INFLUENCE OF HEMPSEED CAKE ON LIPID FRACTIONS IN BOVINE *M. LONGISSIMUS DORSI* OF FRESH AND COOKED TISSUE

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Introduction

Strategies to increase the polyunsaturated fatty acid (PUFA) content of beef tissue, while lowering the n-6/n-3 ratio, have focused on inclusion of forage and lipid sources in the diet. Inclusion of oilseeds, either processed or whole, offer varying degrees of rumen bypass efficiency. Hemp oil consists of 84% PUFA, of which 22% is α-linoleic acid (18:3 n-3) (Callaway 2004). Mustafa et al. (1999) found hemp meal, which contained 32% crude protein and 52% ether extract, to be an excellent source of rumen undegraded protein, with digestion characteristics similar to heat-treated canola meal. Alternatively, feeding full-fat oil seed offers greater protection of lipids from biohydrogenation than if fed as a meal (Aldrich et al., 1997). A feedlot diet (Gibb et al., 2005) containing 14% as-fed whole hemp seed had no adverse effects on daily intake or gain compared to a soybean diet. Fatty acid profile comparison of *M. pars costalis diaphramatic* indicated a greater proportion of α-linoleic acid in hemp-supplemented animals compared to soybean-supplemented animals (Gibb 2005). Whole hemp seed provides a good source of by-pass protein as well as increasing the content of n-3 FA within the tissue. The objective of this study was to compare the lipid composition of fresh and cooked *M. longissimus dorsi* (LD) tissue from steers supplemented with either cold pressed hemp cake or soybean meal.

Materials and Methods

Steers received either hemp seed cake (HC, n=8) or soybean meal (SM, n=8) as a protein supplement during finishing (Table 1). At processing, sections of LD were collected, fresh samples stored at -20°C, remainder aged 7 days then stored at -20°C. Aged samples were thawed for 24h, cooked for 2h at 70°C in a water bath. Changes to the total lipid fractions during storage were investigated using thin-layer chromatography (TLC) to quantify shifts in fraction content (Sampels et al., 2006). Tissue lipid extraction and methylation were performed as described by Sampels et al., (2006). Fatty acid methyl esters (FAME) were analysed by GC using a 50 m fused silica capillary column. Mixed procedure for analysis of variance included treatment and tissue as main effects, with individual animal as a random effect in the model (SAS v9.1, Cary, NC, USA). Protected comparisons across tissues within treatments were made using least significant differences ($P<0.05$).

Results and Discussion

From the TLC separation, cooking influenced phospholipid, cholesterol, free fatty acid and triglyceride content (Table 2). Results could be best explained through loss of triacylglycerides during the cooking process. Remaining lipid fractions increased by similar proportions within treatments (Figure 1).

Soybean meal supplementation resulted in a greater proportion of saturated FA (SFA) deposited within the tissue, particularly of palmitic acid (Table 3). The high content of 16:0 in soy meal could be responsible for direct incorporation into the tissue. Hemp cake supplementation resulted in proportionally more monounsaturated FA (MUFA) being deposited within the tissue in the form of 18:1 *cis*-9. Given the trend of slightly more fat content in the tissue, the MUFA content of the hemp steers could reflect more desaturase activity within the tissue (Daniel et al., 2004). The PUFA content of the tissue was not influenced by the trial parameters suggesting that both supplements in their present form are highly susceptible to rumen hydrogenation. The greater proportion of *trans*-vaccenic acid (VA) within HC steers suggests a build-up of biohydrogenation intermediates leaving the rumen. *Trans*-VA is predominantly responsible for endogenous production of *cis*-9, *trans*-11 conjugated linoleic acid (CLA) (Bauman et al., 2003), which is supported by the subsequent accumulation of CLA *cis*-9, *trans*-11 within the tissue of HC steers. The n-6/n-3 ratio of food is a concern to human health due to its influence on the body's inflammatory response and cardiovascular disease (Bruckner et al., 2000). The HC steers n-6/n-3 ratio was lower, having a more favourable ratio.

