Yeast Culture to Improve Intake, Nutrient Digestibility, and Performance by Dairy Cattle During Early Lactation[1]

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ABSTRACT

Twenty-four primiparous Holstein cows were fed corn silage:grain (1:1, DM basis) and hay (.9 kg/d) beginning 30 d prepartum and through wk 18 of lactation. Ten grams of Biomate® Yeast Plus (5×10^9 cfu of *Saccharomyces cerevisiae*/g) were top-dressed on the a.m. allotment of corn silage:grain fed to 12 cows. Corn silage:grain was restricted during prepartum and thereafter fed for ad libitum intake. Cows fed supplemental yeast peaked earlier and had a higher milk yield compared with control cows (wk 7, 29.5 kg/d vs. wk 11, 28.7 kg/d). Digestibilities of protein and cellulose were improved in cows fed supplemental yeast, contributing to a greater DMI during the first 6 wk of lactation and a higher average milk yield through wk 18 of lactation compared with control cows (27.2 vs. 26.0 kg/d).
(Key words: yeast, feed intake, lactation, digestibility)

INTRODUCTION

Yeasts have been isolated from rumen contents (14), although aerobic strains are viewed only as transient populations. *Saccharomyces cerevisiae*, a facultative anaerobe, exhibits some degree of rumen viability (4) and can influence fermentation and populations of rumen microbes (4, 5, 8, 12).

Yeast cultures have been fed to dairy cattle with varied responses. Improvements in DMI (11), nutrient digestibility (7, 19), milk yield (9, 10), and fat test (9) have been reported, but in other studies (1, 6, 15) no beneficial response was found.

To assess the value of supplementing yeast culture to lactating dairy cows, it is important that trials begin prior to parturition, extend through peak lactation, and measure nutrient digestibility. Therefore, a study was conducted from 30 d prepartum through wk 18 of lactation to determine the effect of yeast culture on DMI, milk yield and composition, nutrient digestibility (DM, CP, NDF, ADF, hemicellulose, and cellulose) and N balance.

MATERIALS AND METHODS

Feeding and Lactation Trial

Twenty-four primiparous Holstein cows were fed corn silage:grain (1:1, DM) and hay (.9 kg/d) beginning 30 d prior to their scheduled parturition date through wk 18 of lactation. Corn silage:grain was restricted during prepartum to meet maintenance and gestation requirements (13) and thereafter was fed ad libitum (one-half at 0600 and 1400 h). The grain contained (as fed) the following: ground corn, 29.20%; soybean meal, 28.85%; crimped oats, 8.76%; dried distillers grains, 8.34%; molasses, 7.32%; wheat bran, 5.88%; wheat middlings, 4.26%; beet pulp, 3.66%; aragonite, 2.00%; monosodium phosphate, 1.10%; salt, .35%; vitamin A, D, and E premix, .17%; potassium sulfate, .07%; and dairy trace mineral mix, .04%. The diet was formulated to provide 18% CP, .9% Ca, .6% P and .3% Mg (DM basis).

Cows were divided into two groups of 12 cows each, blocking for calving date and pedigree type production index (420+, 419+). Beginning 30 d prepartum through wk 18 of lacta-

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tion, 10 g of Biomate® Yeast Plus (a single packet) was top-dressed on the corn silage: grain for 12 cows after one-half of their daily allotment had been placed in their manger at 0600 h. Biomate® Yeast Plus (5×10^9 cfu of *S. cerevisiae*/g) was provided in 10-g quantities packaged in foil-lined, sealed paper by Chr. Hansen's Laboratory, Inc. (Milwaukee, WI). The packaged samples were stored at 5°C prior to feeding. Top-dressing the yeast simulated a grain mix containing .1% Biomate® Yeast Plus. Supplemental yeast was restricted to treatment mangers, avoiding cross diet contamination through use of a mixer.

Feeds offered and orts were weighed daily. Grain and corn silage were sampled daily and composited over 7 d. Hay was sampled weekly. These samples were dried in a forced-air oven at 60°C and ground in a Wiley mill (Arthur H. Thomas, Philadelphia, PA) (1-mm screen), and monthly composites were stored in airtight jars until chemical analyses.

