J. Dairy Sci. 101:1–15
https://doi.org/10.3168/jds.2017-13240

Effects of supplementing yeast culture to diets differing in starch content on performance and feeding behavior of dairy cows

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ABSTRACT

The objectives were to evaluate the effects of a culture of *Saccharomyces cerevisiae* (YC) on lactation performance of cows fed diets differing in starch content. Fifty-six Holstein cows at 42 d postpartum were blocked by parity and milk production and randomly assigned to 1 of 4 treatments, low starch (23% diet DM) and no YC (LS-control), low starch and 15 g/d of YC (LS-YC), high starch (29% diet DM) and no YC (HS-control), and high starch and 15 g/d of YC (HS-YC). The experiment lasted 14 wk. Blood was sampled twice weekly during the first 5 wk in the experiment. Feeding behavior was evaluated in 2 consecutive days when cows were 33 d in the experiment. On d 92 in the experiment, cows were challenged with 3 kg of corn grain DM immediately before the morning feeding. Blood was sampled in the first 12 h after the challenge. Rumen fluid was collected 5 h after the challenge, and pH, ammonia N, short-chain fatty acids, and lactate concentrations were quantified. Lactation performance was measured daily before and after the challenge. Supplementation with YC increased yields of 3.5% fat-corrected milk and energy-corrected milk by 2.2 and 2.0 kg/d, and the increments were observed in both low- and high-starch diets. Feeding HS tended to decrease milk fat content (LS = 3.88 vs. HS = 3.73%), but increased concentration (LS = 2.87 vs. HS = 3.00%) and yield (LS = 1.11 vs. HS = 1.20 kg/d) of milk true protein. Feeding YC increased yields of fat and true protein in milk by 100 and 60 g/d. Energy balance, body weight, and feed efficiency did not differ with treatments. Feeding HS reduced eating time (LS = 177 vs. HS = 159 min/12 h) and intermeal interval (LS = 103 vs. HS = 82 min), but tended to increase eating rate (LS = 139 vs. HS = 150 g/min). Interactions were detected between level of starch and YC for ruminating time, meal duration, and meal size because within LS, feeding YC increased ruminating time 23 min/12 h, but reduced meal duration 6 min/meal and meal size 0.7 kg/meal. Concentrations of glucose in plasma increased (LS = 62.1 vs. HS = 63.8 mg/dL), whereas those of urea N decreased (LS = 10.1 vs. HS = 9.4 mg/dL) with feeding HS compared with LS in the first 5 wk in the experiment, and the same responses were observed after the challenge with corn grain. After the challenge, rumen pH was less and short-chain fatty acid concentrations were greater in cows fed HS compared with those fed LS; however, supplementing YC to high-starch diets increased rumen pH (HS-control = 5.72 vs. HS-YC = 6.12) and reduced concentrations of lactate in rumen fluid (HS-control = 7.72 vs. HS-YC = 1.33 m*M*) and haptoglobin in plasma 28%. Feeding YC improved lactation performance irrespective of the level of dietary starch and reduced the risk of subacute rumen acidosis induced by a grain challenge when cows were fed a high-starch ration.

Key words: dairy cow, rumen acidosis, starch, yeast culture

INTRODUCTION

Saccharomyces cerevisiae-based products are supplemented in diets of dairy cattle because of their effect on DMI, rumen pH, and nutrient digestibility (Callaway and Martin, 1997; Desnoyers et al., 2009; Nocek et al., 2011; AlZahal et al., 2014). These products usually increase yields of milk and milk components (Poppy et al., 2012), or improve efficiency of feed utilization by dairy cows (Schingoethe et al., 2004). Nevertheless, the benefits of feeding yeast culture to lactating dairy cows has been shown to be heterogeneous (Poppy et al., 2012). For instance, when supplemented to diets of lactating dairy cows before 70 DIM, yeast culture improved DMI by approximately 0.6 kg/d, whereas in experiments in which supplementation occurred in mid to late lactation, DMI decreased approximately 0.8 kg/d.

Received May 27, 2017.
Accepted September 7, 2017.
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The decrease in DMI at the same time that production is enhanced likely explains the improvements in feed efficiency of mid-lactation cows when supplemented with yeast culture (Schingoethe et al., 2004).