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Conclusion

Compared to soy bean meal supplementation, hemp cake supplementation would be a viable option for decreasing the n-6 to n-3 fatty acid ratio. Minor decreases in SFA and concurrent increases in MUFA content of hemp cake fed steers, would have positive implications regarding the risk of cardiovascular disease (Bruckner, 2000). The lipid fractions as determined by TLC were influenced more by loss during cooking than by dietary treatment.

Table 1. Fatty acid profile (%FAME) of feed ingredients

	Silage	Barley	Hemp Cake	Soy Meal
TL%, wet wt.	1.3	2.0	8.5	2.3
16:0	17.4	22.0	7.4	17.1
18:0	1.6	1.1	2.4	3.5
18:1 *c*-9	3.1	13.0	8.6	15.2
18:2 n-6	15.3	54.4	53.2	55.0
18:3 n-3	43.5	6.1	19.2	6.0
SFA	24.4	23.8	11.2	21.6
MUFA	4.1	14.5	10.0	17.0
PUFA	58.9	60.7	72.5	61.0
Unknown	6.8	1.0	6.3	0.5
n-6/n-3	0.4	8.9	2.8	9.2

abbreviations: TL=total lipid; FAME=fatty acid methyl esters; SFA=saturated fatty acid; MUFA=monounsaturated; PUFA=polyunsaturated;
n-6= 18:2 n-6 + 20:2 n-6 + 20:3 n-6 + 20:4 n-6 + 22:5 n-6;
n-3= 18:3 n-3 + 20:3 n-3 + 20:5 n-3 + 22:5 n-3 + 22:6 n-3.

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Table 2. Total lipid fraction profile (%) of fresh and cooked *LD* from HC or soy meal fed steers

	Hemp Cake		Soy Meal			
	Fresh	Cooked	Fresh	Cooked	PSEM	P^z
PL	8.7	9.8	10.9	11.9	0.94	b
Chol	4.8	6.1	5.7	6.5	0.54	b
FFA	1.4	3.1	1.2	2.9	0.13	b
TAG	85.1	81.0	82.2	78.5	1.47	b

^{z} P <0.05, b=cooking effect
abbreviations: LD=longissimus dorsi; PL=phospholipid; Chol=cholesterol; FFA=free fatty acid; TAG=triacylglyceride.

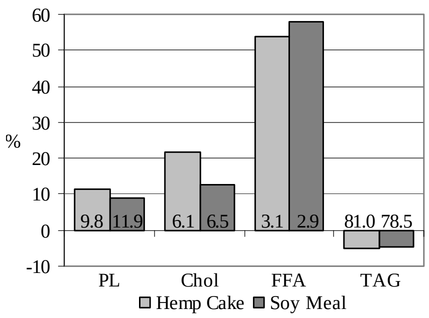

Figure 1. Difference in lipid fractions (% shift, fresh meat as baseline) after cooking from LD of steers fed hemp cake or soy meal. Final cooked proportions shown within bars.
abbreviations: (*see Table 2*)

Table 3. Total lipid fatty acid profile (%FAME) of fresh and cooked *LD* from hemp cake or soy meal fed steers

	Hemp Cake		Soy Meal			
	Fresh	Cooked	Fresh	Cooked	PSEM	P^z
14:0	2.7	2.7	3.0	2.8	0.17	
16:0	28.3	28.3	31.0	30.6	0.74	a
18:0	13.1	12.3	12.8	12.2	0.39	
18:1 *t*-11	0.6	0.5	0.3	0.3	0.04	a
18:1 *c*-9	44.9	44.5	41.8	42.4	0.79	a
18:2 n-6	1.2	1.4	1.4	1.5	0.17	
18:3 n-3	0.2	0.3	0.2	0.2	0.02	a
CLA *c*-9, *t*-1	0.2	0.2	0.1	0.1	0.01	a
SFA	44.6	43.8	47.4	46.2	0.98	a
MUFA	51.4	51.7	48.4	49.4	0.85	a
PUFA	2.1	2.5	2.3	2.6	1.16	
n-6	1.5	1.9	1.8	2.0	0.95	
n-3	0.4	0.4	0.4	0.4	0.24	
n-6/n-3	4.1	4.4	5.0	5.1	0.46	a

^{z} P <0.05, a=dietary treatment effect
abbreviations: (*see Table 1 and 2*) CLA=conjugated linoleic acid.

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