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CAMELINA MEAL SUPPLEMENTATION TO BEEF CATTLE: III. EFECTS ON ACUTE-PHASE AND THYROID RESPONSES

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ABSTRACT: Fourteen halter-trained Angus steers were ranked by initial BW (average 191 ± 2.1 kg), and assigned (d 0) to receive supplements containing (as-fed basis): 1) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO); and 2) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM). Treatments were offered individually, at a daily rate of 1.65 and 1.52 kg of DM/steer for CO and CAM, respectively. Alfalfa-grass hay was offered ad libitum during the study (d 0 to 36). On d 24, steers were fitted with a jugular catheter and were infused (i.v.) on d 25 with 0.5 μg of bovine corticotropin-releasing hormone (CRH)/kg of BW. Blood samples were collected hourly from –2 to 0 h and 4 to 8 h, and every 30 min from 0 to 4 h relative to treatment infusion (0 h). Blood samples were also collected via jugular venipuncture every 6 h from 12 to 72 h, and every 24 h from 96 to 168 h. All samples were analyzed for plasma concentrations of cortisol, ceruloplasmin, and haptoglobin. No treatment effects were detected (P = 0.28) for cortisol concentrations, which peaked for both treatments at 0.5 h relative to CRH infusion (time effect; P < 0.01). Ceruloplasmin concentrations were greater for CO vs. CAM steers at 6, 18, 42, 120, 144, and 168 h relative to CRH infusion (treatment × time interaction, P < 0.01). Mean haptoglobin concentrations tended to be greater (P = 0.10) for CO vs. CAM steers (1.73 vs. 1.54 absorbance @ 450 nm × 100, respectively). On d 34, steers were again fitted with a jugular catheter and were infused (i.v.) on d 35 with 0.33 μg of bovine thyrotropin-releasing hormone (TRH)/kg of BW. Blood samples were collected hourly from –2 to 0 h and 4 to 8 h, every 30 min from 0 to 4 h, and every 4 h from 8 to 24 h relative to treatment infusion (h 0) for determination of serum T_3 and T_4. No treatment effects were detected for T_3 (P = 0.58) and T_4 (P = 0.54) concentrations, which peaked, respectively, at 3 and 5 h relative to TRH infusion in both treatments. In conclusion, camelina meal supplementation did not affect thyroid gland function following a TRH challenge, but alleviated the acute-phase protein response following a CRH challenge in beef steers.

Key Words: Acute-phase, camelina meal, thyroid

Introduction

The acute-phase response is an important component of the innate immune system, but it can be detrimental to cattle performance, particularly when stimulated by stressors such as weaning, transport and feedlot entry (Duff and Galyean, 2007; Araujo et al., 2010, Cooke et al., 2010). Alternatives to prevent this reaction, including supplementation of polyunsaturated fatty acids (PUFA), are thus beneficial to cattle productivity (Cooke et al., 2010). Moreover, Cooke and Bohnert (2011) reported that corticotropin-releasing hormone (CRH) challenge stimulates an acute-phase response in cattle, and this research model can be used to investigate the physiological components and develop alternatives to modulate the stress-induced acute-phase response.

Camelina meal results from the mechanical processing of the seeds for oil extraction, and may contain up to 20% oil with the majority of the fatty acid content as PUFA (Moriel et al., 2010). Therefore, camelina meal may serve as a nutritional alternative to modulate the acute-phase response in cattle subjected to stress of management. However, camelina meal contains elevated concentrations of glucosinolates, which may impair thyroid gland activity in cattle (Lardy and Kerley, 1994) resulting in impaired growth rates (Burel et al., 2001). However, Moriel et al. (2010) reported that camelina meal supplementation did not impair thyroid function in beef heifers. Therefore, we hypothesized that camelina meal supplementation alleviates stress-induced acute-phase responses without impairing thyroid function in beef cattle. The objectives of this study were to evaluate the effects of camelina meal supplementation on concentrations of acute-phase proteins and thyroid hormones in beef steers following a CRH and thyrotropin-releasing hormone (TRH) challenges, respectively.

Materials and Methods

The experiment was conducted in accordance with an approved Oregon State University Animal Care and Use Protocol. Fourteen weaned Angus steers were utilized in these studies. All steers were exposed daily (d -60 to d 0) to halter-training techniques to become acclimated to human interaction; thus preventing confounding effects between human handling, weaning and hormone challenges measured herein (Cooke et al., 2009). Steers were ranked by initial BW (average 191 ± 2.1 kg), and assigned on d 0 to receive 1 of 2 treatments: 1) supplement containing (as-fed basis) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO); and 2) supplement containing (as-fed basis) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM). Treatment intakes were formulated to be iso-caloric and iso-nitrogenous, and offered individually at a daily rate of 1.65 and 1.52 kg of DM/steer for CO and CAM,

respectively. Alfalfa-grass hay was offered ad libitum during the study (d 0 to 36).

