FATTY ACID PROFILE OF CANADIAN SUB-ALPINE SUCKLER BEEF

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Abstract – Suckler beef production systems have been evaluated in Europe and South America for tenderness and nutritive value, but only tenderness has been investigated in Canada. In this work, the fatty acid profile of Canadian sub-alpine suckler beef was compared to sub-alpine grain-finished beef and traditional grass-fed beef. Suckler beef had a higher proportion (*P*<0.001) of polyunsaturated fatty acids (PUFA) (11.3%) than grain-finished (6.5%) and grass-fed beef (6.4%). Suckler beef also contained the highest proportions of omega-3 (n-3) and omega-6 (n-6) PUFA (*P*<0.001), and still had the lowest n-6/n-3 ratio. All steaks in the study had n-6/n-3 ratios below the recommended 4:1. Increased health benefits may be associated with suckler beef, as it was highest in rumen biohydrogenation intermediates, *trans*-11-18:1, and total conjugated linoleic acid (CLA). In addition to a healthy fatty acid profile, most cuts of suckler beef are tender enough to be steak cuts, increasing the overall value of the carcass.

I. INTRODUCTION

Grass-fed and pasture-raised beef have been touted as a healthier alternative to grain-fed beef due to higher levels of beneficial fatty acids (FAs), which have been reported to help prevent cancer and cardiovascular disease (1,2). Convincing consumers to eat grass-fed beef has been a challenge in North America as grass-fed beef are perceived, and in some cases have been shown, to be less tender and flavourful than grain-fed beef (1). Suckler beef has been shown to be a good source of tender meat cuts (3) while being raised in a sub-alpine grass-fed finishing system. Suckler beef production is a method of raising beef, often using mountain pastures or range that may be able to provide the attributes of grass-fed beef without a loss in tenderness. While common in parts of Europe and South America, suckler beef production methods are rarely used in North America, as the majority of North American cattle are weaned prior to entering feedlots for grain finishing (4). Suckler calves are often raised on high mountain pastures with their mothers and are not weaned. They are often sent directly to slaughter at approximately 10 months of age. European-raised suckler cattle contain beneficial fatty acids, similar to levels typically found in grass-fed beef, but are slaughtered at a younger age than traditional grass- or grain-fed cattle (2). Therefore, suckler beef may be more tender than grass- or grain-fed beef, yet still contain the potential health benefits of grass-fed beef. It has been reported (5) that calves that persist in suckling have the ability to maintain the reticular groove closing reflex in varying capacity. These calves receive a mixture of milk and solid feed in the rumen, as well as a portion of milk that bypasses the rumen. If the closing reflex persists, it is expected that biohydrogenation intermediates and *trans*-monounsaturated fatty acids (*t*-MUFA) would be present in smaller amounts and the omega-3 (n-3) fatty acids would be enhanced in the suckler muscle, as compared to a weaned grass- or grain-fed animal (5). In addition, high mountain pastures tend to be more biologically diverse, which may positively affect the fatty acid profile. Herein, the fatty acid content of sub-alpine suckler beef was compared to sub-alpine grain-finished and traditional grass-finished beef. Suckler beef production was examined as an alternative production method for British Columbia cattle producers with access to high mountain pastures.

II. MATERIALS AND METHODS

Samples

Ribeye steaks for this study were collected from three different production methods. Sub-alpine suckler beef (herein referred to as suckler beef) cuts were obtained from Mitchell's Mountain Beef (Mitchell Cattle Co., Barriere, British Columbia, Canada) from Simmental cattle raised with their mothers on sub-alpine mountain pastures and slaughtered at ten months of age. Sub-alpine grain-finished steaks (herein referred to as grain-finished) were also obtained from Mitchell's Mountain Beef from Simmental steers. The steers were initially raised on the same sub-alpine pastures as the suckler beef, before being moved into a feedlot for 100 days of grain/conserved forage finishing in the fall. Steers were fed a 50:50 diet of alfalfa silage and rolled barley grains and slaughtered at sixteen months of age. Grass-fed steaks were purchased from retail locations in southern British Columbia. Ribeyes of the suckler and grain-finished beef were collected at slaughter and stored at -80 °C until extraction.

