets (Table 1) during 5 14-day experimental periods in a Latin-square design. Total mixed rations were composed primarily of corn silage, alfalfa hay, sorghum grain, soybean hulls, and meSBM (Control). Ruminally protected lysine was added to all diets to ensure that methionine was the most limiting amino acid.

Methionine was added to diets either from a commercially available ruminally protected product (**RPMet**; provided as MetiPEARL, a gift from Kemin Industries, Des Moines, IA) or from meSBM with methionine added (0.3% wt/wt on a wet-basis) during manufacture (**meSBM-Met**). The RPMet was added to provide either 2.5 or 5 g/day of metabolizable methionine based on information from the manufacturer (7.5 or 15 g/day of MetiPEARL, respectively). Methionine was provided as meSBM-Met by replacing half or all of the dietary meSBM (Soy Best, Grain States Soya, West Point, NE) with the same product manufactured with methionine added to the soy gums. The meSBM-Met treatments were designed to add either 3.8 or 7.6 g/day of total dietary methionine from meSBM-Met. Attempts were made to provide similar levels of metabolizable methionine from both meSBM-Met and RPMet; however, because the content of metabolizable methionine from meSBM-Met was unknown, inclusions of methionine were designed *a priori* based on the assumption that two-thirds of the methionine added to meSBM was resistant to ruminal degradation.

Feed samples were collected on days 9 through 13 of each period. Daily intake was calculated from feed refusals that were weighed on days 10 through 14. Total milk yields were recorded and an aliquot was collected at each of the 3 daily milkings during the final 4 days of each period. Milk was analyzed for fat, true protein, lactose, MUN, solids not fat, and somatic cells by 24 hours after collection. To estimate nitrogen balance, urine and feces were collected 8 times during days 9 through 13 of each period. Urinary output was estimated assuming cows excreted creatinine at a rate of 13 mg/lb of body weight. Fecal output was estimated using acid detergent insoluble ash as a flow marker. Whole blood was harvested from a tail vessel at 7 hours after the morning feeding on the final day of each period. Plasma was isolated from whole blood and analyzed for free amino acids. Cow body weight was recorded at the beginning and end of each period, and BCS was measured by a single trained technician at the end of each period.

Milk samples were analyzed by Heart of America Dairy Herd Improvement Association (Manhattan, KS), and energy-corrected milk (**ECM**) was calculated as: (7.2 × lb/day of protein) + (12.95 × lb/day of fat) + (0.327 × lb/day of milk).

Results and Discussion

No differences among diets were observed for dry matter intake (Table 2). Average milk yield was 98.8 lb/day, average milk fat was 2.81%, and MUN averaged 8.6 mg/dL. Excluding differences in milk true protein concentrations, no differences were observed (Table 2) in either milk yield or content. Because dry matter intake, milk yields, and milk energy component yields were not different, the efficiency of ECM production was not different among diets.

Milk true protein concentration was greater when methionine was provided as RPMet than meSBM-Met. Increasing percentage of milk protein with additions of metabolizable methionine from RPMet is in close agreement with other reports; when methionine is limiting, milk protein concentration typically increases in response to methionine supplementation. Total yield of milk protein, however, was not affected by diet. Some research indicates that additions of metabolizable methionine increase total milk protein yields in addition to milk protein content, but increases in yield are normally associated with increases in total milk yields.

No differences were observed among diets for changes in body weight or apparent digestibilities of dry matter or nitrogen (protein). Similarly, nitrogen balance was not affected by diet. Nitrogen balance is a measure of whole-body protein accretion or mobilization. Because the periods in this experiment were relatively short, assessing nitrogen balance was necessary to ensure that cows were not mobilizing tissue proteins to support lactation and thereby masking responses to the supplemental methionine. Some reports suggest that nitrogen retention is improved when metabolizable methionine replaces dietary crude protein.

Body condition score increased linearly with greater amounts of methionine provided from meSBM-Met. Responses to additions of methionine from RPMet were quadratic with the 2.5 g/day of methionine yielding body condition increases that were greater than when 0 or 5 g/day of methionine was provided by RPMet. Ruminal fermentation may have benefited from the methionine provided as meSBM-Met, which may have resulted in slight increases in dietary energy content.

Plasma concentrations of a free amino acid generally will increase when supplies of that amino acid exceed the cow's requirement. Plasma free methionine concentrations (Figure 1) increased linearly when methionine was provided from RPMet, but methionine levels were not different from the control when methionine was added from meSBM-Met. This result demonstrates that metabolizable methionine was provided by RPMet.

