J. Dairy Sci. 100:1–10
https://doi.org/10.3168/jds.2016-12258

Supplementing an immunomodulatory feed ingredient to modulate thermoregulation, physiologic, and production responses in lactating dairy cows under heat stress conditions[1]

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ABSTRACT

This study compared vaginal temperature, physiologic, and productive parameters in lactating dairy cows supplemented or not with Omnigen-AF (Phibro Animal Health, Teaneck, NJ) during the summer months in a tropical environment. Thirty-two lactating, primiparous (n = 16) and multiparous (n = 16) pregnant Holstein × Gir cows were ranked by parity, days in milk, body weight, and body condition score (BCS), and assigned to receive (SUPP; n = 16) or not (CON; n = 16) Omnigen-AF (Phibro Animal Health, Teaneck, NJ) at 56 g/cow daily (as-fed basis). During the experimental period (d −6 to 56), cows were maintained in a single drylot pen with ad libitum access to water and a total mixed ration, and milked twice daily. Cows received Omnigen-AF mixed with 200 g of corn (as-fed basis) after the daily morning milking through self-locking head gates, whereas CON cows concurrently received 56 g of kaolin mixed with 200 g of corn. For feed intake evaluation, cows from both treatments were randomly divided in 4 groups of 8 cows each, and allocated to 8 individual feeding stations for 3 d. Intake was evaluated 4 times per group from d 1 to 56. From d −6 to 0, d 15 to 28, and d 43 to 56, cow vaginal temperature was recorded hourly. Environmental temperature-humidity index (THI) was also recorded hourly from d 15 to 28 and d 43 to 56. Cows were evaluated for body weight and BCS on d −6 and 56, individual milk production was recorded daily from d −6 to 56, and milk samples were collected on d −6, 0, 7, 14, 21, 28, 35, 42, 49, and 56 for analyses of somatic cell count and milk components. Blood samples were collected on d −6, −3, 0, 9, 15, 18, 21, 24, 27, 36, 45, 48, 51, 54, and 56. Results from samples or observations collected from d −6 to 0 were included as an independent covariate in each respective analysis. Environmental THI was 74.2 ± 0.5 and cows were exposed to THI >68 for 633 h within a total of 672 h of evaluation. Cows assigned to CON had greater vaginal temperature on d 28, 43, 45, and from d 48 to 55 (by 0.38 to 0.52%), as well as greater mean somatic cell count (by 97%) and serum haptoglobin concentrations (by 89%) compared with SUPP cows. Cows assigned to SUPP had greater mean dry matter intake (by 7%), BCS on d 56 (by 11%), and mean serum insulin concentrations (by 35%) compared with CON cows. Hence, SUPP ameliorated hyperthermia, improved nutritional status, and modulated systemic and mammary gland immune parameters in lactating dairy cows exposed to heat stress conditions.
Key words: heat stress, lactating cow, milk production, Omnigen-AF, temperature

INTRODUCTION

Heat stress is one of the major challenges to dairy production systems in subtropical and tropical environments (West, 2003). St-Pierre et al. (2003) estimated that heat stress costs the US dairy industry approximately $900 million annually, whereas decreased milk yield is a critical contributor to this outcome. Hyperthermia is known to affect milk production by reducing voluntary DMI (West, 1994), but also impairs metabolic and physiological processes required for optimal cattle productivity and welfare (West, 2003; Collier et al., 2008; Rhoads et al., 2009). Hence, management strategies that alleviate the incidence of heat stress in dairy cows are warranted to optimize profitability in dairy production systems (West, 2003).

Omnigen-AF is a patented proprietary branded product recently shown to improve milk production and

Received November 4, 2016.
Accepted February 13, 2017.
[1]The Fundação de Amparo à Pesquisa do Estado de São Paulo (São Paulo, Brazil) provided financial support for T. Leiva (grant no. 2015/21224-0).
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innate immunity parameters in transition dairy cows (Brandão et al., 2016). However, supplementing this ingredient has also been associated with decreased hyperthermia in cattle subjected to heat stress conditions. Brandão et al. (2016) reported that supplemented cows had reduced mean vaginal temperature compared with nonsupplemented cohorts during periods with temperature-humidity index (**THI**; Zimbleman et al., 2009) >68. Supplementing this ingredient also decreased rectal temperature and respiration rates in lactating (Hall et al., 2014) and nonlactating (Fabris et al., 2016) dairy cows exposed to elevated thermal and humidity load. Collectively, these results imply that this ingredient affects thermoregulation of dairy cows under heat stress conditions. Yet, research is still warranted to verify its potential thermoregulatory capabilities (Brandão et al., 2016), including supplementation to lactating dairy cows in a production system with elevated incidence of THI >68. Therefore, this experiment evaluated the effects of Omnigen-AF supplementation on vaginal temperature, metabolic, physiologic, and productive parameters of lactating dairy cows during the summer months in a tropical environment.