Fatty Acid Analysis

Ribeye steaks were thawed at 5 °C overnight, dissected to remove adipose tissue, and the *longissimus dorsi* muscle was homogenized (Hobart Food Equipment Group, North York, Canada). Lipid extractions were carried out using a modified Folch procedure (6) and a dual methylation protocol as described by McNiven *et al.* was used to esterify the fatty acids. A thin layer chromatography (TLC) clean-up procedure was employed to monitor the reaction progress and remove cholesterol and other undesired reaction products.

The fatty acid methyl esters (FAME) were analysed using a CP-3800 gas chromatograph equipped with an 8600-series autosampler (Varian Inc., Walnut Creek, USA) and a CP-Sil88 (100 m, 25 µm ID, 0.2 µm film thickness) column. Hydrogen was used as the carrier gas under constant pressure (25 psi, initial flow rate of 1 mL/min), and injector and flame ionization detectors temperatures were held at 250 °C. The initial temperature, 45 °C, was held for 4 min, increased to 175 °C at 13 °C/min and held for 27 min, then increased to 215 °C at 4 °C/min and held for 35 min. Commercial reference standards (Nu-Chek Prep, Inc., Waterville, USA) were used to identify fatty acids by retention time, along with peak order and retention times reported in literature (8,9).

Statistical Analysis

The data was analyzed as a one-way ANOVA using the PROC MIXED procedure of SAS v9.2 (Statistical Analysis System, NC, USA). The finishing system was used as a random factor. Means and standard error are reported and differences judged as significant when $P<0.05$.

III. RESULTS AND DISCUSSION

The fatty acid profile of sub-alpine suckler beef was compared to sub-alpine grain-finished beef and grass-finished retail beef from British Columbia.

The proportions of polyunsaturated fatty acids (PUFA) were highest in the suckler beef ($P<0.001$, Table 1). The proportion of n-3 was highest in the suckler beef ($P<0.001$, Table 1), most likely due to the higher 18:3n-3 intake from both forage and milk. The moderate amount of grain being fed to the grain-finished cattle did not seem to reduce the amount of n-3 in the muscle. Diet affected the proportion of omega-6 (n-6) in the muscle; it was found to be highest in the suckler beef ($P<0.001$, Table 1). The FAs consumed from milk and forage could account for an overall increase in PUFA, including n-6. The grain-finished group only saw a small increase in n-6 proportion over grass-fed, as the forage-to-concentrate feed ratio was not high. Razminowicz *et al*. (2) suggested that the conversion rate of 18 carbon PUFAs to longer-chain PUFAs does not change with tissue growth, and speculated that long-chain PUFAs became diluted over time as the animal grows. This effect could possibly explain the increased PUFA proportion of the younger suckler beef as compared to its more mature counterparts. The n-6/n-3 FA ratio was below the recommended 4:1, for all diets, but was the lowest in the suckler beef (10). Razminowicz *et al*. (2) and Bispo *et al*. (5) found that pasture-raised beef and suckler beef in Spain and Switzerland had the highest total n-3 content and lowest n-6 content compared to intensive production systems. In addition, the n-6/n-3 ratio was lower in suckler beef than

Table 1 Fatty acid profile (% FAME) of ribeye muscle from sub-alpine suckler, sub-alpine 50:50 forage:grain, and grass-fed beef production systems.

