The Professional Animal Scientist 31 (2015):354–358; http://dx.doi.org/10.15232/pas.2015-01404

Milk yield and composition of lactating dairy cows fed diets supplemented with a probiotic extract

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ABSTRACT

Thirty-six lactating Holstein cows from the Dairy Research Center at the University of Georgia Tifton Campus were used in a 10-wk randomized-design trial to determine the effects of feeding a nonviable probiotic extract (PD; ProDairy, Donaghys Industries Ltd., Christchurch, New Zealand) on DMI, milk yield, and milk composition. During the first 2 wk of the trial, all cows were fed the control diet, and data collected were used as a covariate in the statistical analysis. At the end of wk 2, cows were assigned randomly to 1 of 2 treatments: 0 (CONT) or 10 mL/d of PD per cow for the following 8 wk. A basal diet was fed to cows once daily behind Calan gates as a TMR in amounts to provide at least 5% refusal. The probiotic extract was added to the TMR and mixed for 10 min before feeding. No differences were observed in DMI between treatments, which averaged 25.3 and 25.6 kg/d for CONT and PD, respectively. Yields of milk ($P = 0.001$), protein ($P = 0.05$), and solids-not-fat ($P = 0.002$) were greater for cows fed diets supplemented with PD compared with CONT. Interactions of treatment and week were observed for each variable because the difference between PD and CONT increased as the trial progressed. Milk urea nitrogen concentrations tended to be reduced ($P = 0.10$) for PD compared with CONT. No differences were observed among treatments in concentration of milk components or change in BW or BCS. The probiotic extract used in the trial supported greater yield of milk, protein, and solids-not-fat apparently through improved utilization of nutrients consumed.

Key words: probiotic extract, milk yield, milk composition

INTRODUCTION

"Probiotics" or "direct-fed microbials" are defined as cultures of live microorganisms that have health benefits to the host (Sanders, 2008; Ezema, 2013). Nonviable probiotics including cultural extracts, enzyme preparations, or combinations of these have also been reported to promote similar beneficial effects (Krehbiel et al., 2003; Sanders, 2008; Poppy et al., 2012). Use of these probiotics, live and nonviable, has been reported to improve ADG, feed efficiency, milk yield, and health when fed to cattle, presumably as a result of improved ruminal and intestinal microorganism populations (Krehbiel et al., 2003). Several modes of action have been proposed including stimulation of ruminal microbial growth, stabilization of ruminal pH, improved ruminal fermentation patterns, increased nutrient digestibility and flow of nutrients to the small intestine, improved nutrient retention, and reduced stress (Yoon and Stern, 1995; Krehbiel et al., 2003; Chiquette, 2009). Because dairy cattle consume large quantities of readily fermentable carbohydrates, which can reduce ruminal pH, the use of supplemental probiotics has been proposed as a means of moderating the rapid decline in or stabilizing pH by decreasing lactic acid production and increasing lactic acid utilization (Fulton et al., 1979).

Rossow et al. (2014) reported improved milk yield and ruminal pH and reduced blood ketone concentrations when a commercially produced probiotic extract produced from bacteria and yeasts was administered in water troughs. Data are lacking on the potential of this probiotic extract when applied to a TMR. The objective of this trial was to evaluate the effect of a supplemental nonviable probiotic extract on the milk yield and composition response of lactating dairy cows fed a TMR based on corn silage.

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Table 1. Ingredient composition of basal diet

Ingredient	% of DM
Corn silage	38.54
Alfalfa hay	8.12
Finely ground corn	10.14
Whole cottonseed	7.10
Brewers grains, wet	13.19
Soybean hulls	6.09
Citrus pulp	6.09
Molasses, dried	1.01
Soybean meal, 47.5% CP	3.04
Prolak[1]	3.55
Urea	0.30
Potassium carbonate	0.91
Sodium bicarbonate	0.81
Magnesium oxide	0.30
Potassium-magnesium-sulfate	0.10
Dicalcium phosphate	0.10
Salt	0.41
Availa-4[2]	0.04
Vitamin E, 44,050 IU/kg	0.02
Trace mineral–vitamins[3]	0.14

[1]H. J. Baker & Bro. Inc. (Westport, NJ).

