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Yeast culture increased plasma niacin concentration, evaporative heat loss, and feed efficiency of dairy cows in a hot environment

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ABSTRACT

The supplementation of dairy cows with yeast culture may increase diet digestibility, plasma niacin concentration, heat dissipation, and lactation performance. Our objective was to evaluate the response of Holstein cows in late lactation (234 ± 131 d in milk) to dead yeast culture (YC, 15 g/d, Factor SC, GRASP, *Saccharomyces cerevisiae*) during Brazilian summer (temperature-humidity index >68 for 92.2% of the time). Thirty-two cows were individually fed a standard total mixed ration for 14 d and control (CTL) or YC treatments for 35 d, in a covariate adjusted complete randomized block design. Response was evaluated in wk 5 or as repeated measures over time. Cows were milked 3 times per day and treatments (YC or placebo) were orally dosed to each cow before each milking. Plasma niacin was 1.50 for CTL and 1.66 μg/mL for YC. The YC reduced rectal temperature, respiration rate, and skin temperature, whereas it tended to increase sweating rate. The proportion of cows with rectal temperature ≥39.2°C on CTL and YC was, respectively, 8 and 0% at 0730 h, 52 and 25% at 1500 h, and 35 and 26% at 2200 h. Plasma glucose was increased by YC. The total-tract apparent digestibility of nutrients, plasma urea N concentration, molar proportion of ruminal VFA, and urinary allantoin excretion were not affected by YC. Cows fed YC were less selective against feed particles >19 mm in the morning, in the afternoon were more selective against long feed particles and in favor of particles <8 mm, and refused short particles at night. Milk yield was not different (30.5 kg/d for CTL and 30.2 kg/d for YC). Feeding YC reduced dry matter intake (20.3 vs. 19.4 kg/d) and the digestible organic matter intake (15.6 vs. 13.9 kg/d). The inclusion of YC increased the ratios of milk to dry matter intake (1.50 vs. 1.64) and energy-corrected milk to dry matter intake (1.81 vs. 1.98). The covariate adjusted body weight (648 kg) and body condition score (3.0) did not differ. Milk solids yields and concentrations, linear somatic cell count, and milk urea N were also similar. The supplementation of YC increased plasma niacin concentration, body heat loss, and feed efficiency of late lactation dairy cows by reducing intake at similar milk yield.
Key words: body temperature, digestibility, heat stress, *Saccharomyces cerevisiae*

INTRODUCTION

Although the effect of yeast supplementation on lactation performance seems to be variable across experiments, thorough meta-analysis suggested that the average effect is positive (Desnoyers et al., 2009; Poppy et al., 2012). Additives classified as dead yeast culture are not dependent on the presence of viable (active) yeast cells to have physiological action (Poppy et al., 2012). Yeast culture may provide growth factors for ruminal microorganisms, capable of inducing improvement in nutrient digestibility and reduction in lactic acid accumulation in rumen fluid (Chaucheyras-Durand et al., 2008). Recently, it was shown that the supplementation of dairy cows with live and dead yeast increased the concentration of niacin in plasma (Salvati et al., 2015), capable of having positive effects on peripheral circulation and heat increment dissipation by evaporative loss (Zimbelman et al., 2010, 2013). Yeast cell wall polysaccharides also have the potential to act positively on the immune function of dairy cows (Zaworski et al., 2014).

The selection for high milk yield has increased the sensitivity of dairy cows to heat stress because greater yield increases digestible nutrient intake and metabolic heat production (Kadzere et al., 2002). Heat stress causes major financial loss to the global dairy industry by reducing milk yield, reproductive efficiency, and longevity of dairy cows (St. Pierre et al., 2003). Cows

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subjected to heat stress have reduced feed intake, have a propensity to develop ruminal acidosis (Mishra et al., 1970), and are more dependent on glucose as energy substrate (Baumgard and Rhoads, 2012). Heat stress can also cause immune deficiency (Bradford et al., 2015) and increased maintenance energy requirement (Fuquay, 1981).

