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Effect of dietary monensin supplementation and amino acid balancing on lactation performance by dairy cows

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ABSTRACT

A replicated-pen experiment was conducted to determine effects of dietary monensin supplementation and amino acid balancing on lactation performance by dairy cows. Cows (n = 128) were stratified by breed, parity, and DIM and randomly assigned to 16 pens of 8 cows each. Pens were randomly assigned to 1 of 4 treatments in a 2 × 2 factorial arrangement of treatments: control (no monensin or amino acid balancing), amino acid balanced (AA), control plus monensin (CNMN), or AA plus monensin (AAMN) for a 2-wk covariate period followed by a 10-wk treatment period. The TMR contained, on average (DM basis), corn silage (37.5%), alfalfa silage (23.0%), and concentrate mixture (39.5%). The AA and AAMN treatments were supplemented with blood meal and ruminally protected methionine to achieve a 3:1 lysine:methionine ratio in the metabolizable protein. The CNMN and AAMN treatments were formulated to provide a monensin intake of 540 mg/d per cow. Data were analyzed with pen as the experimental unit. Dry matter intake was reduced ($P < 0.01$) by monensin supplementation (26.9 vs. 27.6 kg/d per cow). Feed conversion was greater ($P = 0.03$) for cows fed monensin (1.81 vs. 1.75 kg of milk/kg of DMI). Milk protein percentage and yield were increased ($P < 0.01$ and $P = 0.03$, respectively) by amino acid balancing (3.15 vs. 3.08% and 1.53 vs. 1.49 kg/d per cow, respectively). Component-corrected feed-conversion ratios were greater ($P = 0.02$) for cows fed monensin. Dietary monensin supplementation increased feed-conversion ratios through reduced DMI, and milk protein percentage and yield were greater for cows fed the amino acid–balanced diets.

Key words: monensin, amino acid, dairy cow

INTRODUCTION

Milk yield and composition and feed conversion are important determinants of income over feed cost on dairy farms. Monensin is a feed additive (ionophore) that alters rumen microbial populations, increases ruminal proportion of propionate, reduces DMI, and increases feed conversion in dairy cows (Duffield et al., 2008; Akins et al., 2014).

Dairy NRC (2001) provided guidelines for amino acid balancing of dairy cattle diets based on milk protein percentage and yield responses with lysine and methionine established as the colimiting amino acids. Optimal concentrations of lysine and methionine of 7.2 and 2.4% of metabolizable protein (**MP**) and a 3:1 lysine:methionine ratio in the MP were recommended (NRC, 2001). St-Pierre and Sylvester (2005) reported that dietary supplementation with MetaSmart (Adisseo Co., Antony, France; **HMBi**: isopropyl-2-hydoxy-4-(methylthio)-butanoic acid), as a rumen-protected methionine source, increased milk yield and protein percentage and yield. Chen et al. (2011), however, reported that only milk protein percentage was increased with dietary HMBi supplementation.

The FDA has approved the inclusion of monensin in diets for lactating dairy cows at 11 to 22 g/ton (DM basis). At typical DMI for lactating cows, this results in monensin intakes ranging from 300 to 600 mg/d per cow. Duffield et al. (2008), from a meta-analysis, reported that milk fat and protein percentages were reduced by monensin supplementation. More recently, Akins et al. (2014) reported that dietary monensin supplementation increased milk yield and de-

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creased milk protein percentage, and fat percentage and yield and protein yield were unaffected by treatment. Amino acid balancing was not done, however, for most trials used in the Duffield et al. (2008) meta-analysis or in the trial of Akins et al. (2014).

We hypothesized that feeding a diet balanced for lysine and methionine when supplementing monensin would alleviate the previously reported depression in milk protein percentage, thereby allowing for greater protein yield for monensin-supplemented cows. The objective of this study was to determine the effect of dietary monensin supplementation and amino acid balancing and both in combination on lactation performance by dairy cows.