	Suckler		Grain-finished		Grass-fed		s.e.m.	*P* value
mg/g muscle	20.73		29.30		38.6			
PUFA	11.3	a	6.5	b	6.4	b	0.718	<0.001
n-6	7.8	a	4.8	b	4.4	b	0.526	<0.001
18:2n-6	5.7	a	3.5	b	3.0	b	0.329	<0.001
20:4n-6	1.6	a	0.9	b	1.0	b	0.164	0.018
n-3	3.5	a	1.6	b	1.9	b	0.217	<0.001
18:3n-3	2.4	a	1.1	b	1.0	b	0.099	<0.001
n-6/n-3	2.2		3.1		2.9		0.427	0.355
t-MUFA	3.8	a	2.4	b	2.5	b	0.157	<0.001
*t*11-18:1	2.6	a	1.5	b	1.6	b	0.143	<0.001
*t*13/14-18:1	0.6	a	0.3	b	0.2	c	0.028	<0.001
*t*16-18:1	0.4	a	0.2	b	0.2	c	0.016	<0.001
CLA	0.8	a	0.3	b	0.1	c	0.036	<0.001
***c*-MUFA**	34.3	b	41.9	a	40.8	a	0.949	<0.001
*c*9-16:1	2.3	b	2.8	a	2.9	a	0.162	0.027
*c*9-18:1	28.8	b	35.9	a	34.6	a	0.772	<0.001
SFA	46.0		46.4		47.5		0.827	0.421
14:0	4.0	a	2.6	b	2.5	b	0.173	<0.001
16:0	24.0	b	26.8	a	26.8	a	0.454	<0.001
18:0	15.9		15.3		16.4		0.631	0.475

s.e.m., standard error of the mean; significance (*P*<0.05) indicated by letters a-d.

PUFA = n-6 + n-3; n-6 = 18:2n-6 + 18:3n-6 + 20:3n-6 + 20:4n-6; n-3 = 18:3n-3 + 20:3n-3 + 20:5n-3 + 22:5n-3 + 22:6n-3; *t*-MUFA = *t*9-18:1 + *t*10-18:1 + *t*11-18:1 + *t*12-18:1 + *t*13/*t*14-18:1 + *t*16-18:1; *c*-MUFA = *c*9-14:1 + *c*9-16:1 + *c*9-18:1 + *c*11-18:1 + *c*13-18:1 + *c*9-20:1; SFA = 14:0 + 16:0 + 18:0 + 20:0.

conventional finishing systems in both studies (2,5), which agrees with our results.

Total *t*-MUFA was highest in the suckler beef (*P*<0.001), which is attributed to the high proportion of *t*11-18:1. *Trans*-11-18:1 has been found to be protective against cardiovascular disease (11) and is a precursor for *c*9,*t*11-18:2 CLA. Total CLA was highest in suckler beef (P<0.001, Table 1), which is considered beneficial, as it has been linked to positive health effects (6,11). Biohydrogenation intermediates such as *t*13/14/16-18:1, which are derived from desaturation of alpha-linoleic acid (ALA), may have potential health benefits for humans, but specifics have yet to be identified (5).

The proportion of *c*-MUFA was higher in the grain-fed and grass-fed beef (*P*<0.001), of which the majority is *c*9-18:1. Higher PUFA proportion in suckler beef could be down-regulating stearoyl-CoA desaturase (SCD), resulting in less SFA being converted to *c*-MUFA.

In this study, suckler beef (*longissimus dorsi* muscle) was shown to have less fat (20.73 mg/g muscle) overall than the grain-finished (29.30 mg/g) and grass-finished (38.6 mg/g) beef (*P*<0.05, Table 1). Suckler beef is not intensively finished, and would be expected to produce a leaner product than the grain-finished animals. The proportion and composition (16:0 and 18:0) of total saturated fatty acid (SFA) did not differ among the feeding systems. A lack of difference in the proportions of 18:0 between diets supports the likelihood that the rumens of these suckler calves' were fully developed, with little evidence for ruminal bypass of the fatty acids in the milk occurring. Similarly, there appears to be no overwhelming evidence that the fatty acid profile of suckler beef differed from grass-fed beef by grazing on more biologically diverse pastures, which are frequently observed in sub-alpine range.

IV. CONCLUSION

Overall, the suckler beef was found to have a fatty acid profile that is similar to mature grass-fed beef, though it was higher in PUFA (proportion of total FA) a slightly lower n-6/n-3 FA ratio. The low input finishing system is a definite natural advantage for the sub-alpine suckler beef producers with access to high mountain pastures. Producers have the benefit of lower input costs resulting from reduced finishing times, along with reductions in labour and resources required in feeding traditional calves when bringing cattle in from pasture in the fall. Although the suckler cattle are slaughtered at 10 months of age and have lower carcass weights, the cost could potentially be recouped as more of the carcass could be used for higher value steak cuts as a direct result of the increased tenderness.

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