THE EFFECTS OF BREED AND DIET ON THE LIPID COMPOSITION AND QUALITY OF BOVINE MUSCLE

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Background

Some studies with beef cattle have shown that breed affects tissue fatty acid composition and meat quality (Zembayashi *et al.*, 1995). Choi *et al.* (2000) showed that Welsh Black cattle had higher proportions of n-3 polyunsaturated fatty acids (PUFA) in muscle neutral lipid and phospholipid. However the effects of breed are often confounded with differences in growth rate and body composition. Diet also affects fatty acid composition, with sources of n-3 PUFA, such as linseed, producing meat with high concentrations of C18:3 n-3 and its long chain derivatives. Enser *et al.* (1998) have shown differences in n-6 and n-3 PUFA content arising from grain (high in C18:2 n-6) and grass (high in C18:3 n-3) feeding. These differences lead to changes in flavour because of the production of different volatiles during cooking (Larick and Turner, 1990). However, feed composition studies are often confounded by the use of mixed diets and few have compared all-forage with all-concentrate diets. This study, therefore, was designed to compare Aberdeen Angus and Holstein-Friesian breeds growing at similar rates and fed either all-forage or a high concentrate diet.

Objectives

To determine the fatty acid composition of muscle total lipids in Aberdeen Angus and Holstein-Friesian steers, fed either grass silage or a concentrate-based diet, and its relation to certain meat quality parameters (colour shelf-life and lipid oxidation).

Methods

Sixteen Aberdeen Angus (AA) and 16 Holstein-Friesian (HF) steers (initial age and live weight six months and ~200kg, respectively) were allocated to one of two dietary treatments (*ad libitum* grass silage plus sugarbeet pulp shreds at *circa* 15% of the total dry matter (DM) intake or a barley-based concentrate and chopped barley straw at a ratio of 70:30 on a DM basis), resulting in eight animals per breed per dietary treatment. Animals were weighed every 14 days and information used to regulate the intake of the concentrate animals in order to maintain similar growth rates between diets within breed. At 14 months of age, animals were transported to Bristol from Aberystwyth for slaughter and carcass fat and conformation assessments were made. Samples of *longissimus dorsi* were obtained 48 h post-slaughter for fatty acid analysis. Steaks were cut and packed in a modified atmosphere (MAP) and displayed for 10 days in simulated retail conditions (4°C, 1000 lux for 18 h out of 24 h). Lipid oxidation was determined as thiobarbituric acid-reacting substances (TBARS) following display. Meat colour was determined daily for 12d (L*a*b*). Lipids were extracted and fatty acids determined as methyl esters by gas chromatography. The data were analysed using a general analysis of variance using breed and diet as the main factors. Sensory assessments were made on grilled steaks (internal temperature of 74°C) by a 10 member trained taste panel using 100mm unstructured line scales followed by analysis of variance with panels treated as a block structure for 7 panels.

Results and discussion

Cold carcass weights were light at this age and carcasses had poor conformation (Table 1). Only the silage-fed AA animals came close to an acceptable commercial score (R3). TBA values were four and six times higher in steaks from concentrate-fed animals compared with the equivalent silage-fed animals after 4 and 7d of retail display, respectively (Figure 1). Steaks from silage-fed animals had a retail colour shelf-life 5d longer than that of steaks from concentrate-fed animals at 11 and 6d, respectively (Figure 2). These effects are probably due to differences in antioxidant levels in the meat, particularly Vitamin E as forages have high natural concentrations of Vitamin E. Feeding silage resulted in higher levels of C18:3*n*-3 in both NL (Table 2) and PL (Table 3) fractions, as well as subsequently higher levels of EPA, DPA and DHA in the PL fraction but with lower proportions of *n*-6 series long-chain PUFA. The concentrate-fed animals had higher proportions of C18:2*n*-6 in both NL and PL, which resulted from high concentrations in the concentrate feed. HF had a lower proportion of C16:1 in both NL and PL. Meat from HF animals scored higher for the attribute 'fishy' compared with the AA, 2.1 *vs.* 0.6 (s.e.d.=0.68;$P<0.05$), respectively and steaks from silage-fed animals scored higher for the attribute 'livery' than those from concentrate-fed animals, 14.0 *vs.* 10.4 (s.e.d.=1.31;$P<0.01$), respectively.

Conclusion

Feeding grass silage rich in C18:3*n*-3 increased levels of this FA in beef muscle and increased the beneficial long-chain *n*-3 PUFA EPA, DPA and DHA, without any deleterious effects on sensory perception. The shelf life effects demonstrate that the two diets probably differed in their antioxidant status. Breed had little effect on most of the parameters measured.

Pertinent literature

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Table 1 Effect of breed and diet on liveweight (kg) and carcass characteristics.

