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Availability to lactating dairy cows of methionine added to soy lecithins and mixed with a mechanically extracted soybean meal

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ABSTRACT

We evaluated a product containing methionine mixed with soy lecithins and added to a mechanically extracted soybean meal (meSBM-Met). Lactational responses of cows, plasma methionine concentrations, and in vitro degradation of methionine were measured. Twenty-five Holstein cows were used in a replicated 5 × 5 Latin square design and fed a diet designed to be deficient in methionine or the same diet supplemented either with 4.2 or 8.3 g/d of supplemental methionine from a ruminally protected source or with 2.7 or 5.3 g/d of supplemental methionine from meSBM-Met. All diets were formulated to provide adequate amounts of metabolizable lysine. Concentration of milk true protein was greater when methionine was provided by the ruminally protected methionine than by meSBM-Met, but milk protein yield was not affected by treatment. Milk yields and concentrations and yields of fat, lactose, solids-not-fat, and milk urea nitrogen were not affected by supplemental methionine. Body condition scores increased linearly when methionine from meSBM-Met was supplemented, but responses were quadratic when methionine was provided from a ruminally protected source. Nitrogen retention was not affected by supplemental methionine. Plasma methionine increased linearly when methionine was supplemented from a ruminally protected source, but plasma methionine concentrations did not differ from the control when supplemental methionine from meSBM-Met was provided. In vitro degradation of supplemental methionine from meSBM-Met was complete within 3 h. Data suggest that meSBM-Met provides negligible amounts of metabolizable methionine to dairy cows, and this is likely related to extensive ruminal destruction of methionine; however, cow body condition may be improved by ruminally available methionine provided by meSBM-Met.

Key words: amino acid, dairy cow, methionine, soybean meal

INTRODUCTION

Increasing the efficiency with which dairy cows use N for productive purposes is a primary goal of protein nutrition. Because optimum profiles of AA are assumed to exist in MP for each physiological state of dairy cows (NRC, 2001), modifying AA flows to the duodenum to more closely match the optimal AA profile for the combined functions of maintenance and lactation might increase lactation performance and efficiency of N use in cows (Clark, 1975; Schwab et al., 1976; NRC, 2001). Although the AA content of microbial CP is well suited to support lactation (Schwab et al., 1976; Santos et al., 1998), the AA profiles of RUP may be less than ideal and could limit production.

When N is provided in amounts adequate to optimize ruminal fermentation, dietary additions of RUP often increase lactational performance (Titgemeyer and Shirley, 1997; Santos et al., 1998; NRC, 2001), and the preponderance of this response is assumed to be related to greater supplies of absorbed limiting AA (Clark, 1975; Schwab et al., 1976; NRC, 2001). Among commonly fed protein supplements, soybean meal and fish meal appear to have the best AA profile to support optimal efficiency of N utilization for lactation (Santos et al., 1998), but soy proteins are extensively degraded in the rumen and must be modified (e.g., chemically treated or heated) to increase RUP. Ruminal escape of soy protein increases when soybean meal is created by mechanical extrusion with soy lecithins (the fraction obtained by degumming the crude oil) added to the meal (Stern et al., 2005). The efficiency with which RUP from soybean meal is used is limited because the AA profile of soy proteins is usually not fully complementary with the AA provided by other sources of MP. Therefore, augmenting the absorbable AA profile of soybean meal with complementary limiting AA could improve efficiency of N use (Chen et al., 2011).

In lactating cows consuming diets based on corn and alfalfa, milk protein production and the efficiency of di-

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etary N use are often limited by absorbable amounts of Met and Lys (Schwab et al., 1976, 1992a; NRC, 2001). Production of milk protein may be increased by ruminally protected Met when Lys is not limiting (Vyas and Erdman, 2009; Patton, 2010). Vyas and Erdman (2009) suggested that milk protein yield can be increased (up to 16 g of milk protein/g of metabolizable Met intake) by additions of ruminally protected Met when Met is limiting. As a consequence of increases in milk protein content and yield in response to Met supplementation, technologies designed to prevent ruminal degradation of Met have garnered significant attention (NRC, 2001; Patton, 2010).

Macgregor et al. (2011) provided evidence from in situ fermentations that Met and Lys were resistant to ruminal degradation when added to a mechanically extracted soybean meal product. We hypothesized that Met in close association with soy lecithins may survive ruminal degradation and conducted 2 experiments to evaluate the ruminal degradation of Met mixed with soy lecithins and applied to mechanically extracted soybean meal.

