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CAMELINA MEAL SUPPLEMENTATION TO BEEF CATTLE: I. EFFECTS ON PERFORMANCE, DMI, AND ACUTE-PHASE PROTEIN RESPONSE OF FEEDER STEERS FOLLOWING TRANSPORT

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ABSTRACT: Sixty Angus x Hereford steers were ranked by BW on d -28 of the study and allocated to 20 drylot pens, which were randomly assigned to receive: 1) supplement containing (as-fed basis) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO) offered during preconditioning (PC; d -28 to 0) and feedlot receiving (FR; d 1 to 29), 2) supplement containing (as-fed basis) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM) offered during PC and FR, 3) CAM offered during PC and CO offered during FR, 4) CO offered during PC and CAM offered during FR. Treatments were offered daily at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively. Alfalfa-grass hay was offered ad libitum during the study. On d 0, steers were loaded into a commercial livestock trailer, transported for 24 h, and returned to the research facility (d 1). Total DMI was evaluated daily, and shrunk BW was collected on d -31, 1, and 30 for ADG calculation. Blood samples were collected on d 0 (prior to loading), 1 (immediately upon arrival), 4, 7, 10, 14, 21, and 29 for determination of plasma cortisol and haptoglobin. Rectal temperatures were recorded concurrently with blood sampling on d 0, 1, 4, and 7. During PC, CAM steers tended to have reduced (P = 0.10) ADG compared to CO (0.26 vs. 0.37 kg/d, respectively). No treatment effects were detected (P > 0.16) for ADG during FR and total ADG. Steers receiving CAM during PC had reduced total DMI during PC and FR compared to CO cohorts (3.07 vs. 3.35 % of BW during PC, and 3.20 vs. 3.35 % of BW during FR, respectively). Steers receiving CAM during PC had reduced mean haptoglobin concentrations vs. CO cohorts on d 0 and 1 (1.64 vs. 1.79 absorbance at 450 nm × 100, respectively). Steers receiving CAM during FR had reduced (P = 0.02) mean haptoglobin and rectal temperatures during FR compared to CO cohorts (1.69 vs. 2.02 absorbance @ 450 nm × 100 of haptoglobin, and 39.05 vs. 39.14 °C for temperature, respectively). In conclusion, camelina meal supplementation alleviated the acute-phase protein response stimulated by transport, but did not benefit performance of feeder steers.

Introduction

Three of the most stressful events encountered by a feeder calf are weaning, transportation, and feedlot entry. These events, which may occur together or in a short period of time, lead to physiological, nutritional, and immunological changes that highly affect subsequent calf health and feedlot performance (Loerch and Fluharty, 1999). One example is the acute-phase response, an important component of the innate immune system that can be detrimental to growth rates in cattle (Qiu et al., 2007). Consequently, management strategies that prevent and/or alleviate the acute-phase response have been shown to benefit cattle productivity and overall efficiency of beef operations (Arthington et al., 2008).

Supplementation of a commercial source of polyunsaturated fatty acids (PUFA) to feeder calves prior to (Cooke et al. 2010) and after transportation (Araujo et al., 2010) reduced the acute-phase response during the initial days following transport, and benefited feedlot performance and carcass parameters (Cooke et al., 2010). Camelina meal, a byproduct from the mechanical processing of the camelina seeds for oil extraction, may contain up to 20% oil with the majority of the fatty acid content as PUFA (Moriel et al., 2010). Therefore, we theorized that camelina meal also serves as a sustainable nutritional alternative to modulate the acute-phase response in cattle subjected to stress of management. Based on this rationale, the objectives of the present study were to evaluate performance, physiological, and health parameters of feeder steers supplemented with camelina meal prior to and/or after transport to the feedyard.