Cows were milked twice daily (0500 and 1550 h). Milk composition was taken from DHI records. On d 35, 70, and 105 of lactation, 20 ml of jugular blood were obtained using a 20 gauge × 38-mm needle and collected in vacutainer tubes containing sodium heparin. Cows were weighed between 0800 and 0830 h for 3 consecutive d on d 30, 29, 28; d 15, 14, 13 prepartum; and d 3, 4, 5, 13, 14, 15, and biweekly thereafter through wk 18 of lactation.

Digestibility and Balance Trial

During d 63 to 70 of lactation, total fecal and urine collections were performed. A 75-cc Foley catheter (C. R. Bard, Covington, GA) was inserted into the bladder of each cow (3). Urine was collected in 24-L polyethylene containers in acid (50 ml 50% H_2SO_4), volume was recorded daily, and aliquots were stored at 4°C and composited by volume at the end of each collection period. Daily fecal production was measured, and 2% was preserved with thymol, stored at 4°C, and composited. Composite samples of orts and feces were dried and prepared for analyses as described.

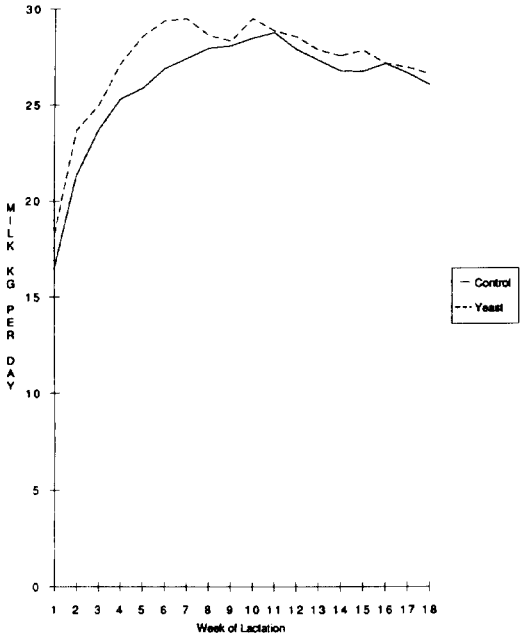

Figure 1. Average daily milk production during the first 18 wk of lactation by primiparous Holstein cows fed corn silage-based diets without (control) or supplemented with Biomate® Yeast Plus (10 g/d).

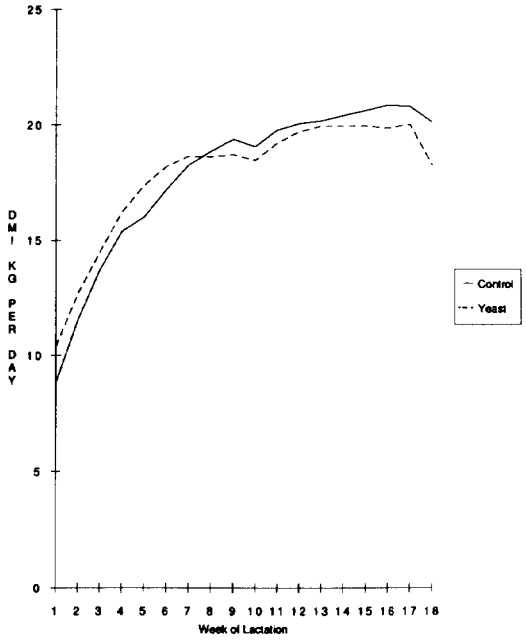

Figure 2. Average daily DMI during the first 18 wk of lactation by primiparous Holstein cows fed corn silage-based diets without (control) or supplemented with Biomate® Yeast Plus (10 g/d).

TABLE 1. Monthly average fat and protein percentages of milk produced by primiparous cows fed corn silage-based diets without (control) or supplemented with Biomate® Yeast Plus (10 g/d).[1]

Month of lactation	Fat[2]			Protein,[2] %		
	Control	Yeast	SE	Control	Yeast	SE
	(%)					
1	3.92	3.92	.10	3.10	3.16	.05
2	3.80	3.77	.10	3.07	3.02	.06
3	3.97	3.87	.09	3.26	3.12	.05
4	3.98	3.91	.10	3.37	3.16	.05
5	4.12	4.06	.09	3.33	3.15	.05
Average	3.96	3.91	.08	3.23	3.12	.04

[1]Twelve primiparous cows assigned to each treatment. Each morning Biomate® Yeast Plus (10 g/d) was top-dressed on one-half of the daily TMR (corn silage:grain) allotment.

