Fatty Acid Composition and Eating Quality of Muscle from Steers Offered Grazed Grass, Grass Silage or Concentrate-Based Diets

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FATTY ACID COMPOSITION AND EATING QUALITY OF MUSCLE FROM STEERS OFFERED GRAZED GRASS, GRASS SILAGE OR CONCENTRATE-BASED DIETS

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Abstract

The effects of grazed grass, grass silage or concentrates on the eating quality and fatty acid composition of intra-muscular fat of steers fed to achieve similar carcass growth rates were investigated. Fifty steers were assigned to one of five dietary treatments. The experimental rations offered daily for 85 days pre-slaughter were (a) grass silage plus 4 kg concentrate, (b) 8 kg concentrate plus 1 kg hay, (c) 6 kg grazed grass dry matter (DM) plus 5 kg concentrate, (d) 12 kg grazed grass DM plus 2.5 kg concentrate or (e) 22 kg grazed grass DM. Decreasing the proportion of concentrate in the diet, which effectively increased grass intake, caused a linear decrease in the concentration of intra-muscular saturated fatty acids (SFA) ($P < .01$) and in the n-6 to n-3 poly-unsaturated fatty acids (PUFA)ratio ($P< .001$) and a linear increase in the PUFA to SFA ratio ($P < .01$) and the conjugated linoleic acid concentration ($P < .001$). There was an interaction ($p<0.05$) between ageing time and treatment with treatment d having higher ($p<0.05$) tenderness, texture and acceptability values after 2 days ageing, but not after 7 or 14 days ageing. The data indicate that intra-muscular fatty acid composition of beef can be improved from a human health perspective by inclusion of grass in the diet without any negative effect on the eating quality.

Keywords: Beef, Fatty Acids, Eating quality,

Introduction

Strategies that lead to an increase in the PUFA to SFA ratio in intra-muscular fat would improve the healthiness of beef from a consumer perspective. While there is evidence that grass consumption increases the ratio of n-3 to n-6 PUFA in beef, many studies are confounded by differences in carcass weight and/or fatness (Marmer *et al*., 1984; Enser *et al*., 1998). The first objective of this study was to determine the impact on intra-muscular fatty acid composition including conjugated linoleic acid (CLA) of grazed grass, grass silage and concentrates in the diet of steers with similar carcass growth rates.

There is also evidence that concentrate-fed animals produce more tender and better-flavored meat than forage-fed animals (Larick *et al.*, 1987), but again dietary effects in many experiments are confounded by differences in animal age or carcass weight at slaughter (e.g. Bowling *et al.*, 1978; Harrison *et al*., 1978). The second objective of this study was to evaluate the effect of diet on the eating quality of meat from cattle while maintaining similar mean carcass growth rates between diets.

Material and Methods

Fifty continental crossbred steers (mean liveweight 504kg) were blocked on liveweight and assigned from within blocks to five treatments. The experimental rations offered daily for 85 days pre-slaughter were (SC) grass (Lolium Perenne) silage plus 4 kg concentrate, (CO) 8 kg concentrate plus 1 kg hay, (CG) 6 kg grazed grass (Lolium Perenne) dry matter (DM) plus 5 kg concentrate, (GC) 12 kg grazed grass DM plus 2.5 kg concentrate or (GO) 22 kg grazed grass DM. Grass allowances were offered daily and concentrates were fed individually. The experiment lasted from 22 August to 1 December after which all animals were slaughtered. *M. Longissmus dorsi* (LD) was excised from all animals 24 hours post slaughter. Steaks were taken at 2, 7, and 14d post-mortem for sensory analysis and Warner Bratzler shear force (WBSF) measurement. Fat was extracted from 1 g of the LD muscle using the Folch wash method and fatty acids were quantified as their fatty acid methyl esters (FAME) by capillary gas liquid chromatography following acid-catalysed methanolysis.

Results and Discussion

Similar carcass weights were achieved on all treatments as planned. There was an interaction ($p<0.05$) between ageing time and treatment with treatment GC having higher ($p<0.05$) tenderness, texture and acceptability values after 2 days ageing, but not after 7 or 14 days ageing (Table 1). There was no effect of diet on any of the eating quality variables measured after 7 or 14 days ageing.

Decreasing the proportion of concentrate in the diet, which effectively increased grass intake, caused a linear ($P< .01$) decrease in intra-muscular SFA concentration (Table 2). The relationship is best described by the equation: SFA concentration (g/100g FAME) = .59 concentrate intake (kg) + 42.98, ($r = .69$). The intra-muscular SFA concentration of SC did not differ ($P > .05$) from CO but was higher ($P < .05$) than all other treatments. Decreasing concentrate intake in grass-based diets resulted in a linear increase in the PUFA: SFA ratio in intra-muscular fat which was best described by the equation PUFA: SFA ratio = .0044 concentrate intake (kg) + .1191, ($r = .48$).

