Livestock Science 210 (2018) 39–46

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

The effect of a commercial feed additive on the immune-metabolic axis, liver function and predicted carcass quality in purebred Angus steers

S.A. Armstrong[a,b,*], D.J. McLean[a], G. Bobe[b]

[a] Phibro Animal Health Corporation, Teaneck, NJ 07666, USA
[b] Department of Animal and Rangeland Sciences, Oregon State University, Corvallis, OR 97330, USA

ARTICLE INFO

Keywords:
Beef cattle
Immune-metabolic axis
Immune supplementation
OmniGen-AF

ABSTRACT

To determine the effect of the commercial feed additive OmniGen-AF® on immune, physiological, and carcass ultrasound variables in steers during backgrounding, transition, and finishing phases, nine purebred Angus half-sibling steers were randomly assigned to one of two treatment groups: Control (n = 4) and OmniGen-AF (OG; n = 5). Cattle were offered 0 (Control) or 56 g daily of OG throughout a 28-d backgrounding period (limit-fed a predominantly forage diet), a 14-d transition period, and a 56-d finishing period on a high concentrate diet (104 days total). During the three feeding periods, whole blood and serum was collected to evaluate markers of immune function and physiology, respectively. Across basal diet phases, OG supplementation increased serum chloride ($P = 0.02$) and haptoglobin ($P = 0.03$) concentrations and decreased serum NEFA ($P = 0.001$) concentrations. At the end of the high-concentrate finishing period, OG supplementation vs. Control attenuated the decrease in serum paraoxonase and the increase in AST concentrations, a marker of liver cell necrosis. Carcass prediction measurements, collected in 30-day intervals during the finishing phase, indicated lower predicted numerical yield grades ($P = 0.03$) due to higher REA ($P = 0.009$) and a tendency for less 12th rib fat ($P = 0.06$) in Control vs. OG steers. Weight gain, feed intake, feed efficiency, and predicted quality grades did not differ between treatments. In conclusion, OG may act on the immune-metabolic axis across the three studied basal diet phases to support healthier livers and improved predicted yield grades in Angus steers by decreasing fat deposition and increasing REA.

1. Introduction

Research has suggested the interconnected role of the immune system and metabolism (Murray et al., 2015) on cross-regulation of immune and metabolic function (Norata et al., 2015). Odegaard and Chawla (2013) indicated a shared regulatory axis between immunity and metabolism with strong architectural commonality responsible for regulating metabolic physiology (identified in this paper as the immune-metabolic axis).

Feedlot cattle experience a number of stressors from receiving to harvest which can exert pressure on the immune-metabolic axis. Specific examples of these stressors include heat stress (Collier et al., 2008; Gaughan et al., 2008; Mader and Davis, 2004; Mitlohner et al., 2001), feed changes (Ametaj et al., 2009), housing conditions (Arthington et al., 2008; Duff and Galyean, 2007), and pathogen challenges (Burciaga-Robles et al., 2010). To introduce more control over the responses to these stressors, adding commercial feed additives to the basal ration is a viable option. Sub-therapeutic antibiotic supplementation (Alexander et al., 2008; Beauchemin et al., 2003; Callaway et al., 2003) and β-adrenergic agonists (Avendaño-Reyes et al., 2006; López-Carlos et al., 2010; Vasconcelos et al., 2008) are common in feedlot rations. However, increasing regulation by regulatory institutions forecasts a limitation on use for these types of supplements. As a result, beef producers need to investigate alternative options to maintain feed efficiency, animal health, and food safety. One product, shown to improve the health of dairy cattle during stressful production scenarios, is OmniGen-AF (OG) (Bewley et al., 2014; Holland et al., 2014, 2013). When OG was added to the diet of beef cattle, both steers and heifers mounted a stronger immune response to an endotoxin challenge (Burdick et al., 2012; Sanchez et al., 2014a). However, detailed information regarding the effect of OG supplementation on maintaining production characteristics, (including feed efficiency, carcass predictions, animal health, and food safety) of beef cattle across stressful production scenarios, including a high-concentrate finishing phase, remains unknown.

