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Yeast product supplementation modulated feeding behavior and metabolism in transition dairy cows

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ABSTRACT

Yeast supplementation has been shown to increase feed intake and production in some studies with early lactation dairy cows, but the mechanisms underlying such an effect remain unknown. The objective of this study was to assess the effects of supplementing a yeast product derived from *Saccharomyces cerevisiae* on production, feeding behavior, and metabolism in cows during the transition to lactation. Forty multiparous Holstein cows were blocked by expected calving date and randomly assigned within block to 1 of 4 treatments (n = 10) from 21 d before expected calving to 42 d postpartum. Rations were top-dressed with a yeast culture plus enzymatically hydrolyzed yeast (YC-EHY; Celmanax, Vi-COR Inc., Mason City, IA) at the rate of 0, 30, 60, or 90 g/d throughout the experiment. Dry matter and water intake, feeding behavior, and milk production were monitored. Plasma samples collected on −21, −7, 1, 4, 7, 14, 21, and 35 d relative to calving were analyzed for glucose, β-hydroxybutyrate, and nonesterified fatty acids. Data were analyzed using mixed models with repeated measures over time. Pre- or postpartum dry matter intake and water intake did not differ among treatments. Quadratic dose effects were observed for prepartum feeding behavior, reflecting decreased meal size, meal length, and intermeal interval, and increased meal frequency for cows received 30 and 60 g/d of YC-EHY. Postpartum feeding behavior was unaffected by treatments. Milk yields were not affected (45.3, 42.6, 47.8, and 46.7 kg/d for 0, 30, 60, and 90 g/d, respectively) by treatments. Tendencies for increased percentages of milk fat, protein, and lactose were detected for cows receiving YC-EHY. Supplementing YC-EHY increased plasma β-hydroxybutyrate and tended to decrease (quadratic dose effect) glucose but did not affect nonesterified fatty acids. Yeast product supplementation during the transition period did not affect milk production and dry matter intake but modulated feeding behavior and metabolism.

Key words: feeding behavior, metabolism, transition cow, yeast

INTRODUCTION

The transition from late gestation to early lactation in dairy cows is characterized by dramatic energy requirements for milk synthesis and secretion, inadequate feed intake, and substantial metabolic stress (Grummer, 1995). Therefore, the transition period directly determines the lactational performance, health, and profitability of dairy cows. Yeast products derived from *Saccharomyces cerevisiae* have been added to diets in an attempt to improve ruminal fermentation, feed intake, and milk yield. Dann et al. (2000) reported that yeast culture supplementation at 60 g/d from approximately 21 d prepartum to 140 d postpartum increased DMI during both the last 7 d prepartum ($P = 0.01$) and the first 42 d of lactation ($P = 0.05$) in Jersey cows. A recent transition cow study (Ramsing et al., 2009) reported that yeast culture supplementation at 57 g/d from approximately 21 d prepartum to 21 d postpartum improved prepartum DMI ($P < 0.01$) and postpartum milk production ($P < 0.01$). Desnoyers et al. (2009) conducted a quantitative meta-analysis using 157 experiments to assess the responses to yeast supplementation and found that yeast products increased rumen pH, DMI, milk yield, and tended to increase milk fat content.

These data indicate that yeast products may improve the production of dairy cows, but mechanisms explaining the link between yeast supplementation and increased productivity remain unclear. Some investigators have proposed that metabolic activity of yeast in the rumen can use oxygen that would otherwise have toxic effects on the anaerobic microbes that are responsible for most ruminal digestion (Newbold et al., 1996). However, this proposal almost certainly does not account for the reported responses to yeast culture products (Poppy et al., 2012), which contain very few

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live yeast cells. Alternatively, cell surface antigens or intracellular growth factors produced by yeast could alter ruminal fermentation, function of the gastrointestinal epithelium, or both (Callaway and Martin, 1997). At the whole-animal level, alteration of immune function could also be important for productivity responses to dietary yeast supplements (Zaworski et al., 2014).

The objectives of this study were to assess whether a yeast product alters milk production, feeding behavior, and biomarkers of lipid and glucose metabolism in transition dairy cows.

MATERIALS AND METHODS

The Kansas State University Institutional Animal Care and Use Committee approved all experimental procedures.