On d 24 and 34 of the study, steers were fitted with a jugular catheter according to procedures described by Merrill et al. (2007), and were infused (i.v.) on d 25 and 35 with 0.5 μg of bovine CRH/kg of BW (Exp. 1) and 0.33 μg of bovine TRH/kg of BW (Exp. 2), respectively. In Exp. 1, blood samples were collected hourly from –2 to 0 h and 4 to 8 h, and every 30 min from 0 to 4 h relative to treatment infusion (0 h) via jugular catheters. Blood samples were also collected via jugular venipuncture every 6 h from 12 to 72 h, and every 24 h from 96 to 168 h. All samples were analyzed for plasma concentrations of cortisol, ceruloplasmin, and haptoglobin. In Exp. 2, blood samples were collected via jugular catheters hourly from –2 to 0 h and 4 to 8 h, every 30 min from 0 to 4 h, and every 4 h from 8 to 24 h relative to treatment infusion (h 0) for determination of serum T_3 and T_4. Blood samples were harvested for plasma and serum, and stored at −80°C until assayed for plasma concentrations of cortisol Endocrine Technologies Inc., Newark, CA), ceruloplasmin (Demetriou et al., 1974) and haptoglobin (Makimura and Suzuki, 1982), and serum concentrations of T_3 and T_4 (Endocrine Technologies Inc.).

Data from Exp. 1 and 2 were analyzed using the PROC MIXED procedure of SAS (SAS Inst., Inc., Cary, NC) and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. The model statement contained the effects of treatment, time, and the interaction. Data were analyzed using steer(treatment) as the random variable. The specified term for the repeated statement was time and the covariance structure utilized was autoregressive, which provided the best fit for these analyses according to the Akaike information criterion. Results are reported as least square means and separated using LSD. Significance was set at $P \leq 0.05$, and tendencies were determined if $P > 0.05$ and ≤ 0.10. Results are reported according to treatment effects, or according to the highest-order interaction detected.

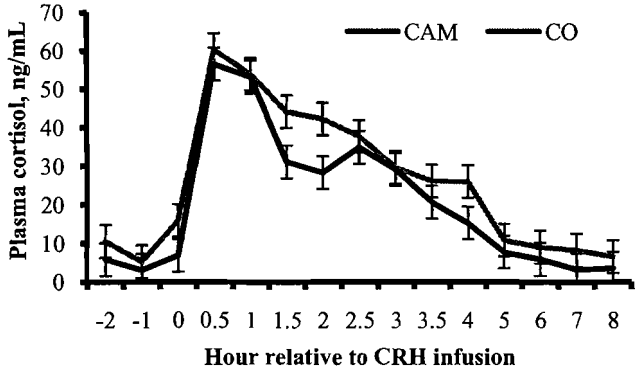

Figure 1. Plasma cortisol concentrations of steers supplemented (CAM) or not (CO) with camelina meal and receiving 0.5 μg of bovine corticotropin-releasing hormone (CRH)/kg of BW at h 0. No treatment effect (P = 0.28) or treatment × time interaction (P = 0.09) were detected.

Results and Discussion

In Exp. 1, no treatment (P = 0.28) effects were observed for cortisol concentrations (Figure 1). Steers receiving CAM tended (P = 0.10) to have reduced mean haptoglobin concentrations compared to CO steers (1.54 vs. 1.73 absorbance @ 450 nm × 100, respectively; Figure 2). A treatment x time interaction (P < 0.001) was detected for ceruloplasmin concentrations, because CAM steers had reduced ceruloplasmin concentrations compared with CO steers at 6, 18, 42, 120, 144, and 168 h relative to CRH infusion (Figure 2). These results suggest that CAM and CO steers experienced a similar increase in plasma cortisol concentrations (Cooke and Bohnert, 2011), but camelina meal supplementation reduced the acute-phase protein response stimulated by the CRH challenge. Similarly, previous research from our group reported that PUFA supplementation alleviated the acute-phase response in beef steers following transport and feedlot entry (Cooke et al., 2010).

