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Physiologic, health, and production responses of dairy cows supplemented with an immunomodulatory feed ingredient during the transition period

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ABSTRACT

This study compared physiological, health, and productive parameters in dairy cows supplemented or not with Omnigen-AF (OMN; Phibro Animal Health, Teaneck, NJ) during the transition period. Thirty-eight nonlactating, multiparous, pregnant Holstein × Gir cows were ranked by body weight (BW) and body condition score (BCS), and assigned to receive (n = 19) or not (CON; n = 19) OMN at 56 g/cow daily (as-fed basis) beginning 35 d before expected date of calving. Before calving, cows were maintained in single drylot pen with ad libitum access to corn silage, and received (as-fed basis) 3 kg/cow daily of a concentrate. After calving, cows were moved to an adjacent drylot pen, milked twice daily, offered (as-fed basis) 35 kg/cow daily of corn silage, and individually received a concentrate formulated to meet their nutritional requirements after both milkings. Cows received OMN individually as top-dressing in the morning concentrate feeding. Before calving, cow BW and BCS were recorded weekly and blood samples were collected every 5 d beginning on d −35 relative to expected calving date. After calving and until 46 DIM, BW and BCS were recorded weekly, individual milk production was recorded, and milk samples were collected daily for total solids and somatic cell count analyses. Blood was sampled daily from 0 to 7 d in milk, every other day from 9 to 21 d in milk, and every 5 d from 26 to 46 d in milk. On 30 and 46 d in milk, cows were evaluated for endometritis via cytobrush technique, based on % of polymorphonuclear (PMN) cells in 100 total cell count (PMN + endometrial cells). On 48.7 ± 1.6 d in milk, 9 cows/treatment received a lipopolysaccharide (LPS) injection (0.25 μg/kg of BW), and blood was sampled hourly from −2 to 8 h, at 12-h intervals from 12 to 72 h, and at 24-h intervals form 96 to 120 h relative to LPS administration. No treatment differences were detected on BW, BCS, serum concentrations of cortisol, fatty acids, insulin, glucose, haptoglobin, cortisol, and insulin-like growth factor-I. Cows receiving OMN had greater milk yield (30.3 vs. 27.1 kg/d) and percentage of PMN cells in endometrial cell population (12.2 vs. 3.9%) compared with CON cows. After LPS administration, cows receiving OMN had greater mean serum haptoglobin (212 vs. 94 μg/mL), as well as greater serum concentration of tumor necrosis factor α at 1, 2, and 3 h relative to LPS injection compared with CON cows. In conclusion, OMN supplementation during the transition period enhanced innate immunity parameters and increased milk production in dairy cows.

Key words: inflammation, milk production, Omnigen-AF, transition cows

INTRODUCTION

During the transition period, dairy cows experience physiological changes associated with parturition and onset of lactation that impair their immune function (Mallard et al., 1998; Drackley, 1999). These include increased lipolysis, altered insulin-glucose and somatotropic axes, as well as heightened inflammatory and acute phase reactions (Grummer, 1995; Sheldon et al., 2001). Consequently, transition dairy cows are highly susceptible to metabolic and infectious diseases that directly affect their lactation productivity and well-being (Goff and Horst, 1997; Mallard et al., 1998). Hence, management strategies that modulate physiology and enhance immunocompetence of transition dairy cows are warranted to optimize profitability in dairy production systems (Overton and Waldron, 2004).

Omnigen-AF (**OMN**; Phibro Animal Health, Teaneck, NJ) is a patented proprietary branded product shown to modulate innate and adaptive immune function in ruminants and other livestock species. For example, OMN supplementation enhanced innate immunity parameters in sheep administered dexametha-

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sone (Wang et al., 2007) and in blood leukocytes from Holstein heifers (Ryman et al., 2013). Wang et al. (2009) supplemented OMN to transition Jersey cows, and reported increased blood leukocytes concentrations and mRNA expression of proinflammatory cytokines in supplemented versus nonsupplemented cows. Collectively, these results are suggestive of heightened innate immunity when OMN is supplemented, although the effects of this feed additive on metabolic, health, and productive responses of transition dairy cows still warrants investigation.