There was no effect of treatment on n-6 fatty acid concentration in intra-muscular fat. Decreasing concentrate intake increased the n-3 fatty acid concentration and linearly decreased the n-6: n-3 ratio. The latter relationship was best described by the equation, n-6: n-3 ratio = .3008 concentrate intake (kg) + .21 ($r = .79$). The n-6: n-3 PUFA ratio of SC did not differ (P < .05) from CO but was higher (P < .05) than all other treatments. Decreasing the proportion of concentrate in the diet caused a linear (P< .001) increase in intra-muscular CLA concentration. The relationship is best described by the equation: CLA concentration (g/100g FAME) = -.079 concentrate intake (kg) + .98, (r = .83). Mean intra-muscular CLA concentration for SC did not differ (P > .05) from CO or CG, but was lower (P < .05) than the other two treatments.

The intra-muscular fatty acid composition of beef can be improved from a human health perspective by inclusion of grass in the diet without any negative effect on the eating quality of beef.

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Table 1 - The effect of diet and *post-mortem* ageing on WBSF and taste panel assessment.

Diet (D)	SC			CO			CG			GC			GO			Significance			
Ageing time (T)	2	7	14	2	7	14	2	7	14	2	7	14	2	7	14	s.e.	D	T	D x T
WBSF (N)	51.9	37.1	35.6	55.0	37.8	33.3	49.7	36.1	37.5	38.9	33.2	31.4	53.4	38.4	39.1	2.39	n.s.	***	*
Tenderness[2]	4.62	5.02	5.34	4.44	5.43	5.73	4.25	4.84	5.63	5.10	5.83	5.60	4.77	5.15	5.65	0.187	n.s.	***	*
Texture[3]	3.57	3.68	3.70	3.42	3.69	4.03	3.41	3.78	3.90	3.77	3.91	3.57	3.48	3.72	3.67	0.123	n.s.	**	n.s.
Flavour[4]	3.79	3.94	3.69	3.76	3.97	3.99	3.74	4.01	3.86	3.83	3.90	3.72	3.69	3.58	3.80	0.112	n.s.	n.s.	n.s.
Juiciness[5]	4.97	4.27	3.59	4.34	4.54	4.03	4.53	4.73	4.08	4.20	4.33	3.64	4.64	4.08	3.97	0.224	n.s.	***	n.s.
Chewiness[6]	3.49	3.27	3.20	3.67	3.21	2.77	3.88	3.40	2.75	3.43	2.87	2.82	3.53	3.28	2.95	0.130	n.s.	***	n.s.
Acceptability[7]	3.37	3.62	3.49	3.19	3.55	3.82	3.20	3.60	3.79	3.54	3.79	3.48	3.27	3.46	3.58	0.134	n.s.	***	*

[2](scale 1-8; 1 = extremely tough, 8 = extremely tender),[3](scale 1-6; 1 = very poor, 6 = very good),

[4](scale 1-6; 1 = very poor, 6 = very good), [5](scale 1-8; 1 = extremely dry, 8 = extremely juicy),

[6](scale 1-6; 1 = not chewy, 6 = extremely chewy), [7](scale 1-6; 1 = not acceptable 6 = extremely acceptable).

Table 2 - The effect of diet on intra-muscular fatty acid composition (g/100 g FAME)

Fatty acid	Treatment						
	SC	CO	CG	GC	GO	SE	SIG[1]
$C_{18:2}$ (CLA)	.47 [cd]	.37 [d]	.54 [bc]	.66 [b]	1.08 [a]	.040	***
SFA[2]	47.72[a]	48.07 [a]	45.71 [b]	44.86 [b]	42.82 [c]	.415	***
MUFA[2]	41.83	41.48	40.90	42.31	43.07	.249	0.08
PUFA[2]	4.14 [a]	4.93 [a]	4.53 [a]	4.71 [a]	5.35 [b]	.29	.053
n-6 fatty acids	2.96	3.21	3.12	3.04	3.14	.106	n.s.
n-3 fatty acids	.91 [c]	.8 4 [c]	1.13 [b]	1.25 [ab]	1.36 [a]	.042	***
n-6 : n-3 ratio	3.61 [ab]	4.15 [a]	2.86 [bc]	2.47 [c]	2.33 [c]	.197	**
PUFA : SFA	.087 [a]	.090 [a]	.100 [a]	.105 [ab]	.125 [b]	.0069	**

[1]Means within rows with common superscripts are not significantly (P<.05) different.

[2]SFA = total saturated fatty acids, MUFA = total monounsaturated fatty acids, PUFA = total polyunsaturated fatty acids.