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CAMELINA MEAL SUPPLEMENTATION TO BEEF CATTLE: II. EFFECTS ON DMI, FORAGE IN SITU DIGESTIBILITY, AND PLASMA CHOLECYSTOKININ CONCENTRATIONS

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ABSTRACT: Nine Angus × Hereford steers, ranked by initial BW (average 250 ± 9 kg), were assigned (d 0) to receive: 1) supplement based (as-fed basis) on 84% corn, 14% soybean meal, and 2% mineral mix (CO); and 2) supplement based (as-fed basis) on 70% corn, 28% camelina meal, and 2% mineral mix (CAM). Treatments were offered daily (0700 h) at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively. Treatment intakes were formulated to be iso-caloric and iso-nitrogenous. Mixed alfalfa-grass hay was offered ad libitum from d 0 to 15, and hay DMI was recorded daily. Intake recorded from d 8 to 15 was used to determine treatment effects on hay and total DMI. From d 16 to d 19, steers were restricted to receive 90% of their voluntary hay DMI (BW basis). Immediately before treatment feeding on d 16, polyester bags (pore size 50-60 μm) containing 4 g of hay (DM basis) were suspended within the rumen of each steer, and incubated in triplicate for 0, 1, 3, 5, 8, 12, 24, 36, 48, 72 and 96 h. After removal, triplicates were washed, dried for 96 h at 50°C, weighed, and combined for NDF analysis. From d 20 to 21, steers received hay ad libitum and blood samples were collected on d 21 at 0, 1, 2, 3, 4, 5, 6, 9, and 12 h relative to treatment feeding for determination of plasma cholecystokinin (CCK) concentrations. Hay DMI tended (P = 0.15) to be reduced whereas total DMI was reduced (P = 0.01) in CAM vs. CO steers (2.71 vs. 2.91% of BW for hay and 3.46 vs. 3.76% of BW for total DMI, respectively). No treatment effects were detected (P > 0.35) for rate of ruminal degradation of DM (7.91 vs. 8.58%/h for CAM and CO) and NDF (7.49 vs. 7.39%/h for CAM and CO). Similarly, no treatment effects were detected (P > 0.55) for effective ruminal degradability of DM (64.3 vs. 64.9% for CAM and CO) and NDF (70.1 vs. 71.0% for CAM and CO). No treatment effects were detected (P = 0.35) for plasma CKK concentrations (22.7 vs. 26.8 pg/mL for CAM and CO). In conclusion, camelina meal supplementation did not impact forage digestibility and plasma CCK, but decreased total DMI in forage-fed beef steers.

Key Words: Beef steers, camelina meal, digestibility

Introduction

Supplemental polyunsaturated fatty acids (PUFA) sources, such as camelina meal, are nutritional alternatives to alleviate the bovine acute-phase response stimulated by transport and feedlot entry (Araujo et al., 2010). However, feeder calves supplemented with PUFA may experience decreased DMI, ADG (Araujo et al., 2010; Cooke et al., 2010a) and feed efficiency (Araujo et al., 2010) compared to cohorts offered control diets. Several factors may be associated with these outcomes, including altered dietary palatability (Grummer et al., 1990), impaired dietary digestibility and consequent feed intake (Schauff and Clark, 1989), reduced gut motility and increased cholecystokinin (CCK) synthesis and release (Drackley et al., 1992; Allen et al., 2000). Therefore, the objective of the present study was to compare DMI, in situ forage digestibility, and plasma CCK concentrations in beef steers offered diets with or without camelina meal.

Materials and Methods

This experiment was conducted at the Eastern Oregon Agricultural Research Center – Burns, in accordance with an approved Oregon State University Animal Care and Use Protocol. Nine Angus x Hereford steers were ranked by initial BW (average = 250 ± 9 kg), and assigned on d 0 to 1 of 2 treatments: 1) supplement based (as-fed basis) on 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO); and 2) supplement based (as-fed basis) on 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM). Treatment intakes were formulated to be iso-caloric and iso-nitrogenous, and offered individually and daily (0700 h) at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively (Table 1).

Mixed alfalfa-grass hay was offered in amounts to ensure ad libitum access from d 0 to 15 of the study, and hay DMI was recorded daily by measuring refusals. Samples of the offered hay and treatment ingredients were collected weekly to determine nutrient composition (Dairy One Forage Laboratory, Ithaca, NY) and DM, whereas samples of refusals were collected daily to determine DM content only. Hay samples were dried for 96 h at 50°C in forced-air ovens. Intake data collected from d 8 to 15 were used to determine treatment effects on hay and total DMI. From d 16 to 19, steers were restricted to receive 90% of their voluntary hay DMI (BW basis).

Immediately before treatment feeding on d 16, polyester bags (pore size 50-60 μm) containing 4 g (DM basis) of mixed alfalfa-grass hay were suspended within the rumen of each steer, and incubated in triplicates for 0, 1, 3, 5, 8, 12, 24, 36, 48, 72 and 96 h. Prior to incubation, all bags were soaked in warm water (37 °C) for 15 min. The 0-h bags were not incubated in the rumen, but were subjected to the same rising procedure used for ruminally incubated bags. After removal, bags were washed repeatedly until the rinse water was colorless, dried for 96 h at 50°C in forced-air ovens, and weighed. Triplicates were combined and analyzed for NDF (Robertson and Van Soest, 1981) using

procedures modified for use in an Ankom 200 Fiber Analyzer (Ankom CO., Fairport, NY).