In conclusion, additions of metabolizable methionine from RPMet resulted in increased milk protein content and plasma free methionine concentrations, but not when methionine was provided by meSBM-Met. Methionine added to meSBM during manufacture did not seem to be available to dairy cows, likely because of extensive ruminal degradation. In vitro evaluations of the meSBM-Met product, conducted subsequent to this experiment, support this conclusion.

Table 1. Composition of diets fed to cows (% of dry matter)

	Dietary treatments				
		meSBM-Met[1]		RPMet[2]	
Item	Control	Low	High	Low	High
Ingredient					
Dry-rolled sorghum	35.3	35.3	35.3	35.3	35.3
Corn silage	25.2	25.2	25.2	25.2	25.2
Alfalfa	15.2	15.2	15.2	15.2	15.2
Soybean hulls	10.0	10.0	10.0	10.0	10.0
Soy Best[3]	9.0	4.5	---	9.0	9.0
Soy Best + methionine	---	4.5	9.0	---	---
MegaLac-R	2.0	2.0	2.0	2.0	2.0
Calcium carbonate	1.2	1.2	1.2	1.2	1.2
Sodium bicarbonate	0.8	0.8	0.8	0.8	0.8
Monocalcium phosphate	0.4	0.4	0.4	0.4	0.4
LysiPEARL[4]	0.3	0.3	0.3	0.3	0.3
Trace mineral salt	0.3	0.3	0.3	0.3	0.3
Magnesium oxide	0.2	0.2	0.2	0.2	0.2
Zinpro 4-plex	0.05	0.05	0.05	0.05	0.05
Vitamin and mineral premix[5]	0.05	0.05	0.05	0.05	0.05
Chemical composition					
Dry matter	60.8	60.8	60.7	60.8	60.8
Crude protein[6]	14.3	14.3	14.3	14.3	14.3
Acid detergent fiber[6]	21.6	21.6	21.5	21.6	21.6
Neutral detergent fiber[6]	29.5	29.6	29.7	29.5	29.5
Crude fat[6]	3.8	3.8	3.8	4.0	4.0

[1] Mechanically extracted soybean meal with methionine added during manufacture (Grain States Soya, West Point, NE). Low = 3.8 g/day of total methionine added. High = 7.6 g/day of total methionine added.
[2] Ruminally protected methionine (MetiPEARL, Kemin Industries, Des Moines, IA). Low = 2.5 g/day of metabolizable methionine provided. High = 5.0 g/day of metabolizable methionine provided.
[3] Grain States Soya.
[4] Ruminally protected lysine provided 16.2 g/day of metabolizable lysine (Kemin Industries, Des Moines, IA).
[5] Provided to diets (dry matter basis): 1,497 IU of vitamin A/lb, 1,020 IU of vitamin D/lb, 16 IU of vitamin E/lb, and 0.06 ppm Se.
[6] Percentage of total diet dry matter.

Table 2. Effect of supplemental methionine from mechanically extracted soybean meal with methionine added during processing (meSBM-Met) or from ruminally protected methionine (RPMet) on production, nitrogen status, and digestibility of lactating dairy cows

	Dietary treatments						
		meSBM-Met[1]		RPMet[2]			
Item	Control	Low	High	Low	High	SEM	*P*- value
Dry matter intake (DMI), lb/day	56.2	56.7	56.0	55.3	56.2	1.3	0.79
Milk yield, lb/day	99.2	99.9	99.0	98.5	97.7	3.1	0.65
Energy-corrected milk (ECM), lb/day	88.2	88.8	89.5	88.6	86.9	3.1	0.66
Fat, %	2.77	2.79	2.90	2.84	2.77	0.12	0.61
Fat, lb/day	2.76	2.80	2.89	2.80	2.71	0.15	0.60
Protein[3], %	2.82	2.81	2.82	2.89	2.86	0.05	0.05
Protein, lb/day	2.78	2.78	2.76	2.82	2.76	0.07	0.76
Lactose, %	4.80	4.81	4.84	4.84	4.85	0.03	0.47
Lactose, lb/day	4.76	4.81	4.78	4.76	4.72	0.15	0.91
Solids not fat, %	8.52	8.51	8.56	8.64	8.61	0.08	0.14
Solids not fat, lb/day	8.42	8.47	8.42	8.49	8.36	0.22	0.92
Milk urea nitrogen, mg/dL	8.8	8.5	8.6	8.6	8.5	0.3	0.62
ECM:DMI	1.6	1.6	1.6	1.6	1.5	0.05	0.32
Body weight change[4]	15.4	19.0	11.5	12.6	19.2	7.1	0.90
BCS change[5]	-0.06	0.06[L]	0.10[L]	0.06[Q]	-0.01[Q]	0.04	0.03
Nitrogen balance, g/day							
Intake	590	594	586	582	590	14	0.88
Urine	155	153	151	157	153	5	0.70
Fecal	233	234	219	224	236	10	0.47
Milk[6]	197	198	197	200	197	4	0.76
Retention[7]	4	9	19	1	3	7	0.30
Productive[8]	202	207	216	202	200	9	0.54
Apparent digestibility, %							
Dry matter	62.1	62.9	63.9	63.7	62.1	1.2	0.71
Nitrogen	60.8	60.9	62.8	61.8	60.0	1.2	0.49