OG-supplementation has impacted markers of immune function (*IL8R*; *CXCR1/CXCR2* and *L-Selectin CD62L*) in rats (Branson et al., 2016), mice (Ortiz-Marty et al., 2012), sheep (Wang et al., 2004), and

* Corresponding author at: Phibro Animal Health, 1767 NW Kings Blvd, Corvallis, OR 97330, USA.
E-mail address: shelby.armstrong@pahc.com (S.A. Armstrong).

https://doi.org/10.1016/j.livsci.2018.02.002
Received 10 October 2017; Received in revised form 2 February 2018; Accepted 5 February 2018

dairy cattle (Nace et al., 2014; Playford et al., 2014; Ryman et al., 2013; Wang et al., 2009). An impact on metabolic status has also been identified during heat stress (Hall et al., 2014) and lipopolysaccharide challenge (Sanchez et al., 2014a, 2014b, 2017) in dairy and beef cattle, respectively. When OG was included in the diet of replacement beef heifers and steers without an experimentally induced immune or metabolic challenge, carbohydrate metabolism was altered during a 49-d supplementation period and the 21-d following supplementation (Schell et al., 2016). However, detailed information regarding the effect of OG supplementation on the immune-metabolic axis across various basal diet phases in beef cattle, including a high-concentrate finishing phase, remains unknown.

Thus, the objective of this study was to determine the effect of OG supplementation on production parameters, carcass predictions, and the immune-metabolic axis in beef cattle when they transition from a primarily forage-based, limit-fed background diet to a high-concentrate finishing diet. We hypothesized that OG supplementation supports the immune-metabolic axis to maintain health and production characteristics across various basal diet phases, including a high-concentrate finishing phase.

2. Materials and methods

2.1. Cattle and diets

All steers were cared for under guidelines outlined in the Phibro Animal Health Animal Care and Use Policy. Nine half-sibling, purebred Angus steers were housed in a free stall barn (Corvallis, OR) with access to a Calan Broadbent Feeding System (American Calan, Northwood, NH). Steers were allowed a 20-d training and acclimatization period and were randomly assigned to two treatment groups: control animals (no nutritional supplement; Control; n = 4), and a treatment group provided a nutritional supplement at 56 g/hd/d (n = 5; OmniGen-AF® Phibro Animal Health Corporation, Teaneck, NJ). Feed was mixed in a custom mix wagon and offered to cattle twice daily. Orts were collected every 24 h, and dry matter analysis was conducted to determine dry matter intake (DMI). Cattle were weighed weekly throughout the study.

Cattle were offered four different basal diets throughout the study: Priming (P), Transition 1 (T1), Transition 2 (T2; for analysis T1 and T2 are pooled into one phase identified as Transition or T), and Finishing (F; diet compositions found in Table 1). During the 28-d P phase, cattle were limit fed (10.5 kg, dry matter basis) a predominately forage-based ration. Those in the treatment group were supplemented 56 g/hd/d of OmniGen-AF (OG) top-dressed into the top half of the feed bin. The second and third diet phases (T1 and T2) lasted a week each to facilitate an appropriate transition time between a forage-based diet and a high-concentrate diet (Fig. 1). The F phase lasted for 62 d (Fig. 1), steers were fed a diet rich in fermentable carbohydrates (Table 1).

2.2. Ultrasound data

Ultrasound data were collected on aSSD-500V ultrasound using a UST-5044-3.5 linear transducer (Aloka, Hitachi Aloka Veterinary, Ltd., Wallingford, CT) to scan for ribeye area (REA), relative ribeye area (REA/cwt), fat deposition over the 12th Rib (FT), rump fat (RF), and intramuscular fat (%IMF). Data were translated in real time using Designer Genes BIA Pro Plus Software (Designer Genes Technologies, Harrison, AR 72601). Estimated hot carcass weights (eHCW) were calculated as 62% of the live body weight on the day of ultrasound data collection, and eHCW was used in the yield grade equation to calculate predicted yield grade.