Design and Treatments

Forty multiparous Holstein transition cows from the Kansas State University Dairy Cattle Teaching and Research Facility were used in a randomized complete block design. Cows were blocked by expected calving date (10 blocks) and randomly assigned within block to 1 of 4 treatments 21 d before their expected calving date. Cows remained on their respective treatments through 42 d postpartum. Cows received a product containing yeast culture plus enzymatically hydrolyzed yeast (**YC-EHY**; Celmanax, Vi-COR, Mason City, IA) at a rate of 0, 30, 60, or 90 g/d. These doses are consistent with the levels of supplementation reported in previous studies (Ramsing et al., 2009; Zaworski et al., 2014), and were chosen to characterize the response surface across the range of feeding rates that have been efficacious. The YC-EHY was administered daily to each cow in the treatment groups by top-dressing and manually mixing the premix into the upper part of each TMR. Diets were formulated to meet or exceed NRC (2001) requirements (Table 1). Samples of corn silage were collected weekly; all other dietary ingredients were collected every 2 wk and stored at −20°C. Upon study completion, feed ingredients were composited monthly for analysis by near-infrared reflectance spectroscopy by Dairy One Forage Laboratory (Ithaca, NY).

Management of Cows, Data Collection, and Sample Analysis

Cows used in the study had a dry period of 58.4 ± 6.5 d (mean ± SD) and consumed a diet containing grass hay, corn silage, wet corn gluten feed, and a grain/micronutrient supplement during the first 30 d of the dry period, providing an estimated 2.18 Mcal of ME/kg of DM (NRC, 2001). Cows were moved into the maternity barn approximately 1 wk before entering the study and were allowed ad libitum access to the designated treatment rations by an electronic gating system (Roughage Intake System, Insentec B.V., Marknesse, the Netherlands). After parturition, cows were moved into a tie-stall facility, where they remained through 42 d postpartum. Individual feed bunks in the tie-stall facility were suspended from load cells, and bunk weights were monitored continuously by computer. Feed weights and times were stored before and immediately after any deviation in bunk weight. Dry cows were fed twice daily (1100 and 1800 h), and lactating cows were fed twice daily (1200 and 1900 h). All cows were fed for ad libitum intake. All feeding activity, including meal length and size, were recorded electronically. Feed refusals were measured daily and as-fed feed intake of each cow was calculated. As-fed ration consumption was adjusted for DM content for determination of meal and daily DMI. Dry matter percentage was determined

Table 1. Ingredient and nutrient composition of diets

Item	Prepartum	Postpartum
Ingredient, % of DM		
Corn silage	29.5	15.9
WCGF[1]	21.3	34.3
Alfalfa hay	—	14.2
Wheat straw	10.9	3.3
Prairie hay	16.8	—
Cottonseed	—	5.0
Ground corn	3.4	11.2
Dry-rolled sorghum grain	3.4	6.4
Mechanically extracted soybean meal[2]	12.3	4.8
Molasses	1.2	1.2
Ca salts of long-chain fatty acids[3]	—	0.8
Micronutrient premix[4]	1.3	2.9
Nutrient, % of DM		
DM, % as-fed	45.4	51.1
CP	13.0	17.7
Starch	21.1	20.2
ADF	24.4	16.9
NDF	42.5	31.0
NFC	33.8	41.1
Ether extract	3.3	4.2
Ash	6.0	8.3

[1]Wet corn gluten feed, SweetBran, Cargill Inc. (Blair, NE).

[2]Soy Best, Grain States Soya (West Point, NE).

[3]Megalac-R, Church & Dwight Co (Princeton, NJ).

[4]Prepartum premix consisted of 53.0% vitamin E premix (44 IU/g), 11.6% selenium premix (600 mg/kg of Se), 10.5% trace mineral salt, 9.6% vitamin A premix (30 IU/g), 6.4% 4-Plex (Zinpro Corp., Eden Prairie, MN; contains 2.58% Zn, 1.48% Mn, 0.90% Cu, 0.18% Co, 8.21% Met, and 3.80% Lys), 4.3% vitamin D premix (30 IU/g), 4.3% Rumensin 90, and 0.48% ethylenediamine dihydriodide premix (3.65% I). Postpartum premix consisted of 47.5% limestone, 27.9% of sodium bicarbonate, 10.1% trace mineral salt, 6.4% magnesium oxide, 4.5% vitamin E premix (44 IU/g), 1.79% 4-Plex (Zinpro Corp., Eden Prairie, MN; contains 2.58% Zn, 1.48% Mn, 0.90% Cu, 0.18% Co, 8.21% Met, and 3.80% Lys), 1.1% selenium premix (600 mg/kg of Se), 0.56% vitamin A premix (30 IU/g), 0.01% vitamin D premix (30 IU/g), and 0.03% ethylenediamine dihydriodide premix (3.65% I).