[1] Low = 3.8 g/day of total methionine added. High = 7.6 g/day of total methionine added.
[2] Low = 2.5 g/day of metabolizable methionine provided. High = 5.0 g/day of metabolizable methionine provided.
[3] RPMet differed from meSBM-Met.
[4] Change in body weight (lb) during 14 days.
[5] Change in body condition score during 14 days.
[6] Calculated as milk crude protein ÷ 6.38.
[7] Calculated as N intake – (Urine N + Fecal N + Milk N).
[8] Calculated as N intake – (Urine N + Fecal N).
[L] Linear ($P \leq 0.05$).
[Q] Quadratic ($P \leq 0.05$).

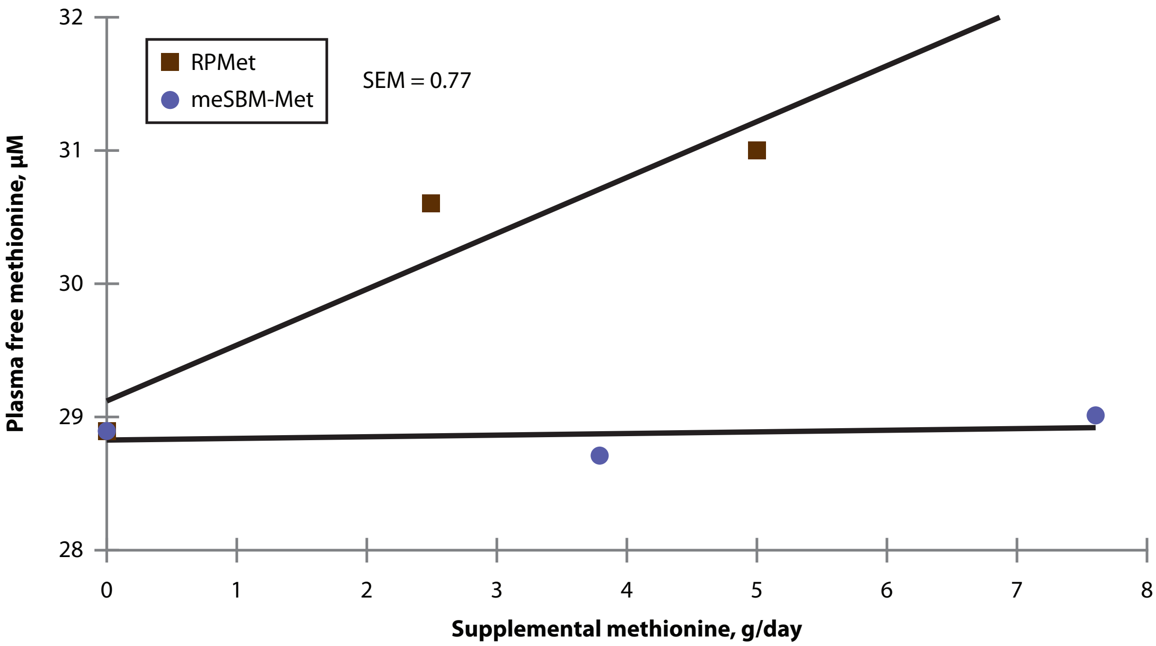

Figure 1. Effect of supplemental methionine from mechanically extracted soybean meal with methionine added during processing (meSBM-Met) or from ruminally protected methionine (RPMet) on plasma methionine concentrations of lactating dairy cows.
Supplemental methionine from meSBM-Met is listed as total methionine, whereas that from RPMet is listed as metabolizable methionine.