The fatty acid composition of cooked longissimus muscle from grass-fed, concentrate-fed or grass silage and concentrate-fed heifers

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Abstract - The effects of a novel "all grass-based" diet and the more traditional concentrate/silage-diets on the fatty acid composition of cooked beef muscle were compared. Early maturing heifers (n=15/group) were offered either : barley/soya ration *ad libitum* + 10kg grass silage (CONC), grazed grass followed by grass silage *ad libitum* + 2 kg of the above concentrate (GSR) or 2 kg concentrate supplemented with ruminally protected linseed meal (GSN) or high digestibility grass (GPO). When the two extreme diets were compared, cooked beef from GPO had higher proportions of PUFA, MUFA, Omega-3, EPA and CLA than CONC. Consumption of grass-fed beef with increased n- 3 fatty acids and CLA can contribute to daily requirements of these beneficial fatty acids.

Key Words – Beef, Pasture-fed, Grazing, Omega-3, Conjugated linoleic acid

I. INTRODUCTION

Reducing the intake of saturated fatty acids (SFA) and increasing the intake of omega 3 polyunsaturated fatty acids (PUFA) have been shown to play an important role in reducing the risk of cardiovascular disease Calder [1]. Studies [1] have identified that a lower ratio of n-6/n-3 PUFA in food is desirable in reducing the risk of many chronic diseases in humans. The diet that cattle are fed throughout their lifetime impacts the concentration of the meat constituents, especially fatty acids. For example, cattle are frequently finished on a diet consisting of concentrates, which may be unfavourable to the n-6/n-3 ratio in beef because the concentrates generally contain more n-6 fatty acids whereas grass is a source of n-3 fatty acids French et al. [2]. The objective of this study was to examine the effects of a novel "grass-fed" finishing diet with the more traditional concentrate-fed finishing diet on the fatty acid composition of cooked beef muscle.

MATERIALS AND METHODS

Animal Production: In November, sixty early maturing breed sired heifers that had not received concentrates prior to arrival at Grange, were blocked according to bodyweight , and within block assigned randomly to one of four dietary treatments (n=15), namely, barley/soya ration *ad libitum* + 10kg grass silage (CONC) throughout, grass silage *ad libitum* + 2 kg concentrate until April followed by grazed grass until housing in July and then grass silage *ad libitum* + 4 kg concentrate (GSR), a similar diet to GSR but the finishing concentrate was nutritionally enhanced with ruminally protected linseed meal (GSN) or high digestibility grass silage and a mineral and vitamin supplement (56g/head/day) during the winter followed by grazed grass until slaughter. After slaughter, the weight of the carcass was recorded, carcasses chilled for 24 h, and samples of steaks taken (25 mm thick) from the 10 rib region of the longissimus thoracis, and stored at -20ºC prior to analysis.

Fatty Acid extraction and GCFID quantification: Beef muscle was cooked to an internal temperature of 72ºC using sous vide and transferred into Teflon Xpress™ vessels tubes (CEM corporation, NC, USA), fatty acids were extracted from homogenised muscle using a 2-step microwave-assisted (CEM corporation) saponification and esterification process. For saponification, 10ml of 2.5% methanolic KOH was added to each tube, microwaved, heating the sample from ambient to 130ºC in 4 min and then held at 130ºC for a further 4 min. For esterification, 15ml of 5 % methanolic acetyl chloride was added to each tube, microwaved, heating the sample to 120ºC in 4 min, then held at 120ºC for a further 2 min. Pentane (10ml) was added to each tube to extract fatty acid methyl esters (FAME). Saturated NaCl (20ml) was added to each tube to induce phase separation. The pentane layer was then removed and placed directly into a 2ml glass GC vial prior to injection on the GC-FID for fatty acid quantifciation as previously described [2].

Statistical analysis:
Data were subjected to ANOVA and Tukey HSD according to dietary treatment performed using PASW version 19 (IBM SPSS – NY, USA).

