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Effect of direct-fed microbial supplementation on lactation performance and total-tract starch digestibility by midlactation dairy cows

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ABSTRACT

The objective of this study was to evaluate the effect of direct-fed-microbial addition to a TMR on lactation performance by midlactation dairy cows. A total of 112 Holstein cows (28 primiparous and 84 multiparous; 139 ± 47 DIM at trial initiation) were stratified by parity and DIM and randomly assigned to 14 pens of 8 cows each. Pens were then randomly assigned to 1 of 2 treatments in a continuous-lactation trial consisting of a 2-wk covariate adjustment period with cows fed the basal TMR followed by a 10-wk treatment period with cows fed their assigned treatment diets. The 2 treatments were basal TMR plus either 1 g/cow per day of a direct-fed microbial (BOV, 1 × 10^9 cfu/g Lactobacillus acidophilus NP51 and 2 × 10^9 cfu/g Propionibacterium freudenreichii NP24) or placebo (control). Milk yield was similar between treatments and averaged 44.9 kg/d. There was a trend (P < 0.08) for DMI to be decreased by 0.4 kg/d per cow for BOV overall, and DMI was lower (P < 0.05) for BOV than control during wk 2, 3, 6, 9, and 10. However, measures of feed conversion (milk or component-corrected milk yields per unit DMI) were unaffected (P > 0.10) by treatment. Milk fat, protein and urea nitrogen concentrations were unaffected (P > 0.10) by treatment and averaged 3.75%, 3.11%, and 15.2 mg/dL, respectively. Likewise, BW change and condition score did not differ (P > 0.10). Under the conditions of this study, with midlactation cows fed a 54% forage TMR (DM basis), there was no improvement in lactation performance from the inclusion of a direct-fed microbial in the diet.

Key words: direct-fed microbial, dairy cow, milk production

INTRODUCTION

High-producing dairy cows require a high intake of energy to support milk-production and body-condition requirements (NRC, 2001). Propionate is the major precursor of glucose in the liver (Reynolds et al., 2003). Furthermore, it may act as an intake regulator (Allen et al., 2009). Generally, when ruminal propionate is manipulated via starchy feeds, either greater milk production or feed efficiency (due to lower intake at similar milk yield) can be observed (Ferraretto et al., 2011, 2012). Perhaps the use of a direct-fed microbial (**DFM**) containing propionic bacteria may result in greater milk production or feed efficiency. In addition, supplementation of DFM may also result in a modification of the microbial population of rumen and lower gut, increases of nutrient flow to duodenum, improvement of diet digestibility, and improvement of immune function (Krehbiel et al., 2003).

Although reports of the supplementation of DFM containing propionic bacteria are existent in the literature, the results are inconsistent. Therefore, the objective of this study was to evaluate the effect of DFM addition to a TMR on lactation performance and total-tract starch digestibility by midlactation dairy cows.

MATERIALS AND METHODS

A total of 112 Holstein cows (28 primiparous and 84 multiparous; 139 ±

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Table 1. Ingredient and nutrient composition of the basal TMR[1]

Item	TMR
Ingredient (% of DM)	
Corn silage[2]	27.1
Alfalfa silage[3]	27.1
High-moisture corn[4]	13.4
Concentrate mix[5]	
Soybean meal, expeller	9.0
Dry ground shelled corn	7.1
Soybean meal, solvent	6.3
Soy hulls	3.5
Corn gluten feed, dried	1.9
Energy Booster 100[6]	1.77
Calcium carbonate	0.94
Sodium bicarbonate	0.70
Trace mineral salt[7]	0.39
Magnesium oxide	0.20
Mono calcium phosphate	0.20
Vitamin premix[8]	0.20
Rumensin[9]	0.12
Mg-K-S[10]	0.08
Nutrients (% of DM)	
DM (% of as fed)	51.2
OM	92.2
CP	18.0
Ether extract	6.4
NDF	28.6
Nonfiber carbohydrates	40.1
Starch	24.6

[1]Treatment diets contained direct fed microbial (BOV) or control (CON) premixes added to basal TMR.

[2]Contained 8.1% CP, 41.7% NDF, 7.7% ether extract, and 33.0% starch (DM basis).

[3]Contained 22.9% CP, 37.4% NDF, and 4.0% ether extract (DM basis).

[4]Contained 8.1% CP, 7.0% NDF, 3.8% ether extract, and 72.1% starch (DM basis).

[5]Contained 26.8% CP, 20.2% NDF, 8.5% ether extract, and 15.2% starch (DM basis).