	AA		HF			
	Concentrate	Silage	Concentrate	Silage	s.e.d.	significance
Mean liveweight (kg)	395.6	404.1	373.9	365.2	13.92	NS
Half carcass weight (kg) (cold)	98.2	100.8	91.1	89.1	3.82	NS
Conformation (1-155)	59 (O+)	78 (R)	40 (O-)	37 (O-)	6.8	*
Fat class (1-145)	44 (2)	66 (3)	20 (1)	41 (2)	5.8	NS

AA= Aberdeen Angus; HF = Holstein-Friesian. NS, not significant; ***P<0.001; **P<0.01; *P<0.05.

Table 2 Effect of breed and diet on fatty acid composition (proportion x 100) of the neutral lipid fraction in *Longissimus dorsi*.

	Breed				Diet			
	AA	HF	s.e.d.	sig.	Concentrate	Silage	s.e.d.	significance
C14:0 myristic	2.9	2.8	0.10	NS	2.8	2.9	0.10	NS
C16:0 palmitic	28.6	27.7	0.49	NS	27.0	29.4	0.41	***
C16:1 palmitoleic	4.1	3.7	0.18	*	3.6	4.2	0.17	***
C18:0 stearic	14.7	14.7	0.51	NS	15.3	14.1	0.48	*
C18:1 *n*-9 oleic	37.1	37.3	0.60	NS	36.2	38.2	0.55	***
C18:1 *trans*	1.9	2.2	0.28	NS	3.0	1.0	0.13	***
C18:2 *n*-6	1.5	1.9	0.24	NS	2.5	0.7	0.08	***
C18:3 *n*-3	0.4	0.4	0.04	NS	0.3	0.6	0.02	***
CLA[1]	0.4	0.4	0.05	NS	0.5	0.2	0.02	***

[1]9-*cis*, 11-*trans* octadecadienoic acid

Table 3 Effect of breed and diet on fatty acid composition (proportion x 100) of the phospholipid fraction in *Longissimus dorsi*.

	Breed				Diet			
	AA	HF	s.e.d.	sig.	Concentrate	Silage	s.e.d.	significance.
C14:0 myristic	0.26	0.22	0.02	NS	0.2	0.3	0.02	***
C16:0 palmitic	15.2	14.9	0.20	NS	14.8	15.4	0.18	**
C16:1 palmitoleic	1.2	1.0	0.11	*	0.7	1.5	0.05	***
C18:0 stearic	10.8	11.0	0.14	NS	11.2	10.6	0.12	***
C18:1 *n*-9 oleic	19.7	17.6	1.22	NS	14.3	23.4	0.47	***
C18:1 *trans*	0.5	0.5	0.06	NS	0.7	0.2	0.03	***
C18:2 *n*-6	15.7	16.8	1.89	NS	23.3	8.7	0.36	***
C18:3 *n*-3	2.2	2.1	0.38	NS	0.8	3.7	0.05	***
CLA	0.1	0.1	0.03	NS	0.2	0.1	0.02	*
C20:3 *n*-6	1.9	2.1	0.21	NS	2.7	1.2	0.06	***
C20:4 *n*–6	8.2	8.8	0.55	NS	10.5	6.3	0.17	***
C20:5 *n*-3 (EPA)	2.1	2.1	0.33	NS	0.8	3.4	0.06	***
C22:5 *n*-3 (DPA)	3.4	3.3	0.33	NS	2.1	4.6	0.09	***
C22:6 *n*-3 (DHA)	0.5	0.6	0.09	NS	0.2	0.9	0.04	***

Figure 1. Effect of breed and diet on mean TBARS of beef loin steaks after 4 and 7 days display in MAP (Conc = Concentrate).

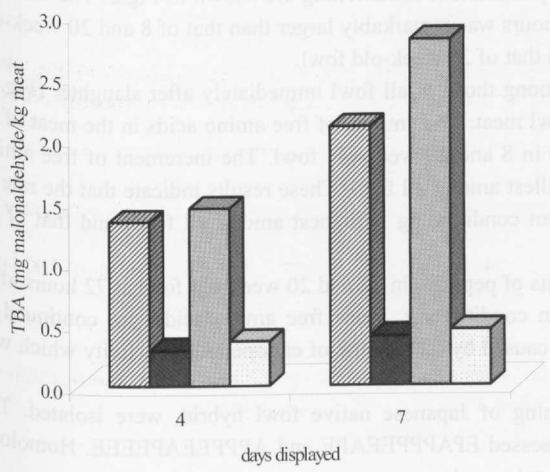

Figure 2. Effect of breed and diet on colour shelf-life of beef loin steaks displayed in MAP (Conc = Concentrate).