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# Response of lactating cows to live yeast supplementation during summer

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## ABSTRACT

Dairy cows experiencing heat stress have reduced intake and increased reliance on glucose, making feeding strategies capable of improving diet digestibility plausible for improving postrumen nutrient flow and performance. The effect of yeast on digestion and performance of lactating cows during the warm summer months of southeastern Brazil was evaluated. Cows were individually fed in tie stalls and temperature-humidity index was above 68 during 75.6% of the experiment. Twenty-eight Holstein cows (207 ± 87 d in milk) received a standard diet for 14 d and then a treatment for 70 d, in a covariate-adjusted, randomized block design with repeated measures over time. Treatments were yeast (*Saccharomyces cerevisiae*) or control. Yeast was top dressed to the diet in the morning, equivalent to $25 \times 10^{10}$ cfu of live cells and $5 \times 10^{10}$ cfu of dead cells. The diet contained corn silage (37.7%), Tifton silage (7.1%), raw soybeans (4.1%), soybean meal (16.5%), finely ground corn (20.7%), and citrus pulp (11.9%). Yeast increased milk (26.7 vs. 25.4 kg/d) and solids yield (3.06 vs. 2.92 kg/d), especially lactose. Response in milk yield was consistent over time and started at d 5. The daily intake of digestible OM, total-tract digestibility of nutrients, urinary allantoin excretion, chewing pattern throughout the day, and dry matter intake did not respond to yeast. A trend was observed for increased plasma glucose with yeast (62.9 vs. 57.3 mg/dL), lowered respiratory frequency (48 vs. 56 breaths/min), and increased plasma niacin content (1.31 vs. 1.22 μg/mL), though cows had similar rectal temperature. Ruminal lactate and butyrate as proportions of ruminal organic acids were reduced by yeast, but no effects on other organic acids, ruminal pH, or protozoa content were detected. Plasma urea N over 24 h was increased by yeast. On d 72 to 74, citrus pulp was abruptly replaced with finely ground corn to induce acidosis. The increased load of starch increased dry matter intake between 0700 and 1300 h, jugular blood partial pressure of $CO_2$, $HCO_3^-$, and base excess, and decreased blood pH for both treatments. The yeast treatment had a higher blood pH compared with the control, 7.34, and 7.31, respectively. Yeast supplementation improved lactation performance of dairy cows under heat stress. Improvement in lactation performance apparently involved the regulation of body homeothermia, rather than improved digestibility.
**Key words:** heat stress, niacin, *Saccharomyces cerevisiae*, plasma glucose, respiratory frequency

## INTRODUCTION

Heat stress negatively affects productivity and longevity of dairy cows (Kadzere et al., 2002). Advances in management, such as cooling systems (Armstrong, 1994) and nutritional strategies (West, 2003), may attenuate the negative effects of heat stress, but the economic loss due to reduced milk production, reproductive efficiency, and animal health during warm seasons is a major issue for the dairy industry worldwide (St. Pierre et al., 2003).

Reduced lactation performance during heat stress has been attributed to the reduction in DMI of heat-stressed cows (Beede and Collier, 1986). However, reduced DMI seems to account for only 35 to 50% of the reduction in milk yield under heat stress, whereas the remainder could result from alterations in endocrine profiles and energy metabolism of heat-stressed cows (Rhoads et al., 2009; Wheelock et al., 2010). Heat-stressed cows may be in negative energy balance (**NEB**; Moore et al., 2005) and have increased energy demand for maintenance (NRC, 1981), due to energy expenditure for homeothermic regulation (Fuquay, 1981), capable of decreasing feed efficiency (Britt et al., 2003). During heat stress, cows are more dependent on glucose as an energy source (Rhoads et al., 2009) and despite the NEB, the mobilization of adipose tissue seems to be reduced in comparison with cows experiencing NEB at a thermoneutral temperature (Shwartz et al., 2009). The

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response may be related to increased plasma insulin levels during heat stress, apparently to spare glucose usage by peripheral tissues (Wheelock et al., 2010).

Heat stress may also decrease rumen pH and disturb ruminal function (Mishra et al., 1970). Cows in heat stress are more prone to respiratory alkalosis (Schneider et al., 1988), which may reduce $HCO_3^-$ concentration in saliva (Schneider et al., 1984). In addition, a reduction is found in daily rumination time (Soriani et al., 2013), capable of reducing saliva production. Ruminal motility (Silanikove, 1992), blood flow to the digestive tract (McGuire et al., 1989), as well as digesta fractional passage rate, are reduced in heat-stressed cows (Schneider et al., 1988), increasing the propensity of ruminal acidosis.