I. RESULTS AND DISCUSSION

Table 1: Fatty acid composition of cooked beef muscle from grass-fed (GPO), concentrate-fed (CONC), grass silage and concentrate-fed heifers (GSR) or GSR plus ruminally protected linseed meal (GSN)

Fatty acids, proportion of total fatty acids *100	CONC	GSR	GSN	GPO	*SEM*	*P-Value*
C14_0	2.66[a]	2.93[a]	2.30[b]	2.32[b]	*0.040*	*0.000*
C16_0	24.42[a,c]	27.15[b]	25.33[c]	24.23[a]	*0.167*	*0.000*
C18_0	11.85[a]	13.50[b]	13.72[b]	13.88[b]	*0.154*	*0.000*
C18_1c9	38.99[a]	38.94[a]	41.60[b]	40.81[b]	*0.207*	*0.000*
C18_1t11	0.62[a]	1.54[b]	1.77[b]	2.81[c]	*0.091*	*0.000*
C18_2c9_t11 Conjugated Linoleic Acid (CLA)	0.26 [a]	0.52 [b]	0.77 [c]	0.47 [b]	*0.033*	*0.000*
C18_3c9_12_15	0.37[a]	0.76[b]	1.02[c]	1.13[c]	*0.033*	*0.000*
Eicosapentaenoic acid (EPA)	0.20[a,b]	0.08[b]	0.17[a,b]	0.35[a]	*0.026*	*0.001*
Total saturated fatty acids (SFA)	40.82[a]	44.92[b]	42.30[c]	41.53[a,c]	0.241	*0.000*
Total monounsaturated fatty acids (MUFA)	44.43[a]	43.78[a]	47.24[b]	46.93[b]	*0.236*	*0.000*
Total poly unsaturated fatty acids (PUFA)	5.56[a]	4.70[b]	5.51[a]	5.96[c]	*0.111*	*0.000*
Omega n-6 fatty acids (n-6)	1.20[a]	1.37[a]	1.74[b]	1.94[b]	*0.462*	*0.000*
Omega n-3 fatty acids (n-3)	0.70[a]	0.83[a]	1.94[b]	2.26[b]	*0.087*	*0.000*
PUFA:SFA ratio	0.14[a,b]	0.11[b]	0.13[a]	0.14[c]	0.004	*0.000*
Omega n-6: Omega n-3 ratio (n-6:n-3)	1.72[a]	1.71[a]	0.93[b]	0.84[b]	0.054	*0.000*
Total fatty acids (mg/g of cooked beef)	61.92[a]	50.03[b]	43.01[b]	44.81[b]	*1.537*	*0.000*

Several studies have investigated the effect of various proportions of grass and or concentrates in the finishing diet of the cattle on the fatty acid composition of uncooked meat French et al. [2], Moloney et al. [3], Noci et al. [4]. The cooked beef from the two extreme diets (GPO and CONC) in this study had different proportions of PUFA, MUFA, Omega n-3, EPA and CLA which were significantly greater for GPO treatment. Beef from cattle with grass in their finished diets had generally lower total fatty acids than that of cattle that were concentrate-finished. CLA was lowest in the beef from the CONC fed animals, although increased levels of CLA *cis-9. trans-11* are found in fatter animals, this study found that animals fed GSN, which contained a ruminally protected fatty acid supplement, had increased CLA *cis-9. trans-11* in the cooked beef, suggesting that the linseed oil was not fully protected. The PUFA: SFA was most favourable for GPO-fed beef, although values across all diets were generally more similar than other studies comparing grass-fed and grain fed diets Moloney et al. [3], Noci et al. [4].

IV. CONCLUSION

The profile of health-promoting fatty acids identified in this study illustrates that the consumption of grass-fed beef with increased n- 3 fatty acids and CLA can contribute to daily requirements of these healthy fatty acids.

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