[2]Milk sampled and analyzed by DHI.

Chemical Analyses

Dry matter of feeds, orts, and feces was determined by standard methods (2). Nitrogen in these samples and urine was determined by the Kjeldahl procedure (2). Ash-free NDF, ADF, and cellulose (72% H_2SO_4 procedure) were determined using a Fibertec System (1010 Heat Extraction) by Tecator (17). Hemicellulose represented the difference between NDF and ADF fractions. Fecal pH was measured when .5 g of dry feces was suspended in 50 ml of distilled, deionized water through use of a magnetic stir bar. Hematocrit of jugular blood was determined using a microcapillary centrifuge and reader (International Equipment Co., Needham, MA). The remaining heparinized blood was centrifuged at 1000 × *g* for 30 min. Plasma was collected, stored at −15°C, and urea N was determined (18).

Statistical Analysis

Data were analyzed using ANOVA (16) by the general linear models procedure of the SAS. Sources in the model included treatment (without and with supplemental yeast), cow (treatment), time (week or month) and treatment × time. Data having $P < .05$ were significant, but trends are noted and also discussed.

RESULTS AND DISCUSSION

Peak milk yield occurred earlier and was greater when primiparous cows fed a corn silage-based diet also were fed a supplemental yeast culture (wk 7, 29.5 kg/d vs. wk 11, 28.5 kg/d; treatment × week, $P = .10$; Figure 1). This improvement in milk yield supports data of earlier studies (9, 10). The earlier and higher peak milk yield enabled the cows fed yeast to maintain an advantage in milk production over those fed the control diet during wk 8 to 18 (Figure 1) and an advantage in average production over wk 1 to 18 of lactation (27.2 vs. 26.0 kg/d). Cows fed yeast averaged an additional 196 kg of milk during the 126-d study.

Milk fat test was high, averaging 3.93%, and did not differ between control and supplemented cows (Table 1). Protein test was similar between treatments during the first 8 wk of lactation but increased thereafter in control cows (treatment × week, $P < .01$).

Dry matter intake during wk 4, 3, 2, and 1 prepartum averaged 8.7, 8.7, 8.4, and 7.9 and 9.5, 8.9, 8.8, and 8.2 kg/d for cows fed the control and yeast-supplemented diets, respectively. The decrease in DMI normally associated with calving occurred in both groups of cows but to a lesser extent in those fed supplemental yeast. After calving, diets were offered for ad libitum intake, and increases in DMI tended to be greater in each of the first 6 wk of lactation for cows fed yeast compared with those fed the control diet, averaging 14.9 vs. 13.8 kg/d [treatment × week ($P < .002$); Figure 2]. This improved DMI was an important factor contributing to the earlier and higher peak milk yield observed in cows fed supplemental yeast.

Dry matter intake during total fecal and urine collections (Table 2) was equal to that recorded in the lactation study (Figure 2). Digestibility of DM, NDF, ADF, and hemicellulose was similar for all cows (Table 2). However, CP and cellulose digestibility tended ($P =$

TABLE 2. Average intake, nutrient digestibility, and fecal pH of corn silage-based diets without (control) or with supplemental Biomate® Yeast Plus (10 g/d) fed to primiparous cows.

	Dietary treatments[1]			
	Control	Yeast	SE	$P <$
DM, kg/d				
Fed				
Grain	10.7	10.4	. . .	. . .
Corn silage	9.8	8.8	. . .	. . .
Hay	.8	.8	. . .	. . .
Refused	1.3	1.5	. . .	. . .
Intake	19.2	18.5	. . .	. . .
Nutrient digestibility, %				
DM	72.4	72.8	.6	.68
CP	73.8	75.4	.8	.29
NDF	55.3	55.5	1.2	.94
ADF	48.7	47.7	1.4	.72
Hemicellulose	61.1	61.0	1.3	.96
Cellulose	61.0	66.3	2.1	.23
Fecal pH	7.15	7.20	.13	.84

[1]Twelve primiparous cows assigned to each treatment. Each morning Biomate® Yeast Plus (10 g/d) was top-dressed on one-half of the daily TMR (corn silage:grain) allotment. A 6-d total fecal and urine collection was performed during wk 9 to 10 of lactation.

