

EFFECTS OF POLYUNSATURATED FATTY ACID SUPPLEMENTATION (PUFA) ON FORAGE INTAKE AND DIGESTIBILITY IN BEEF COWS

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ABSTRACT: The objective was to compare DMI and in situ forage digestibility in beef cows supplemented or not with a rumen-protected PUFA source. Three Angus x Hereford cows (724 ± 39 kg of BW) fitted with ruminal cannulas were allocated to a 3 x 3 Latin Square design containing 3 periods of 21 d each. Treatments consisted of grain-based supplements without (CO) or with the inclusion (10%; as-fed basis) of a PUFA source (PF; Megalac-R[®], Church and Dwight, Princeton, NJ) or a SFA source (SF; Megalac[®], Church and Dwight). Treatment intakes were formulated to be iso-caloric and iso-nitrogenous, and offered daily at a rate of 0.7 % of BW/cow/d. Within each experimental period, mixed alfalfa-grass hay was offered in amounts to ensure ad libitum access from d 1 to 13, and hay DMI was recorded daily. Data collected from d 8 to 13 were used to determine treatment effects on hay and total DMI. From d 14 to d 21, cows were restricted to receive 90 % of their voluntary hay DMI. Immediately before treatment feeding on d 16, polyester bags containing 4 g of hay (DM basis) were suspended within the rumen of each cow, and incubated in triplicates for 0, 4, 8, 12, 24, 36, 48, 72, and 96 h. After removal, bags were washed, dried for 96 h at 50°C in forced-air ovens and weighed. Triplicates were combined and analyzed for NDF content. Hay and total DMI were reduced ($P < 0.05$) in PF cows compared to SF and CO cows (2.19, 2.30, and 2.31 % of BW for forage DMI, SEM = 0.04; and 2.86, 2.98, and 3.05 % of BW for total DMI, SEM = 0.05). However, no treatment effects were detected ($P > 0.48$) for ruminal degradation rate of hay DM (6.81, 7.48, and 6.86 %/h for CO, PF, and SF; SEM = 0.40) and hay NDF (6.05, 6.43, and 6.17 %/h for CO, PF, and SF; SEM = 0.30). Similarly, no treatment effects were detected ($P > 0.63$) for effective ruminal degradability of hay DM (64.53, 64.93, and 64.94 % for CO, PF, and SF; SEM = 0.38) and hay NDF (71.24, 71.76, and 71.57 % for CO, PF, and SF; SEM = 0.36). In conclusion, PUFA supplementation did not impact forage digestibility, but decreased forage and total DMI in beef cows.

Introduction

Supplementation of rumen-protected PUFA to feeder cattle might be an alternative to alleviate the bovine acute-phase response stimulated by transportation and feedlot entry (Araujo et al., 2009). However, feeder calves supplemented with a rumen-protected PUFA source during preconditioning or feedlot receiving period experienced reduced ADG, feed intake (Araujo et al., 2008), and feed efficiency (Araujo et al., 2009) compared to cohorts offered

iso-caloric and iso-nitrogenous control diets. It can be hypothesized that these outcomes were due to reduced dietary digestibility and consequent feed intake in PUFA-supplemented calves (Schauff and Clark, 1989). In these studies, however, total fat content of diets were less than 6% of the DM, the limit in which fat can be present in cattle diets without detrimental effects on ruminal digestibility (Hess et al., 2008).

Therefore, the objectives of the present study were to compare DMI and in situ forage digestibility in beef cows offered diets containing less than 6% of fat (DM basis), and enriched or not with a rumen-protected PUFA source.

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.

Three Angus x Hereford cows (724 ± 39 kg of BW), housed in individual drylot pens and fitted with ruminal cannulas were allocated to a 3 x 3 Latin Square design containing 3 periods of 21 d each. Treatments consisted of corn and soybean meal-based supplement without (CO) or with the inclusion (10%; as-fed basis) of a PUFA source (PF; Megalac-R[®], Church and Dwight, Princeton, NJ) or a SFA source (SF; Megalac[®], Church and Dwight). Treatment intakes were formulated to be iso-caloric and iso-nitrogenous, and offered daily at a rate of 0.7 % of BW/cow/d (Table 1).

Within each experimental period, mixed alfalfa-grass hay was offered in amounts to ensure ad libitum access from d 1 to 13, 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. Data collected from d 8 to 13 were used to determine treatment effects on hay and total DMI. From d 14 to d 21, cows were restricted to receive 90 % of their voluntary hay DMI.

Immediately before treatment feeding on d 16, polyester bags (pore size 50-60 μ m) containing 4 g (DM basis) of mixed alfalfa-grass hay were suspended within the rumen of each cow, and incubated in triplicates for 0, 4, 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 rinsing procedure used for the 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).

Table 1. Nutrient profile of treatments.