Supplementation of live yeast may improve nutrient digestibility (Bitencourt et al., 2011; Ferraretto et al., 2012) and control ruminal pH (Bach et al., 2007). Improvements in DMI, lactation performance, and feed efficiency have been reported in response to yeast supplementation of heat-stressed cows (Bruno et al., 2009; Moallem et al., 2009; Marsola et al., 2010). Shwartz et al. (2009) observed that the supplementation of a mixture of exogenous enzymes and yeast culture reduced rectal temperature of heat-stressed dairy cows, suggesting an action on thermoregulatory functions. Under heat stress, feeding strategies capable of increasing digestive efficiency, such as live yeast supplementation, may increase nutrient flow to the small intestine and dairy cow performance.

The objective of this study was to evaluate the effect of live yeast supplementation on digestion, lactation performance, and physiological variables of dairy cows during the hot summer months of southeastern Brazil.

## MATERIALS AND METHODS

The experiment was conducted from January 9 to April 1, 2012, in an open-walled, sand-bedded, tie-stall barn with fans and high-pressure sprinklers at the Better Nature Research Center, located at Ijaci, Minas Gerais, Brazil (http://www.holandesflamma.com.br/). The protocol was approved by the Federal University of Lavras Bioethic Committee in Utilization of Animals (protocol n° 046/14). The barn was located at an altitude of 846 m, 21°09′52.41″S and 44°55′52.40″W. Environmental temperature and humidity at the center of the barn was measured at 30-min intervals with a digital thermometer (EasyLog-USB-2-LCD, Lascar Electronics, Salisbury, United Kingdom) 2.5 m from the floor. The temperature-humidity index (**THI**) was calculated according to Yousef (1985): THI = T + 0.36 × DP + 41.2, where T = temperature (°C) and DP = dew point (°C).

Twenty-eight Holsteins (207 ± 87 DIM) were fed a standard diet for 14 d (covariate period). At the end of the covariate period, cows were paired blocked based on calving order and milk yield, and assigned to 1 of 2 treatments for 10 wk. Treatments were yeast (*Saccharomyces cerevisiae*, strain NCYC 996, Procreatin7, Lesaffre Feed Additives, Toluca, Mexico) and control. The yeast product (10 g/d) was top dressed to the diet of each cow once per day in the morning. The daily dose of yeast per cow was $25 \times 10^{10}$ cfu of live cells and $5 \times 10^{10}$ cfu of dead cells. The composition of the yeast product was 92.3% DM, 45.7% CP, and 4.4% ash. The niacin content was 45.12 mg/100 g (VitaFast niacin microbiological assay, R-Biopharm, Darmstadt, Germany) and amino acid composition was (g/100 g): aspartate (3.90), glutamate (3.85), serine (1.38), glycine (1.62), histidine (0.85), arginine (1.54), threonine (2.00), alanine (2.30), proline (1.04), tyrosine (1.33), valine (2.10), methionine (0.54), cysteine (0.51), isoleucine (1.18), leucine (2.09), phenylalanine (1.64), and lysine (3.63). The amino acids were analyzed by HPLC (HP Agilent 1100. Agilent Technologies, Waldbronn, Germany).

The TMR was mixed in a stationary mixer and offered twice daily at approximately 0600 and 1400 h. Individual cow intake was assessed throughout the experiment, by recording the amount of feed offered and orts daily (as-fed basis). Samples of ingredients were collected daily and composite samples made per week. Likewise, ort samples were collected daily and composited per cow per week. Composite samples were dried in forced-air oven at 55°C for 72 h and ground through a 1-mm screen in a Wiley mill (Arthur H. Thomas, Philadelphia, PA). The DM content was determined by drying at 100°C for 24 h and CP was determined by micro-Kjeldahl analysis (AOAC, 1990). The ether extract (EE) was analyzed according to AOAC (1990) after hydrolysis with hydrochloric acid. Ash was analyzed by incineration at 550°C for 8 h. The NDF was analyzed using a TE-149 fiber analyzer (Tecnal Equipamentos para Laboratórios, Piracicaba, Brazil) with amylase and sodium sulfide. Starch was analyzed according to Hall (2009). The NFC fraction was calculated: NFC = 100 − (CP + EE + ash + NDF). Composition of consumed diets is reported in Table 1.

Cows were milked twice daily, at 0430 and 1600 h, and milk yield was recorded daily. Milk samples were obtained weekly on the same 2 d for 4 consecutive milkings. Solids and MUN content were measured (Laboratório Centralizado da Associação Paranaense de Criadores de Bovinos da Raça Holandesa, Curitiba, Brazil) by infrared analysis (Bentley 2000, Bentley Instruments Inc., Chaska, MN). Milk energy secretion (**milk E**; Mcal/d) was calculated as [(0.0929 × %fat) +