Based on this rationale, we hypothesized that OMN supplementation to dairy cows will optimize metabolic and innate immune responses during the transition period, resulting in enhanced milk production. Therefore, this experiment compared physiological, health, and productive parameters in dairy cows supplemented or not with OMN before calving and during early lactation.

MATERIALS AND METHODS

This experiment was conducted at the São Paulo State University, Lageado Experimental Station, located in Botucatu, São Paulo, Brazil. The animals used 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-eight nonlactating, multiparous, pregnant Holstein × Gir cows (initial mean ± SE; BW = 638 ± 12 kg, BCS = 3.33 ± 0.08) were ranked by parity, BW, and BCS (Wildman et al., 1982) in a decreasing order and alternatingly assigned to receive (n = 19) or not (**CON**; n = 19) 56 g/cow daily (as-fed basis) of OMN beginning 35 d before expected date of calving. This allocation procedure was adopted to ensure that both treatment groups had similar parity, BW, and BCS at the beginning of the experiment (OMN-supplemented cows = 3.3 ± 0.3 parities, 656 ± 16 kg of BW, and 3.19 ± 0.11 of BCS; CON cows = 3.2 ± 0.3 parities, 628 ± 16 kg of BW, and 3.15 ± 0.12 of BCS). According to the manufacturer, OMN contains a mixture of active dried *Saccharomyces cerevisiae*, dried *Trichoderma longibrachiatum* fermentation product, niacin, vitamin B_{12}, riboflavin-5-phosphate, D-calcium pantothenate, choline chloride, biotin, thiamine monohydrate, pyridoxine hydrochloride, menodione dimethylpyrimidinol bisulfate, folic acid, calcium aluminosilicate, sodium aluminosilicate, diatomaceous earth, calcium carbonate, rice hulls, and mineral oil (full formulation is proprietary).

Table 1. Composition and nutritional profile of concentrate offered to transition dairy cows before calving and during lactation

Item	Prepartum[1]	Lactation[2]
Composition, % DM basis		
Ground corn	45.5	56.8
Soybean meal	45.5	40.5
Prepartum mineral mix[3]	9.0	0.0
Lactation mineral mix[4]	0.0	2.7
Nutritional profile, % DM basis		
NDF	12.0	13.0
NFC	58.0	58.0
ME	2.76	2.99
NE_L	1.80	1.92
NE_M	1.91	2.04
CP	24.2	23.1

[1]Prior to calving, cows received corn silage for ad libitum consumption and were offered 3 kg/cow daily (as-fed basis) of the prepartum concentrate. Based on actual calving dates, cows received prepartum diets for 33.7 ± 1.5 d.

[2]After calving, cows received 35 kg/cow daily (as-fed basis) of corn silage and were offered the lactation concentrate for 46 d. Concentrate intake was adjusted weekly using the Spartan Dairy Ration Evaluator/Balancer (version 3.0; Michigan State University, East Lansing, MI), according to DIM, BW, BCS, and milk yield, with fat and protein concentrations set at 3.5 and 3.2%, respectively.

[3]Containing 25% Ca, 4.7% S, 4.5% Mg, 3.3% Cl, 0.001% Se, 422,000 IU/kg of vitamin A, 21,200 IU/kg of vitamin D_3, and 0.211% of vitamin E (Milk Ionic, M. Cassab Tecnologia Animal, São Paulo, Brazil).

[4]Containing 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).

Prior to calving, cows were maintained in a single drylot pen with ad libitum access to corn silage (1.5 m of linear bunk space/cow), water, and a commercial prepartum mineral mix (25% Ca, 4.7% S, 4.5% Mg, 3.3% Cl, 0.001% Se, 422,000 IU/kg of vitamin A, 21,200 IU/kg of vitamin D_3, and 0.211% of vitamin E; Milk Ionic, M. Cassab Tecnologia Animal, São Paulo, Brazil). Cows individually received 3 kg/cow daily of a concentrate through self-locking head gates once daily (0800 h); prepartum concentrate composition and nutritional profile are described in Table 1. All cows completely consumed their concentrate allocation within 30 min after feeding.

Upon calving, cows from both treatments were moved to an adjacent single drylot pen, with ad libitum access to water and a commercial lactation mineral mix (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). Cows were milked twice daily in a side-by-side milking system (0600 and 1700 h). Cows were group-fed (as-fed basis) 35 kg/cow daily