Item	Treatments		
	CO ¹	SF ²	PF ³
NE _g , Mcal/kg ⁴	0.75	0.80	0.81
NE _m , Mcal/kg ⁴	1.41	1.48	1.49
TDN, %	59.0	60.0	61.0
CP, %	16.5	16.7	16.7
NDF, %	52.5	52.9	52.4
Ether extract, %	2.2	4.0	4.1
Ca, %	0.4	0.6	0.7
P, %	0.3	0.3	0.3

¹ CO = Corn and soybean meal-based supplement (90:10 ratio, respectively; as-fed basis), fed at 0.75% of BW, without supplemental fat.

² SF = Corn and soybean meal-based supplement with the addition of rumen-protected SFA (Megalac[®]; Church & Dwight, Princeton, NJ) source (75:15:10 ratio, respectively, as-fed basis) fed at 0.67% of BW.

³ PF = Corn and soybean meal-based supplement with the addition of rumen-protected PUFA (Megalac-R[®]; Church & Dwight) source (75:15:10 ratio, respectively, as-fed basis) fed at 0.67% of BW.

Voluntary forage and total DMI 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, day, and the interaction, in addition to period as independent variable. Data were analyzed using cow 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 effects of treatment and period as independent variables. Data were analyzed using cow as the random variable. Results are reported as least square means and were separated using PDIFF. 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 if no interactions were significant.

Results & Discussion

Cows receiving PF had decreased ($P < 0.05$) forage and total DMI compared to SF and CO cows, whereas no differences were detected between SF and CO cows (Figure 1). These results support previous efforts indicating that rumen-protected PUFA supplementation, more specifically as calcium soaps of fatty acids, reduced DMI in cattle (Araujo et al., 2008, Araujo et al., 2009). One

could speculate that reduced feed intake in PF-fed calves was due to reduced dietary digestibility (Schauff and Clark, 1989).

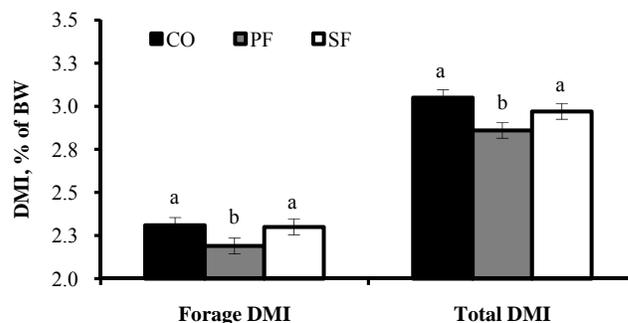


Figure 1. Forage and total DMI, as percentage of BW, of cows offered diets without (CO) or with the inclusion of a rumen-protected SFA or PUFA (PF) source. A treatment effect was detected ($P < 0.05$). Within variables, values bearing a different letter differ ($P < 0.05$).

However, in present study, total fat content of PF and SF was approximately 4% (DM basis; Table 1) based on feed intake and nutritional analysis. According to Hess et al. (2008), ruminal digestibility is not impaired if diets contain less than 6% (DM basis) of fat. Supporting this rationale, no treatment effects were detected ($P > 0.48$) on ruminal degradation rate (K_d) of hay DM and NDF (Table 2). Similarly, no treatment effects were detected ($P > 0.63$) for effective ruminal degradability of hay DM and NDF (Table 2).

Table 2. In situ disappearance kinetics of DM and NDF of mixed alfalfa-grass hay incubated in cows offered diets without (CO) or with the inclusion of a rumen-protected SFA or PUFA (PF) source.

Treatment	K_d , /h	Effective degradability, %
DM analysis		
CO	0.069	64.53
SF	0.068	64.94
PF	0.075	64.93
SEM	0.004	0.38
P-value	0.48	0.71
NDF analysis		
CO	0.061	71.24
SF	0.062	71.57
PF	0.064	71.76
SEM	0.003	0.36
P-value	0.69	0.63

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).

These results indicate that PUFA supplementation did not impact forage digestibility, but decreased forage and total DMI in beef cows. These negative outcomes cannot be attributed to the chemical composition of the PUFA source, given that the SFA source used in the present experimental was also based on calcium soaps of fatty acids. Therefore, additional research is needed to understand the mechanisms by which PUFA reduces feed intake in cattle, so strategies to alleviate this effect can be developed, which will allow

the inclusion of PUFA sources into preconditioning and receiving diets without major pitfalls.

Implications

Inclusion of a rumen-protected PUFA source into cattle diets reduced forage and DMI intake; however, forage digestibility parameters were not affected. Therefore, additional research is required to understand the negative effects of supplemental PUFA on feed intake in beef cattle.

Acknowledgements

We would like to thank Andy Covington and Elliot Block from Church and Dwight for the donation of the treatments offered in the present study. We also would like to thank Stephanie Falck for her assistance in this study.

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