TABLE 3. Nitrogen utilization by primiparous cows fed corn silage-based diets without (control) or supplemented with Biomate® Yeast Plus (10 g/d).

	Dietary treatments[1]			
Nitrogen	Control	Yeast	SE	$P <$
Grams per day				
Intake	534	533	14	.99
Feces	140	131	6	.40
Absorbed	394	402	11	.63
Urine	143	149	6	.63
Milk	133	132	3	.82
Retained	118	121	8	.76
Productive[2]	251	253	9	.85
Percentage of intake				
Feces	26.2	24.6	.8	.28
Absorbed	73.8	75.4	.8	.23
Urine	26.8	27.9	1.0	.73
Milk	24.9	24.8	.5	.77
Retained	22.1	22.7	1.3	.62
Productive	47.0	47.5	1.1	.66
Percentage of absorbed				
Urine	36.3	37.0	1.3	.98
Milk	33.8	32.8	.9	.49
Retained	29.9	30.1	1.6	.78
Productive	63.7	62.9	1.3	.92

[1]Twelve primiparous cows assigned to each treatment. Each morning Biomate® Yeast Plus (10 g/d) was top-dressed on one-half of the daily TMR (corn silage:grain) allotment. A 6-d total fecal and urine collection was performed during wk 9 to 10 of lactation.

[2]Milk + retained.

.25) to be improved by yeast supplementation. The improved CP and cellulose digestibility measured during wk 9 to 10 may reflect differences in digestibility during the first 6 wk of lactation. This may have in turn contributed to the greater DMI by cows fed supplemental yeast during that time period.

Yeast cultures may provide factors stimulatory to rumen cellulolytic and proteolytic bacteria, especially when high concentrate (> 50%) diets are fed (20). Feeding yeast cultures has increased numbers of cellulolytic rumen bacteria (8, 19) and resulted in improved fiber digestibility (7, 19), although not always (1, 8). Improvement in digestibility of a specific nutrient with no change in total tract DM digestibility when yeast culture was fed has been reported previously (7). Williams (20) suggested that yeast cultures may increase ruminal digestion; however, hindgut fermentation may mask this effect.

The trend for improved CP digestibility in cows fed yeast culture also was expressed in fecal and absorbed N as a percentage of N intake [($P = .28$), ($P = .23$); Table 3]. Although supplementation with yeast had no effect on N balance, the similarity in percentages of N intake distributed between milk and retained N indicated that N utilization for growth was equally as demanding as that for lactation in 2-yr-old cows. The minimal weight loss supports this concept (Table 4). Blood hematocrit and plasma urea N were not affected by dietary treatments (Table 4).

CONCLUSIONS

At calving, DMI is depressed, but this is also a period of transition, because the dairy cow is suddenly expected to consume large amounts of an energy dense ration. Supplemental yeast culture was beneficial in improving

TABLE 4. Blood constituents and BW change during the first 18 wk of lactation by primiparous cows fed corn silage-based diets without (control) or with supplemental Biomate® Yeast Plus (10 g/d).

	Dietary treatments[1]			
	Control	Yeast	SE	$P <$
Hematocrit, %				
Day				
35	33.4	31.4	.5	.05
70	32.6	32.4	.4	.87
105	32.5	32.6	.5	.97
BUN,[2] mg %				
Day				
35	15.1	16.0	.7	.50
70	15.7	16.6	.5	.38
105	17.7	17.6	.5	.86
BW, kg				
Week				
–4	594	590	9	.82
–2	605	608	10	.88
0	526	528	9	.91
2	516	525	9	.63
4	513	523	8	.57
6	516	526	9	.58
8	527	530	10	.86
10	534	528	10	.77
12	542	543	10	.96
14	546	541	10	.80
16	553	538	11	.52
18	559	546	11	.57

[1]Twelve primiparous cows assigned to each treatment. Each morning Biomate® Yeast Plus (10 g/d) was top-dressed on one-half of the daily TMR (corn silage:grain) allotment.

[2]BUN = Blood urea N.

DMI and milk yield. Income from the additional milk (33¢ per cow/d) exceeded the material cost of the yeast culture (5¢ per cow/d). Additional studies are needed to define the role of yeast and its effect on DMI and nutrient utilization by the ruminant.

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