Materials and Methods

This experiment was conducted in accordance with an approved Oregon State University Animal Care and Use protocol, and was divided into a preconditioning (PC; d -28 to 0) and a feedlot receiving phase (FR; d 1 to 29). Both phases were conducted at the Eastern Oregon Agricultural Research Center, Burns. Sixty Angus x Hereford steers weaned at 7 mo of age (d -55) were ranked by initial BW (221 ± 28.51 kg) on d -28 of the study, and randomly allocated to 20 dry lot pens (3 steers/pen). Pens were assigned to 1 of 4 treatments (5 pens/treatment): 1) supplement containing (as-fed basis) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO) offered during PC (d -28 to 0) and FR (d 1 to 29), 2) supplement containing (as-fed basis) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM) offered during PC and FR, 3) CAM offered during PC and CO offered during FR, 4) CO offered during PC and CAM offered during FR. Supplements were offered once a day (0700 h) at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively. Composition and nutritional profile of the supplements are described in Table 1. Supplement intakes were formulated to

be iso-caloric and iso-nitrogenous, whereas mixed alfalfa-grass hay was offered in amounts to ensure ad libitum access throughout the experiment. On the morning of d 0, steers were loaded into a commercial livestock trailer, transported for 24 h, and returned to the research facility (d 1). Total and forage DMI were evaluated daily (d -28 to 28), and shrunk BW was assessed on d -31, 1, and 30 for ADG calculation.

Table 1. Composition and nutrient profile of supplements offered during the study.

Item	CO	CAM
Ingredient, DM basis		
Corn, kg	1.82	1.39
Soybean Meal, kg	0.32	--
Camelina, kg	--	0.59
Mineral Salt, kg	0.06	0.06
Nutrient profile, DM basis		
DM, %	87.0	88
TDN, %	94	95
CP, %	14.7	15.6
NDF, %	9.6	14.7
Ether extract, %	4.5	9.8
Ca, %	0.1	0.3
P, %	0.4	0.5

Blood samples were collected on d 0 (prior to loading), 1 (immediately upon arrival), 4, 7, 10, 14, 21, and 29, via jugular venipuncture into commercial blood collection tubes (Vacutainer, 10 mL; Becton Dickinson, Franklin Lakes, NJ) containing sodium heparin. Steer rectal temperature (RT) was measured at 30-min intervals with an automatic RT recording device during transport (Reuter et al., 2010), whereas on d 4 and 7 RT was measured with a digital thermometer (GLA M750 digital thermometer; GLA Agricultural Electronics, San Luis Obispo, CA) concurrently with each blood collection. All blood samples were harvested for plasma and stored at −80°C until assayed for concentrations of cortisol (Endocrine Technologies Inc., Newark, CA), and haptoglobin (Makimura and Suzuki, 1982).

Performance and physiological data 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 used for PC performance contained the effects of PC treatment. Data were analyzed using pen(PC treatment) as the random variable. The model statement for FR performance contained the effects of PC treatment, FR treatment, and the resultant interaction. Data were analyzed using pen(PC × FR treatment) as the random variable. The model statement used for RT, cortisol, and haptoglobin data obtained on d 0 and 1 relative to transport contained the effects of PC treatment, day, and the resultant interaction because steers were assigned to their FR treatment after blood sampling on d 1. Data were analyzed using pen(PC treatment) as the random variable. Accordingly, the model statement used for RT, cortisol, and haptoglobin data obtained from d 4 to d 29 contained the effects of PC treatment, FR treatment, day, and all the resultant interactions. Data were analyzed using pen(PC × FR treatment) as the random variable. Results are reported as least square means and separated using LSD or PDIFF. Significance was set at $P \leq 0.05$. Results are reported according to treatment effects if no interactions were significant, or according to the highest-order interaction detected.

Results & Discussion

During the PC phase (Table 2), CAM steers had reduced ($P < 0.01$) forage and total DMI compared to CO cohorts. Accordingly, CAM steers tended ($P = 0.10$) to have reduced ADG during PC compared to CO cohorts. However, no treatment effects ($P = 0.24$) were detected on preconditioning G:F. These findings support previous studies from our research group indicating that PUFA supplementation reduced DMI in cattle, but did not impair feed efficiency parameters (Araujo et al., 2010; Cooke et al., 2010).

Table 2. Preconditioning performance of beef steers supplemented (CAM) or not (CO) with camelina meal.

Item	CAM	CO	SEM	*P* =
Forage DMI, % of BW	2.23	2.46	0.04	< 0.01
Total DMI, % of BW	3.07	3.35	0.04	< 0.01
ADG, [1] kg/d	0.26	0.37	0.04	0.10
G:F, [2] kg/kg	0.038	0.049	0.006	0.24

[1] Calculated using shrunk values obtained on d -31 and d 1.
[2] Calculating using total DMI and BW gain from d -28 to d 1.