The positive effect of yeast supplementation on the performance of dairy cows subjected to heat stress has been postulated for quite some time (Huber et al., 1994). Cows under heat stress appear to have a greater positive response in milk yield to yeast-based products (Bruno et al., 2009; Moallem et al., 2009; Salvati et al., 2015) than would be predicted from meta-analysis of the literature on yeast supplementation (Desnoyers et al., 2009; Poppy et al., 2012). Positive effects of yeast-based products on feed efficiency of dairy cows under heat stress have been observed, either driven by increased milk yield at similar intake (Moallem et al., 2009; Liu et al., 2014) or reduced intake at similar yield (Schingoethe et al., 2004). However, when dairy cows were subjected to a short-term thermal challenge in climatic chambers, the supplementation of live yeast and enzymes reduced the rectal temperature, but did not attenuate the negative effect of the excessive heat load on lactation performance and intake (Shwartz et al., 2009).

We evaluated the effect of dead yeast culture on feed efficiency, nutrient digestibility, plasma metabolites, body heat dissipation, and chewing and ingestion behavior of dairy cows subjected to a hot environment during Brazilian summer. We hypothesized that yeast culture would have positive effects on nutrient utilization and heat dissipation capable of inducing improvement in lactation performance and feed efficiency of dairy cows.

MATERIALS AND METHODS

The protocol was approved by the University of Lavras Bioethic Committee in Utilization of Animals.

Location, Cows, and Experimental Design

The experiment was conducted from November 15 to December 28, 2015, in an open-walled, sand-bedded tiestall barn with fans and high-pressure sprinklers at the Better Nature Research Center (http://www.holandesflamma.com.br/), located at Ijaci, Minas Gerais, Brazil. The research center is located at 846 m above sea level, 21° 09′ 52.41” latitude south, and 44° 55′ 52.40” longitude west. Environmental temperature and relative humidity at the center of the barn were measured at 30-min intervals with a digital thermometer (EasyLog-USB-2-LCD, Lascar Electronics, Salisbury, United Kingdom) located 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).

Thirty-two Holstein cows (234 ± 131 DIM at the beginning of the experiment), 10 primiparous, were individually fed the same TMR for a 2-wk standardization period and data obtained on d 11 to 14 were used as a covariate in the statistical model. Cows were paired blocked based on parity and milk yield and assigned to a treatment for a 35-d comparison period, in a covariate adjusted randomized block design with repeated measures over time. Treatments were control (**CTL**) or yeast culture (**YC**; Factor SC, GRASP Indústria e Comércio Ltda, Curitiba, Brazil). The product is marketed as dead yeast culture with growing medium and metabolites. Paper capsules containing 5 g of the YC were orally given to each cow 3 times per day, before milking (15 g/cow per d). Cows on CTL received paper only.

The concentrations of live and dead cells per gram of product were determined. The yeast culture was rehydrated in peptone water (0.1%) warmed to 30°C and allowed to stand for 10 min before the addition of the same volume of a methylene blue solution (0.01%). Cell count was performed in a Neubauer chamber with a bright field optical microscope (400× magnification), according to the recommendations of Lee et al. (1981). Dead yeast cells stain dark blue, whereas live cells stain light blue due to the difference in cell permeability to the dye. The niacin concentration of the sample was determined by HPLC in a commercial laboratory (Eurofins Alac, Garibaldi, Brazil).

Feed Management, Measurements, and Analytical Procedures

The composition of the experimental diet is listed in Table 1. The same TMR batch was offered to all cows during the comparison period. The TMR was prepared 2 times per day in a vertical stationary vertical mixer (Unimix 1200, Casale, São Carlos, Brazil) and cows had access to new feed at 0700 and 1300 h. The silage DM concentration was monitored weekly with an electric moisture tester (Koster Crop Tester, Strongsville, OH) and diet were adjusted accordingly. Individual cow intake was assessed daily by recording the amount of feed offered and orts (as-fed basis). The feed was offered in sufficient quantity to obtain at least 10% of the offered as daily refusals.

Samples of dietary ingredients were collected daily and composite samples made per week. Likewise, ort