2.3. Serum collection and analysis

Blood was collected via jugular puncture into a serum separator tube (SST) at baseline, and on d 7, 14, 21, 28, 35, 43, 56, 70, 84, 98, and 104 of supplementation. Samples were stored at 4 °C until centrifugation at 3000 × *g* for 20 min. Serum was aliquoted in 1.25 mL amounts and frozen at − 80 °C until shipment to the Istituto di Zootecnica, Universitá Cattolica del Sacro Cuore, Piacenza Italy for analysis, with the exception of glucose and cortisol which were analyzed according to manufacturer's instructions (Glucose-cat no 997-03001, Wako Chemicals GmbH, Neuss, Germany and Cortisol-cat no K003-H1W, Arbor Assays, Ann Arbor, MI) at the Phibro Animal Health Corvallis Research Center. All other blood metabolites were analyzed at 37 °C by a clinical auto-analyzer (ILAB 650, Instrumentation Laboratory, Lexington, MA). Total protein, albumin, total cholesterol, creatinine, urea, Ca, P, Mg, aspartate aminotransferase (AST/GOT), and γ-glutamyl transpeptidase (GGT) were determined using kits purchased from Instrumentation Laboratory (IL Test, Bedford, MA, USA). Globulin was calculated as the difference between total protein and albumin. Electrolytes (Na^+, K^+, and Cl^-) were detected by the potentiometer method (Ion Selective Electrode connected to ILAB 600). Zinc and NEFA were determined by commercial kits (Wako Chemicals GmbH, Neuss, Germany). Haptoglobin, Serum Amyloid A (SAA) and BHBA were analyzed using methods described by Bertoni et al. (1998) that were adapted to the ILAB 650 conditions. Paraoxonase, NO_x, NO_2, and NO_3 concentrations were determined as previously described (Trevisi et al., 2012). Cortisol was analyzed using commercial kit available from Arbor Assays (cat no K003-H5) according to manufacturer's directions.

2.4. Sample collection, and processes for RTqPCR data

Blood samples were collected at baseline (before supplementation began) and on days 14, 21, 28, 35, 43, 56, 70, 84, 98, and 104 of supplementation (Fig. 1). Whole blood was collected via jugular

Table 1
Diet composition and nutrient specifications for all diets used in finishing steer study. Ingredients are given as % of total diet, all values are based on a dry matter basis.

	Priming	Transition 1	Transition 2	Finishing
Ingredients (% of total diet)				
Alfalfa	58.13	0	0	0
Oregon Hay	34.88	50	26	15
Corn	0	27.35	51.35	63.35
Cane Molasses	6.98	3	3	3
Soybean Meal 47.7%	0	1.5	1.5	1.5
Limestone 38%	0	1	1	1
ADE	0	0.15	0.15	0.15
Vitamin E	0	1	1	1
Urea	0	1	1	1
Distillers grain	0	15	15	15
CHS vitamin Premix[a]	0.15	0.15	0.15	0.15
Nutrient specifications				
NE_m (Mcal/kg)	1.34	1.713	1.933	2.04
NE_g (Mcal/kg)	0.76	1.06	1.23	1.32
ADF (%)	33.26	22.82	14.49	10.39
NDF (%)	47.44	38.22	26.41	20.6
eNDF (%)	54.77	10.47	18.59	22.59
Crude Protein (%)	13.91	14.78	15.33	15.61
Ca (%)	1.28	0.64	0.58	0.55
P (%)	0.23	0.29	0.32	0.33

[a] CHS vitamin premix contains the following (approximately): Calcium 12–13%, Phosphorus 6%, Salt 18–21.5%, Magnesium 6.75%, Sulfur 1.0%, Copper 3500 ppm, Iodine 195 ppm, Manganese 3300 ppm, Selenium 53–58 ppm, Zinc 7500 ppm, Vitamin A 250,000 IU/lb, Vitamin D 25,000 IU/lb, Vitamin E 250 IU/lb.

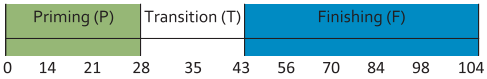

Fig. 1. Experimental design of diet phases including Priming (P), Transition (T1/T2) and Finishing (F) used during OG supplementation (blood and body weights were collected on all days listed; ultrasound data were collected on day 49, 69, and 104 of supplementation).