Experiments conducted in vivo and in vitro have shown that yeast cultures are able to stimulate growth of rumen cellulolytic bacteria (Harrison et al., 1988; Callaway and Martin, 1997), which is critical for carbohydrate digestion. Some strains of live *S. cerevisiae* favor the establishment of fibrolytic bacteria in the digestive tract of gnotobiotically reared lambs, which demonstrated to accelerate microbial activities in the rumen (Chaucheyras-Durand and Fonty, 2001). Desnoyers et al. (2009) reviewed the literature on yeast products and found that *S. cerevisiae* supplementation increased the OM digestibility in a dose-dependent manner. The positive effect of yeast on OM digestibility decreased as the proportion of concentrate in the diet increased, suggesting that the benefits on OM digestion were dependent on the supply of fiber in the diet. However, one of the documented benefits of live yeast products is the control of rumen acidosis. Cows fed TMR in the feedbunk, but receiving concentrates during milking, showed increased rumen pH when the diet was supplemented with a live yeast product (Bach et al., 2007). Some of the benefit was attributed to changes in feeding behavior because yeast-supplemented cows had increased meal frequency, which is thought to alleviate the acid load in the rumen. Nevertheless, in vitro experiments have shown that yeast culture can influence microbial populations and favor fibrolytic microorganisms and those considered lactate utilizers (Callaway and Martin, 1997). Nevertheless, shifts in microbial populations in vitro have not always translated into changes in vivo in dairy cows (Mullins et al., 2013). It is possible that the increase in rumen pH with feeding yeast products results from the combined effect on lactate utilization and changes in feeding behavior that favor a more stable rumen fermentation. It is interesting to note that the benefits of supplementing yeast products on rumen pH are exacerbated by increased DMI or by feeding more concentrates (Desnoyers et al., 2009). This might explain the benefit of yeast culture supplementation in preventing milk fat depression when cows were challenged with rumen-fermentable starch (Longuski et al., 2009).

Poppy et al. (2012) observed that the effect of yeast culture on DMI and yield of milk components is heterogeneous, and one of the possible factors explaining this variability is the fermentability of the diet. Williams et al. (1991) showed that supplementing a yeast culture increased yield of FCM, but the benefit was greater in the diet with 60% compared with 50% concentrate content. Variation in diet fermentability is common, either because purposely formulated, or because of mixing errors on farms. Yeast culture and live yeast products have the ability to minimize fluctuations in rumen pH, which might be more beneficial in diets of increased fermentability. The hypothesis of the current experiment is that yeast culture improves dairy cow performance and the benefits are greater in diets with increased starch content. Therefore, the objectives were to evaluate response to supplemental yeast culture in early lactation Holstein cows when fed diets varying in starch content.

MATERIALS AND METHODS

All procedures with experimental cows were approved by the University of Florida Institute of Food and Agriculture Science Animal Research Committee under protocol number 007–13ANS.

Cows and Housing

The experiment was conducted from October of 2013 to January of 2014. Fifty-six early-lactation Holstein cows from the University of Florida Dairy Unit were enrolled in the experiment in 4 weekly cohorts of 4 to 24 cows each. Cows at 32 ± 11 DIM were moved to the experimental pens for a 2-d period to acclimate to individual feeding gates (Calan Broadbent feeding system, American Calan Inc., Northwood, NH). From 34 to 41 DIM, all cows were fed the same TMR which corresponded to the low-starch diet not supplemented with yeast culture. Data collected during this 8-d pre-treatment period were used as covariate during statistical analysis. At experiment enrollment, cows averaged 591 ± 78 kg of BW, BCS of 2.90 ± 0.03, and 41.1 ± 12.0 kg of 3.5% FCM. Treatments initiated at 42 ± 12 DIM and the experiment ended 14 wk later, when cows averaged 140 ± 12 DIM. Therefore, the measurements corresponded to wk 7 to 21 postpartum. Cows were housed in the same freestall barn with sand-bedded stalls, and each cow was randomly assigned to an individual feeding gate for measurements of individual feed intake.

Experimental Design, Treatments, and Feeding

The experiment followed a randomized complete block design with a 2 × 2 factorial arrangement of treatments. Weekly cohort of cows were blocked by parity as primiparous or multiparous and 3.5% FCM during the 8-d pre-treatment period and, within each block, randomly assigned to 1 of the 4 treatments. Treatments were 2 levels of dietary starch, 23 or 29% of the diet DM, without or with supplemental yeast