MATERIALS AND METHODS

Experiment 1: Lactation Responses in Cows

Twenty-five multiparous (mean parity 2.3, SD = 0.45) Holstein cows averaging (mean ± SD) 44.9 ± 7.0 kg of milk/d, 87 ± 28 DIM, and 630 ± 54 kg of BW were blocked on DIM and placed in 1 of 5 replicates of 5 × 5 Latin squares. Effects of carryover from previous treatments were balanced across the experiment as well as possible. Experimental periods were 14 d and included an adequate amount of time for adaptation to treatments (10 d; Benefield et al., 2009), with samples collected in the final 4 d of each period. Cows were housed in tiestalls with free access to water, milked 3 times daily (0200, 1000, and 1800 h), and fed twice daily (0700 and 1900 h) for ad libitum intake through individual mangers located in front of each stall. Total daily feed offerings were adjusted based on previous 24-h intake so refusals were approximately 3%. All sampling and animal husbandry protocols were approved by the Kansas State University Institutional Animal Care and Use Committee (Manhattan).

Treatments consisted of 5 separate diets (Table 1) fed as TMR, composed from a common basal mix that consisted primarily of corn silage, alfalfa hay, sorghum grain, and soybean hulls. Each diet was mixed by hand-blending additions to the basal mix of either mechanically extracted soybean meal with soy lecithins (**meSBM**; Soy Best, West Point, NE), meSBM plus either 2.5 or 5 g of metabolizable Met/d added as rumen-protected DL-Met (**RPMet**; MetiPEARL; Kemin Industries Inc., Des Moines, IA; this product contained 55% DL-Met and was assumed to contain 33% metabolizable Met), or 50 or 100% replacement of meSBM with meSBM with DL-Met added during manufacture (**meSBM-Met**; manufactured to contain 0.33% added Met, as-is basis), which was intended to deliver either 3.8 or 7.6 g of total Met/d when cows consumed 25.4 kg of diet DM. The meSBM-Met was manufactured using equipment that applied 8.15 kg of dry, crystalline DL-Met (99% Met) per hour to a continuous stream of soybean cake (soybean remnants after lipid extraction, consisting largely of particles between 7.6 × 12.7 × 0.6 cm and 12.7 × 35.6 × 0.6 cm in size; Macgregor et al., 2005) in a mixing auger that produced 2,449 kg of treated soybean cake per hour; the product was ground in a hammer mill and cooled to ambient temperature. Attempts were made to provide similar levels of metabolizable Met from both meSBM-Met and RPMet; however, because the content of metabolizable Met from meSBM-Met was unknown, inclusions of Met were designed a priori based on the assumption that two-thirds of the DL-Met added to meSBM was resistant to ruminal degradation. Measured content of supplemental (free) Met in meSBM-Met was 0.23% (DM basis), which was less than that intended during manufacture. No free methionine was detected in meSBM. Based on these analyses, cows fed the diets containing meSBM-Met consumed 2.7 and 5.3 g of supplemental Met/d. If two-thirds of the added Met in meSBM-Met was protected from ruminal degradation (the basis for our treatment structure), the meSBM-Met treatments would have provided 1.8 and 3.5 g of metabolizable Met/d.

Samples of the basal mix, meSBM, and meSBM-Met (200 g/d) corresponding to feed offerings on d 11 through 14 of each period were pooled and frozen (−20°C) before analyses. Daily intake was calculated from feed offered and refused on d 11 through 14; 10% of refusals were retained daily, composited within period, and immediately frozen (−20°C). Total milk yields were recorded, and a 25-mL volume was collected at each milking during the final 4 d of each period. Milk samples were preserved with 8 mg of bronopol and 0.3 mg of natamycin (D & F Control Systems, Norwood, MA), stored at 4°C after collection, and analyzed for fat, true protein, lactose, MUN, SNF, and somatic cells within 24 h. To estimate N balance, urine and fecal samples were collected twice daily on d 11 through 14 of each period. Samples, which were pooled within cow by period, were collected at 1100 and 1500 h on d 11, at 1000 and 1400 h on d 12, at 1200 and 1600 h on d 13, and at 1300 and 1700 h on d 14. Immediately after each collection, 25 mL of urine was acidified (pH <3) with