During the FR phase (Table 3), steers that received CAM during PC had reduced (PC treatment effect; $P < 0.01$) forage and total DMI compared to steers that received CO during the same period (2.46 vs. 2.61 % of BW for forage DMI, and 3.20 vs. 3.35 % of BW for total DMI, respectively; SEM = 0.03). Feed intake during FR was not affected by FR treatment or the PC × FR treatment interaction ($P > 0.20$). Moreover, ADG during FR was also not affected by PC treatment, FR treatment, or the PC × FR treatment interaction ($P > 0.21$). However, steers that received CAM during PC tended (PC treatment effect; $P = 0.10$) to have improved G:F during the FR compared to steers that received CO during the same period (0.231 vs. 0.215 kg/kg of G:F, respectively; SEM = 0.006). No FR treatment or PC × FR treatment interaction were detected for G:F during the FR phase.

Regarding RT and blood samples collected on d 0 and 1, no PC treatment effects were detected ($P > 0.56$) for plasma cortisol concentrations (41.8 vs. 39.4 ng/mL for CAM and CO steers, respectively; SEM = 5.2) or RT (39.19 vs. 39.16 °C for CAM and CO steers, respectively; SEM = 0.03). However, CAM steers had reduced ($P = 0.04$) haptoglobin concentrations compared to CO cohorts (1.65 vs. 1.80 absorbance at 450 nm x 100, respectively; SEM =

0.05). Regarding RT and blood samples collected after d 4, no main treatment effects (P > 0.51) or interactions (P > 0.11) effects were detected for plasma cortisol concentrations (Table 3). During the same period, mean RT and plasma haptoglobin concentrations were reduced (FR treatment effect; P = 0.02) for steers receiving CAM during FR compared to cohorts receiving CO (Figure 1).

These results suggest that, based on similar cortisol concentrations among treatment combinations, all steers experienced a similar stress challenge due to transport and feedlot entry (Crookshank et al., 1979; Sapolsky et al., 2000), whereas CAM supplementation modulated the stress-induced haptoglobin response. More specifically, steers receiving CAM during preconditioning had reduced haptoglobin concentration at the time of transport, whereas steers receiving CAM supplementation after transport had reduced haptoglobin concentrations during FR. Rectal temperature, another key component of the acute-phase response (Carroll and Forsberg, 2007) was also reduced for steers receiving CAM following transportation and feedlot entry. Similar to our previous effort (Cooke et al., 2010), PUFA supplementation during preconditioning improved feedyard performance of beef steers, as reported herein by the PC treatment effects detected on G:F during FR. On the other hand, PUFA supplementation during FR alleviated the concurrent acute-phase protein response, but did not benefit steer FR performance (Araujo et al., 2010).

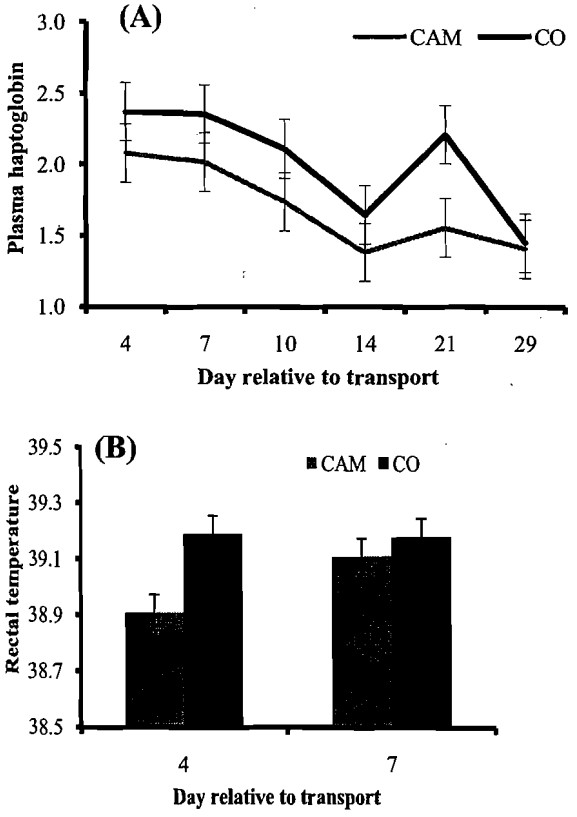

Figure 1. Plasma haptoglobin concentrations (Panel A; absorbance at 450 nm × 100) and rectal temperatures (Panel B; °C) of steers transported to the feedlot on d 0, and supplemented (CAM) or not (CO) with camelina meal beginning on d 1 of the study. A treatment effect was detected (P = 0.02) for both variables.