[6]Minimum 98% total fatty acids (MSC Company, Dundee, IL).

[7]88% NaCl; 0.002% Co; 0.2% Cu; 0.012% I; 0.18% Fe; 0.8% Mn; 0.006% Se; and 1.4% Zn.

[8]Vitamin A, 3,300,000 IU/kg; vitamin D, 1,100,000 IU/kg; and vitamin E, 11,000 IU/kg.

[9]Rumensin premix contained 11 g/kg.

[10]Dynamate (11% Mg , 18% K, 22% S; The Mosaic Co., Plymouth, MN).

47 DIM at trial initiation) were stratified by parity and randomly assigned to 14 pens of 8 cows each (2 primiparous and 6 multiparous cows per pen) at the University of Wisconsin–Madison Emmons Blaine Dairy Research Center (Arlington, WI). Cows were housed in sand-bedded free-stalls and milked in a double-16 parlor. Pens were randomly assigned to 1 of 2 treatments in a completely randomized-design continuous-lactation trial consisting of a 2-wk covariate adjustment period with cows fed the basal TMR plus 0.454 kg/cow per day dry ground shelled corn followed by a 10-wk treatment period with cows fed their assigned treatment diets. Ingredient and nutrient composition of the basal diet is provided in Table 1. The concentrate mixture was prepared at the University of Wisconsin Feed Mill (Arlington, WI). Diets were fed as a TMR mixed once daily at 0700 h and offered to allow for 5% refusal, with daily DMI determined on individual pens throughout the 12-wk trial. Daily pen intake was measured as the difference between the amount of as-fed TMR offered and the amount of as-is orts using the Feed Supervisor Software (Supervisor Systems, Dresser, WI), with that amount then multiplied by the DM concentration of the TMR to determine DMI. The TMR for both treatments was pushed up 3× daily (0530, 1200, and 2000 h) using an individual pusher for each diet to avoid contamination. All cows were injected with bovine somatotropin (Posilac, Monsanto Company, St. Louis, MO) every 14 d beginning the first day of the covariate period.

The animal research was conducted under a protocol approved by the Institutional Animal Care and Use Committee of the University of Wisconsin Madison College of Agricultural and Life Sciences. Body weight and BCS (1 to 5 in 0.25 increments; Wildman et al., 1982) were recorded on individual cows at the end of the covariate period and every 2 wk during the treatment period. Body-weight change was determined by regression of the treatment-period BW measurements over time. Milk yield was recorded daily (DairyComp305, Valley Agricultural Software, Tulare, CA) on individual cows milked 2× daily in a double-16 parlor (Metatron P21, GEA Farm Technologies, Bakel, the Netherlands) throughout the 12-wk trial and composited by pen before statistical analysis. Milk samples were obtained from all cows every 2 wk on the same 2 consecutive d from the a.m. and p.m. milkings throughout the 12-wk trial and composited based on equal volume by pen by week, and composites were analyzed for fat, true protein, lactose, and MUN concentrations and SCC by infrared analysis (AgSource Milk Analysis Laboratory, Menomonie, WI) using a Foss FT6000 (Foss Electric, Hillerød, Denmark) with average daily yields of fat, protein, and lactose calculated from these data for each week. Yields of fat-, solids-, and energy-corrected milk were calculated according to NRC (2001) equations. Actual-milk and fat-, solids-, and energy-corrected milk feed conversions were calculated by week using average daily yield and DMI data. Estimated diet energy concentrations were calculated by summing the megacalories of NE_l from milk production, required for maintenance, and change in BW (NRC, 2001), and then dividing the sum by DMI.

The DFM contained 1×10^9 cfu/g *Lactobacillus acidophilus* NP51 and 2×10^9 cfu/g *Propionibacterium freudenreichii* NP24 (Bovamine; Nutritional Physiology Co., Guymon, OK). The DFM (**BOV**) and control (**CON**) premixes were fed at the rate of 0.455 kg/cow per day and added to the TMR separate from the concentrate mixture. Premixes were prepared daily at 1600 h the day before feeding. First, 2,270 g of carrier (dry ground shelled corn) was mixed with 56 g of the assigned treatment (1 g/cow of either placebo or BOV) for 3 min in a rotating drum mixer (KP26M1XER, Kitchen Aid, Greenville, OH). The carrier plus treatment mixture (2,326 g) was then transferred to a cement mixer (Betoniera Minuteman 1126605, IMER International, Washington, DC) containing 23.2 kg of the carrier (dry ground shelled corn) and mixed