MATERIALS AND METHODS

The experimental protocol was approved by the Animal Care and Use Committee of the College of Agricultural and Life Sciences at the University of Wisconsin–Madison. A total of 128 dairy cows were stratified by breed (Holstein and Holstein × Jersey), parity (primiparous and multiparous), and DIM (104 ± 39 d at trial initiation) and then randomly assigned to 16 pens of 8 cows each in a continuous-lactation experiment conducted in the University of Wisconsin–Madison free-stall, milking parlor facility (Arlington, WI). Each balanced pen consisted of 6 multiparous Holstein cows, 1 multiparous Holstein × Jersey cow, and 1 primiparous Holstein cow. Pens were randomly assigned in a 2 × 2 factorial arrangement of treatments in a completely randomized design with covariate adjustment. Treatments were control (**CN**; no monensin supplementation and no amino acid balancing), amino acid balanced (**AA**), CN plus monensin (**CNMN**), or AA plus monensin (**AAMN**). During a 2-wk covariate period, all pens were fed a common nonexperimental diet that contained 12 g of monensin/t of DM (approximately 360 mg/d per cow) without amino acid balancing followed by a 10-wk treatment period with cows fed their assigned treatment diet.

The CNMN and AAMN treatments were formulated using Rumensin 90 (Elanco Animal Health, Greenfield, IN) to provide a monensin intake of approximately 540 mg/d per cow (18 g of monensin/t of DM). Ingredient and nutrient composition of diets, protein supplements, and mineral-vitamin supplements are in Tables 1, 2, and 3, respectively. Nutrient composition of corn and alfalfa silages, dry and high-moisture corns, and whole cottonseed are in Table 4. There was a change in the corn-silage inventory available for use in the trial at wk 5 of the treatment period, and the change in its nutrient composition caused a need for reformulation of the diets. Therefore, the corn-silage nutrient composition and diet ingredient and nutrient composition tables contain data for 2 separate time periods (wk 1–4 and wk 5–10 of the treatment period).

Diets were formulated based on the NRC (2001) to meet or exceed all nutrient requirements for a 682-kg Holstein cow producing 41 kg of milk containing 3.8% milk fat and 3.0% true protein. Because of diet reformulation, the nutrient composition of the diets differed slightly between periods. During wk 1 to 4 diets were formulated on average among treatments to contain (DM basis) 16.2% CP, 26.0% starch, and 31.5% NDF. During wk 5 to 10 diets were formulated on average among treatments to contain (DM basis) 16.2% CP, 27.2% starch, and 32.0% NDF. The overall trial TMR contained, on average (DM basis), corn silage (37.5%), alfalfa silage (23.0%), and concentrate mixture (39.5%). The amino acid–balanced diets (AA and AAMN) were formulated to supply 182.4 g of Lys (6.58% MP) and 60.6 g of Met (2.19% MP), resulting in a 3.01 lysine:methionine ratio. Diets that were not amino acid balanced (CN and CNMN) supplied 174.6 g of Lys (6.35% MP) and 51.2 g of Met (1.86% MP), resulting in a 3.41 lysine:methionine ratio.

Diets were fed as TMR mixed and fed once daily. The pens were supplied with TMR to allow for 5% refusals, with daily DMI determined on a pen basis throughout the study. Daily pen refusals were recorded each morning before new feed delivery using feeding-management software (Feed Supervisor, Supervisor Systems, Dresser, WI). Daily pen DMI was measured as the difference between the as-fed offered and as-is refused (orts) multiplied by the DM content of the TMR. All cows received recombinant bovine somatotropin (Posilac, Elanco Animal Health) every 14 d starting on d 1 of the covariate period.

Body weight and BCS (1 to 5 in 0.25-unit increments; Wildman et al., 1982) were recorded every other week, once during the last week of the covariate period and 5 times during the treatment period. Body-weight change was determined for each pen by regression across the 5 treatment-period measurements. Cows were milked twice daily, and milk yield was recorded daily on individual cows throughout the entire trial. Milk samples were collected from individual cows each week on Tuesday p.m., Wednesday a.m. and p.m., and Thursday a.m. These samples were composited by pen. Milk composites were analyzed for fat, true protein, lactose and milk urea nitrogen (**MUN**) concentrations, and SCC by infrared analysis (AgSource Milk Analysis Laboratory, Menomonie, WI) using a Foss FT6000 (Foss Electric, Hillerod, Denmark). Yields of 3.5% FCM, solids-corrected milk, and energy-corrected milk were calculated according to NRC (2001) equations. Actual-milk, 3.5% FCM, solids-corrected milk, and energy-corrected milk feed efficiencies were calculated by pen by week using average daily pen-based yield and DMI data.

Estimated diet energy concentrations were calculated by summing the NE_l (Mcal) from milk production and required for maintenance and BW change (NRC, 2001), and dividing the sum by DMI. Samples of TMR, corn silage, alfalfa silage, fine-ground dry corn, high-moisture corn, whole cottonseed, protein supplements, and mineral–vitamin supplements were obtained weekly. The samples from the