Implications

Camelina meal supplementation alleviated the acute-phase protein response stimulated by transport and feedlot entry, but benefited, at least partially, feedlot performance of feeder steers if supplemented during preconditioning only.

Literature Cited

Araujo, D. B., R. F. Cooke, G. R. Hansen, C. R. Staples, and J. D. Arthington. 2010. Effects of rumen-protected polyunsaturated fatty acid supplementation on performance and physiological responses of growing cattle following transportation and feedlot entry. J. Anim. Sci. 87:4125-4132.

Arthington, J. D., X. Qiu, R. F. Cooke, J. M. B. Vendramini, D. B. Araujo, C. C. Chase Jr., and S. W. Coleman. 2008. Effects of pre-shipping management on measures of stress and performance of beef steers during feedlot receiving. J. Anim. Sci. 86:2016-2023.

Carroll, J. A., and N. E. Forsberg. 2007. Influence of stress and nutrition on cattle immunity. Vet. Clin. Food. Anim. 23:105-149.

Cooke, R. F., F. N. T. Cooke, A. B. Scarpa, F. M. Nery, P. Moriel, B. W. Hess, R. R. Mills, and D. W. Bohnert. 2010. Effects of polyunsaturated fatty acid supplementation during preconditioning on performance and acute-phase response of transported beef steers. Proc. West. Sec. Am. Soc. Anim. Sci. 61:251-254.

Crookshank, H. R., M. H. Elissalde, R. G. White, D. C. Clanton, and H. E. Smalley. 1979. Effect of transportation and handling of calves upon blood serum composition. J. Anim. Sci. 48:430-435.

Loerch, S. C., and F. L. Fluharty. 1999. Physiological changes and digestive capabilities of newly received feedlot cattle. J. Anim. Sci. 77:1113-1119.

Makimura, S., and N. Suzuki. 1982. Quantitative determination of bovine serum haptoglobin and its elevation in some inflammatory diseases. Jpn. J. Vet. Sci. 44: 15-21.

Moriel, P., B. I. Cappellozza, V. Nayigihugu, K. M. Cammack, and B. W. Hess. 2010. Camelina meal and crude glycerin as feed supplements for developing replacement beef heifers. Proc. West. Sec. Am. Soc. Anim. Sci. 61:91-95.

Qiu, X., J. D. Arthington, D. G. Riley, C. C. Chase Jr., W. A. Phillips, S. W. Coleman, and T. A. Olson. 2007. Genetic effects on acute-phase protein response to the stresses of weaning and transportation of beef calves. J. Anim. Sci. 85:2367-2374.

Reuter, R. R., J. A. Carroll, L. E. Hulbert, J. W. Dailey, and M. L. Galyean. 2010. Technical note: Development of a self-contained, indwelling rectal temperature probe for cattle research. J. Anim. Sci. 88:3291-3295.

Sapolsky, R. M., L. M. Romero, and A. U. Munck. 2000. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. Endocr. Rev. 21:55-89.

Table 3. Feedlot receiving performance and plasma cortisol concentrations of beef steers supplemented (CAM) or not (CO) with camelina meal during preconditioning and/or feedlot receiving.

Item[1]	CAM-CAM	CO-CO	CAM-CO	CO-CAM	SEM	*P* =
Forage DMI, % of BW	2.50	2.63	2.42	2.59	0.05	0.20
Total DMI, % of BW	3.22	3.39	3.18	3.30	0.05	0.20
ADG,[2] kg/d	1.76	1.79	1.78	1.63	0.07	0.31
G:F,[3] kg/kg	0.225	0.221	0.237	0.210	0.009	0.99
Cortisol,[4] ng/mL	29.22	32.42	25.95	29.44	4.68	0.51

[1] Treatment description; first component refers to treatment provided preconditioning phase (CO or CAM), whereas second component refers to treatment provided during feedlot receiving phase (CO or CAM).
[2] Calculating using shrunk values obtained on d 1 and 30.
[3] Calculating using total DMI and BW gain from d 1 to d 28.
[4] Blood samples collected on d 4, 7, 10, 14, 21, and 29 relative to transport (d 0) and feedlot entry (d 1).