Fatty acid metabolism on pasture- and feedlot-finished cattle

Cuk T Noviandi [A], Robert E Ward [B], Jong-Su Eun [A], Dale R ZoBell [A], Rusty D Stott [A], Blair L Waldron [C], and Mike D Peel [C]

[A] Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan, UT 84322, USA, www.advs.usu.edu
[B] Department of Nutrition, Dietetics, and Food Sciences, Utah State University, Logan, UT 84322, USA, www.ndfs.usu.edu
[C] Forage and Range Research Laboratory, USDA-ARS, Logan, UT 84322, USA, http://www.usda.gov
Contact email: c.t.noviandi@gadjahmada.edu

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Introduction

Feeding high-grain diets to finishing beef cattle results in high proportions of saturated fatty acids (SFA) in the beef, which is considered to confer negative impacts on human health. In contrast, pasture-finished cattle produce lower proportion of SFA, greater n-3 and less n-6 polyunsaturated fatty acids (PUFA), and higher conjugated linoleic acids (CLA) compared to high grain-finished beef (Noviandi *et al.* 2012). Increased n-3 PUFA, especially C18:3 n-3, can reduce the risk of heart disease, hypertension, inflammation, and mammary cancer, and lower cholesterol concentration in blood (De Deckere *et al.* 1998; Tapiero *et al.* 2002).

Nitrogen fertilisation can increase biomass production and nitrogen (N) concentration of tall fescue (TF; *Festuca arundinacea*) (Berg and Sims 2000; Teuton *et al.* 2007), which positively affected beef cattle performance (Berg and Sims 1995). However, the metabolism of fatty acids (FA) in pasture-finished beef steers due to N fertilization on TF has not yet been studied. Therefore, the current study was performed to test a hypothesis that due to its potential impacts on nutrient and energy utilization, N fertilization would affect FA compositions in ruminal fluid, blood serum, and adipose tissue of pasture-finished beef steers. In addition, we were interested in beneficial effects of grazing steers by comparing the FA profiles between pasture- and feedlot-finished beef steers.

Methods

A completely randomized design was used to test 3 treatments: grazing on TF without N fertilizer (TF–NF), grazing on TF with N fertilizer (TF+NF), and feeding a total mixed ration (TMR) in a feedlot (FLT). Twenty seven Angus crossbred steers were randomly assigned into the treatments. A total of 168 kg/ha N fertilizer was applied in three split applications at 56 kg/ha to the TF+NF. From May through September 2011 (a total of 16 wk), pasture-finished steers grazed on replicated 0.47-ha paddocks, while steers on the FLT were fed a typical beef finishing diet containing 76% barley grain. Samples of ruminal fluid, blood, and subcutaneous adipose tissue were taken at the end of study (wk 16) from all steers.

Results and Discussion

In general, applying N fertilizer did not affect FA profiles of pasture forages (Table 1). Proportion of C18:0 in ruminal fluid increased in cows fed the FLT compared to those grazed pasture. This result indicates that greater proportions of C18:3 n-3 in pasture forages may have resulted in less completion of ruminal biohydrogenation process, which is supported by higher C18:2 n-6 profiles in FLT cattle. The proportions of C18:1 *t*-11 and *c*-9 *t*-11 CLA increased in steers grazed on pastures compared to those fed the FLT. In blood serum, proportions of C18:1 *t*-11 and *c*-9 *t*-11 CLA increased due to grazing, while proportion of C18:2 n-6 increased in steers fed the FLT. In adipose tissue, proportions of C18:0, C18:3 n-3, and *c*-9 *t*-11 CLA increased in steers grazed on pastures compared to those fed the FLT. Ratio between n-6 and n-3 FA was greater in steers fed the FLT in feed, ruminal fluid, blood serum, and adipose tissue.

Fertilization of N did not affect FA profiles in ruminal fluid, blood serum, and adipose tissue due to its minor impacts on FA compositions in pasture forages. Greater proportion of C18:3 n-3 in pasture induced increased proportions of C18:1 *t*-11, C18:3 n-3 and *c*-9 *t*-11 CLA in ruminal fluid, blood serum, and adipose tissue compared with the FLT. However, the increased proportion of *c*-9 *t*-11 CLA in the adipose tissue is likely due to desaturation of C18:1 *t*-11 in the adipose tissue rather than direct effect of biohydrogenation of C18:3 n-3 in the rumen, because C18:1 *t*-11 increased in blood serum.

Conclusion

Grazing beef steers on TF shifted FA concentrations to a more favorable profile for human health benefits compared to a typical finishing TMR.

References

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Table 1. Fatty acid profiles in feeds (pasture forages vs. TMR), ruminal fluid, blood serum, and adipose tissue of pasture- and feedlot- finished beef steers (n = 3).

Item	Fatty acids (g/100g fatty methyl esters)							
	C14:0	C16:0	C18:0	C18:1 *t*-11	C18:2 n-6	C18:3 n-3	*c*-9 *t*-11 CLA	n-6:n-3
Feed								
TF–NF	0.37 b	15.3 b	1.32 a	-	12.6 a	53.9 b	-	0.23 a
TF+NF	0.28 a	14.3 a	1.18 a	-	13.0 a	54.1 b	-	0.24 a
FLT	0.52 c	21.0 c	1.74 b	-	51.5 b	4.82 a	-	10.8 b
P value	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Ruminal fluid								
TF–NF	2.06 a	18.3 ab	25.9 a	6.14 b	1.55 a	3.11 b	0.67 b	0.52 a
TF+NF	1.82 a	15.6 a	25.7 a	6.44 b	1.52 a	2.33 b	0.71 b	0.65 a
FLT	3.78 b	21.0 b	36.2 b	4.11 a	3.39 b	0.30 a	0.44 a	11.8 b
P value	0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Blood serum								
TF–NF	0.83	12.5	18.3	2.74 b	18.9 a	13.6 b	0.94 b	1.45 a
TF+NF	0.86	12.7	17.9	2.80 b	17.7 a	14.5 b	1.14 c	1.22 a
FLT	0.79	12.5	16.5	1.09 a	42.8 b	1.83 a	0.70 a	23.4 b
P value	0.84	0.91	0.37	0.02	<0.01	<0.01	<0.01	<0.01
Adipose tissue								
TF–NF	3.49	29.6	13.2 b	1.66	1.00 a	0.43 b	1.25 b	2.31 a
TF+NF	3.62	28.6	14.2 b	1.80	1.08 ab	0.38 b	1.32 c	2.89 a
FLT	3.39	28.6	8.82 a	1.15	1.26 b	0.20 a	0.98 a	6.44 b
P value	0.55	0.05	<0.01	0.15	0.05	<0.01	<0.01	<0.01

a-c within a column, means without a common letter differ ($P<0.05$). TF–NF = tall fescue without N fertilizer; TF+NF = tall fescue with N fertilizer; and FLT = feedlot finishing TMR

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