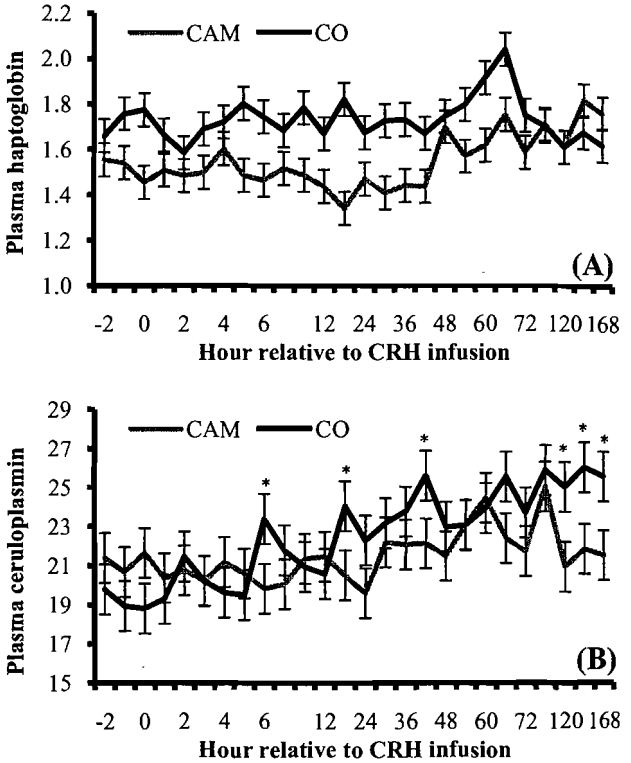

Figure 2. Plasma haptoglobin (panel A; absorbance at 450 nm × 100) and ceruloplasmin (panel B; mg/dL) concentrations of steers supplemented (CAM) or not (CO) with camelina meal and receiving 0.5 μg of bovine corticotropin-releasing hormone (CRH)/kg of BW at h 0. Steers receiving CAM tended (P = 0.10) to have reduced mean haptoglobin concentrations compared to CO steers. A treatment × time interaction was detected for ceruloplasmin concentrations (treatment comparison within time: * P < 0.05).

In Exp. 2, no treatment effects were detected for serum T_3 (P = 0.58) and T_4 (P = 0.55) concentrations, which peaked, respectively, at 3 and 5 h relative to TRH infusion in both treatments (Figure 3). Moriel et al. (2010) reported that heifers fed camelina meal had greater T_3 concentrations compared to cohorts fed a corn-soybean meal diet, whereas no differences were detected for serum T_4 concentrations. Therefore, camelina meal does not impair thyroid gland function in beef cattle when supplemented at the rates utilized herein and by Moriel et al. (2010)

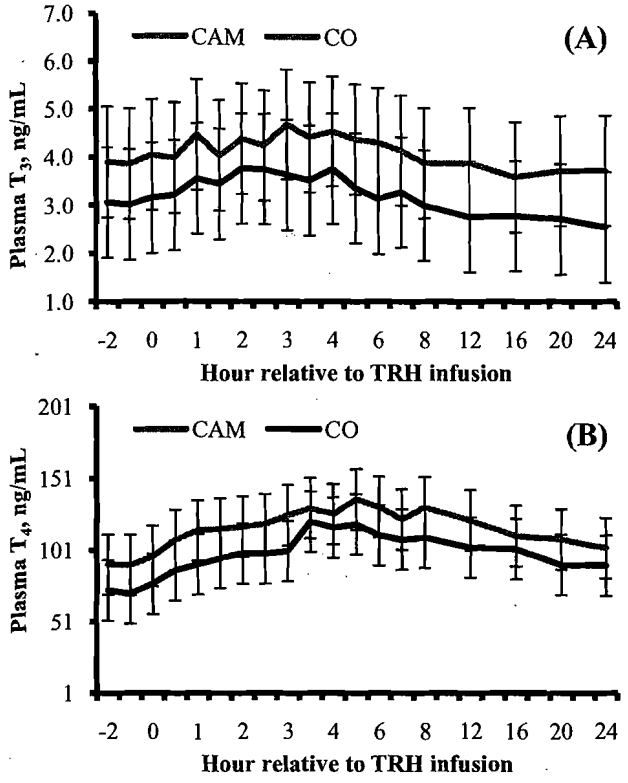

Figure 3. Plasma concentrations of T_3 (panel A) and T_4 (panel B) of steers supplemented (CAM) or not (CO) with camelina meal and receiving 0.33 μg of bovine thyrotropin-releasing hormone (TRH)/kg of BW at h 0. No treatment effects were detected (P > 0.55).

Implications

Camelina meal supplementation did not impair thyroid gland function following a TRH challenge, but alleviated the acute-phase protein response stimulated by CRH challenge in beef steers.

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