MATERIALS AND METHODS

This experiment was conducted from December 2015 to February 2016 at the São Paulo State University Lageado Experimental Station located in Botucatu, São Paulo, Brazil. The animals were cared for in accordance with acceptable practices and experimental protocols reviewed and approved by the São Paulo State University Animal Ethics Committee.

Animals and Diets

Thirty-two lactating, primiparous (n = 16) and multiparous (n = 16) pregnant Holstein × Gir cows (initial mean ± SE; BW = 517 ± 11 kg, BCS = 3.06 ± 0.06, DIM = 167 ± 9, 1.6 ± 0.2 parities) were assigned to this experiment. On d −6, cows were ranked by parity, DIM, BW, and BCS (Wildman et al., 1982) in a decreasing order, and alternatingly assigned to receive (**SUPP**; n = 16, 8 primiparous and 8 multiparous cows) or not (**CON**; n = 16, 8 primiparous and 8 multiparous cows) 56 g/cow daily (as-fed basis) of Omnigen-AF (Phibro Animal Health, Teaneck, NJ) from d 1 to 56.

During the experimental period (d −6 to 56), cows were maintained in a single drylot pen with ad libitum access to water and a TMR (1.5 m of linear bunk space/cow). The drylot pen had no available shade or cooling system. The TMR consisted (DM basis) of 58.9% corn silage and 41.1% concentrate (Table 1) and was formulated with the Spartan Dairy Ration Evaluator/Balancer (version 3.0; Michigan State University, East Lansing, MI) to yield 25 kg of milk/d. Cows were milked twice daily in a side-by-side milking system (0600 and 1700 h) from d −6 to 56.

Table 1. Composition and nutritional profile of the TMR offered for ad libitum consumption to lactating dairy cows during the experimental period

Item	Component
Composition (DM basis)	
Corn silage, %	58.87
Soybean meal, %	20.57
Ground corn, %	18.93
Mineral mix,[1] %	1.23
Urea, %	0.40
Nutritional profile (DM basis)	
NDF, %	40.69
Starch, %	18.49
ME, Mcal/kg	2.57
NE_M, Mcal/kg	1.62
NE_L, Mcal/kg	1.62
NE_G, Mcal/kg	1.08
CP, %	15.60

[1]Contained 22% Ca, 7.5% P, 6.5% Na, 1.0% K, 3.6% Mg, 2.0% S, 0.003% Co, 0.115% Cu, 0.004% I, 0.220% Mn, 0.003% Se, 0.400% Zn, 400,000 IU/kg of vitamin A, 100,000 IU/kg of vitamin D_3, and 0.150% of vitamin E (Milk MAC, M. Cassab Tecnologia Animal, São Paulo, Brazil).

From d 1 to 56, SUPP cows individually received 56 g of Omnigen-AF mixed with 200 g of finely ground corn (as-fed basis), immediately after the daily morning milking (0800 h) through self-locking head gates. The feed bunk containing the self-locking head gates had no shade, but contained a sprinkler + fan cooling system. Each CON cow concurrently received 56 g of kaolin (rumen-inert substance) mixed with 200 g of finely ground corn (as-fed basis) through self-locking head gates. Omnigen-AF was offered in the amount recommended by the manufacturer (Phibro Animal Health) and used in previous research (Wang et al., 2009; Ryman et al., 2013; Brandão et al., 2016).

Sampling

Intake Parameters. Samples of the offered TMR were collected weekly, pooled into one sample, and analyzed for nutrient content (Table 1) via wet chemistry procedures by a bromatology laboratory (3rlab, Belo Horizonte, Brazil). Calculations of ME, NE_l, and NE_m used the equation proposed by the NRC (2001).

To determine treatment effects on voluntary DMI from d 1 to 56, cows from both treatments were randomly divided in 4 groups of 8 cows each (4 cows/treatment in each group, being 2 primiparous and 2 multiparous from each treatment). Cows from each group were allocated to 8 individual feeding stations (15 m^2; 2.0 m of linear bunk space) with soft rubber flooring for