From d 20 to 21, steers received hay ad libitum and blood samples were collected on d 21 at 0, 1, 2, 3, 4, 5, 6, 9, and 12 h relative to treatment feeding for determination of plasma CCK concentrations (KT-10170; Kamiya Biomedical Company, Seattle, WA)

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

Voluntary forage, total DMI, and plasma CCK concentrations 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 statements contained the effects of treatment, day, and the interaction. Data were analyzed using steer(treatment) as the random variable. Kinetic parameters of hay DM and NDF disappearance were estimated using nonlinear regression procedures of SAS, as described by Vendramini et al. (2008). Treatment effects on ruminal degradation rate and effective ruminal degradability (Coblentz and Hoffman, 2009) were analyzed using the PROC MIXED procedure of SAS and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. The model statement contained the effect of treatment. Data were analyzed using steer(treatment) as random variable. Results are reported as least square means and were separated using LSD. Significance was set at $P \leq 0.05$, and tendencies were determined if $P > 0.05$ and ≤ 0.15. Results are reported according to treatment effects if no interactions were significant.

Results and Discussion

Steers receiving CAM had decreased (P = 0.01) total DMI compared to CO cohorts, whereas a trend (P = 0.15) was observed for forage DMI (Figure 1). Our results support previous efforts reporting that PUFA supplementation reduced DMI in cattle (Araujo et al., 2010; Cooke et al., 2010a; Cooke et al., 2010b). The reasons for this outcome may include impaired dietary digestibility (Schauff and Clark, 1989), as well as reduced gut motility and increased CCK synthesis and release (Drackley et al., 1992; Allen et al., 2000).

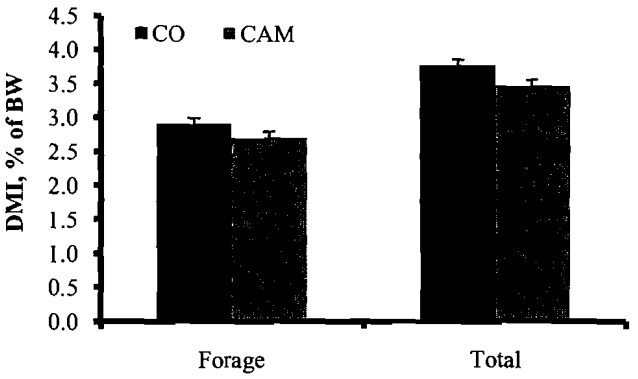

Figure 1. Forage and total DMI, as percentage of BW, of steers offered supplements containing (CAM) or not (CO) camelina meal. A trend (P = 0.15) was detected for forage DMI, whereas a treatment effect was detected (P = 0.01) for total DMI.

However, no treatment effects were detected ($P > 0.35$) on ruminal degradation rate (K_d) of hay DM and NDF (Table 2). Similarly, no treatment effects were detected ($P > 0.55$) for effective ruminal degradability of hay DM and NDF (Table 2). Accordingly, previous research from our group reported that ruminal digestibility parameters are not affected by PUFA supplementation, even when forage and total DMI are impaired (Cooke et al., 2010b); Plasma CCK concentrations were not different (P = 0.35) between CAM and CO steers (Figure 2). These results were not expected, since CCK is related to satiety (Baile et al., 1986) and fat supplementation has been shown to decrease DMI while increasing plasma CCK concentrations (Choi et al., 2000).

Table 2. In situ disappearance kinetics of DM and NDF of mixed alfalfa-grass hay incubated in steers offered supplements containing (CAM) or not (CO) camelina meal.

Treatment	K_d, /h	Effective degradability,[1] %
DM analysis		
CO	0.085	64.95
CAM	0.079	64.30
SEM	0.005	0.008
P-value	0.35	0.57
NDF analysis		
CO	0.074	70.98
CAM	0.075	70.15
SEM	0.006	0.01
P-value	0.91	0.55

[1] Calculated as $A + B \times [(K_d + K_p)/K_d]$, where K_p was the ruminal passage rate, which was arbitrarily set at 0.025/h (Coblentz and Hoffman, 2009).

Implications

These results indicate that camelina meal supplementation did not impact forage digestibility and

plasma CCK concentrations, but decreased total DMI in beef steers. Therefore, additional research is needed to understand the mechanisms by which PUFA supplementation reduces feed intake in cattle.

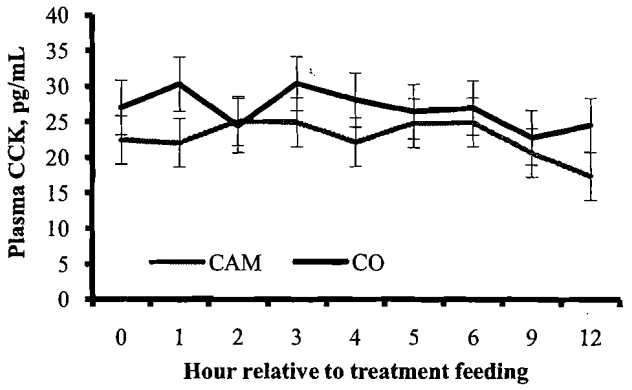

Figure 2. Plasma cholecystokinin (CCK) concentrations of steers offered supplements containing (CAM) or not (CO) camelina meal (P = 0.35).

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