[2]Zinpro Corp. (Eden Prairie, MN).

[3]Mineral–vitamin premix contained (DM basis) 26.1% Ca; 0.38% Mg; 1.76% S; 144 mg/kg Co; 9,523 mg/kg Cu; 1,465 mg/kg Fe; 842 mg/kg I; 28,617 mg/kg Mn; 220 mg/kg Se; 25,343 mg/kg Zn; 4,210,830 IU/kg vitamin A; 1,684,330 IU/kg vitamin D; and 21,045 IU/kg vitamin E.

MATERIALS AND METHODS

Thirty-six lactating Holstein cows (8 primiparous and 28 multiparous) were selected from the herd at the University of Georgia Tifton Campus for use in the 10-wk trial. All protocols were approved by the Institute of Animal Care and Use Committee of the University of Georgia. Before beginning the trial, all cows were trained to eat behind Calan doors (American Calan Inc., Northwood, NH). Cows were housed in a 4-row freestall barn equipped with 91-cm fans mounted over the feed alley and freestalls every 6.1 m. The fans were programmed to come on automatically when the temperature in the barn exceeded 23°C. The fans were fitted with high-pressure misters programmed to operate when the fans were running until the relative humidity exceeded 85%. Cows were provided access to an exercise lot once daily at approximately 0830 through 0900 h.

A basal diet (Table 1) was formulated to meet minimum NRC (2001) requirements and fed once daily as a TMR in amounts to provide at least 5% refusal. Feed was pushed up at least twice daily for each cow. During the 2-wk preliminary period, all cows were fed the control diet. At the end of wk 2, cows were randomly assigned to 1 of 2 treatments for the following 8 wk. At the beginning of the experimental period, cows averaged 183 ± 28 DIM, 33.7 ± 5.7 kg/d milk, 3.73 ± 0.61% fat, and 2.85 ± 0.20% protein. Treatments were 0 (**CONT**) or 10 mL/d of the probiotic extract (**PD**; ProDairy, Donaghys Industries Ltd., Christchurch, New Zealand) per cow. Cows assigned to PD were fed last to minimize any possible contamination of the CONT. The PD was sprayed onto the ingredients as ingredients were mixed (DataRanger, American Calan Inc.) and blended for 10 min before feeding. The amount of feed offered and refused was recorded daily. Samples of dietary ingredients and experimental diets were collected 3 times each week. Samples were dried at 55°C for 48 h to determine DM, ground to pass through a 6-mm screen (Thomas Scientific, Swedesboro, NJ), and composited by week within sample type. Diets were adjusted for changes in DM content of individual ingredients as necessary. Samples were ground to pass through a 1-mm screen before being analyzed for DM, ash, ether extract (AOAC International, 2000), ADF, and NDF (Van Soest et al., 1991).

Cows were milked twice daily at 0300 and 1500 h. Milk weights were recorded electronically (Alpro, DeLaval Inc., Kansas City, MO) at each milking, totaled each day, and averaged weekly. Milk samples were collected from 2 consecutive p.m. and a.m. milkings each week. Samples were shipped to Dairy One (Ithaca, NY) for analyses of fat, protein, lactose, solids-not-fat (**SNF**), and milk urea N (**MUN**) using a Foss 4000 equipped with an A filter (Foss North America, Eden Prairie, MN) as described by AOAC International (2000). Energy-corrected milk (**ECM**) was calculated as outlined by Tyrell and Reid (1965): ECM = (0.327 × kg of milk) + (12.95 × kg of fat) + (7.65 × kg of protein).

Body weights were recorded on 3 consecutive days at the end of the standardization period and end of wk 8 of the experimental period. To minimize variation, BW was recorded after the p.m. milking and before cows had access to feed or water. The BCS was recorded at the end of the preliminary period and during wk 4 and 8 according to Wildman et al. (1982) by 2 evaluators.

Intake, milk yield and composition, BW, and BCS data were subjected to analyses of covariance using PROC MIXED procedures of SAS (SAS Institute Inc., Cary, NC). Sums of squares were partitioned to covariate, treatment, week, and interaction of week and treatment. Cow within treatment was included as a random variable and week was considered a repeated measure. Changes in BW