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Comparison of fat quality from *organically* and *conventionally* husbanded steers

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Introduction

There has been an increasing trend in the United Kingdom to develop low input (organic) systems for the production of agricultural commodities such as meat, milk and milk products, grains, vegetables and fruits. This trend is driven by a combination of consumer demand, environmental concerns and premium payments for such produce. There is also a consumer presumption that produce obtained 'organically' and animals reared under organic regimes are more natural and thus 'better' than products produced using more intensive systems. Meat quality related to its system of production has thus become a topical issue.

Organic meat is produced under a set of standards which defines welfare, nutritional and veterinary production procedures. These include the need for access to pasture, bedded accommodation (rather than slats), a minimum proportion of roughage in the diet, and limits on the routine use of conventional medicines. No soluble fertilizer or agrochemical can be used on the forage area, resulting in a high clover content in the grazed herbage and in silage compared with conventional systems. In order to maintain organic conditions for the animals, essential micronutrients such as vitamins and minerals cannot be supplied from synthetic mineral and vitamin premixes.

It is well documented that the fat soluble vitamins and their precursors as well as a number of other naturally occurring compounds such as polyphenolics are important factors in maintaining the nutritional and immune status of animals as well as the storage properties of meat (Bendich, 1989 and 1991; Ranken, 1989: Pratt and Hudson, 1990; Buckley, 1990; Sheehy, Morrissey and Flynn, 1991). Meat quality and flavour are frequently dependent on the fatty acids present in the meat and fat, and on the degree of oxidation of the fat (Buckley, 1990; Sheehy *et al.*, 1991; Frankel, 1991). Thus the absence or presence of various antioxidants and the oxidation products of fats are extremely important in quality assessment (Frankel, 1991). It is well known that vitamin E acts as a potent intracellular antioxidant in animals inhibiting (quenching) free radical formation and by reacting with hydroperoxides (Nakamura and Masugi, 1979). Thus adequate amounts of vitamin E have considerable beneficial effects on animal health and on meat quality. To a lesser extent beta-carotene and other carotenoids act as antioxidants in meat and fats (Krinsky, 1979; Warner and Frankel, 1987). Other compounds found naturally, especially in weeds and herbs also have antioxidant properties (Pratt and Hudson, 1990).

Natural (organic) pastures tend to have a higher proportion of weeds and herbs compared with their intensively reared counterparts (Turner, 1955). Thus animals that consume such pastures may have a higher intake of antioxidants (Pratt and Hudson, 1990). It is also possible that they have a higher intake of free radical initiators (Frankel, 1991).

Previous work has demonstrated differences in the beta-carotene and vitamin E levels in well established organic and conventional pastures and substantial differences in blood levels of these and retinol in steers allocated to either of the pastures (Acamovic, Tolla, Scaife and Younie, 1992).

The purpose of the work was to assess the quality of fat obtained from extensively and intensively reared steers.

Material and methods

Friesian × Hereford steers of mean live weight 195 kg and 7 to 8 months of age were overwintered under organic (no. = 21) or conventional (no. = 21) husbandry regimes where the diet consisted of silage prepared from the respective pastures and offered *ad libitum*, oats, barley and vitamin and mineral supplement or seaweed meal, as appropriate. The animals were released, from April until October 1990 to either an organic or conventional perennial

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Table 1 *Results of the analyses of fat from steers on organic and conventional husbandry regimes*

Husbandry type	Roche fan	Wavelength maximum	Absorbance†	Peroxide value at:		
				0 h	24 h	168 h
Organic	< 1	400·8	110	0·49	0·87	94·5
Conventional	< 1	400·5	97	0·53	0·66	116·2
s.e.d.				0·159	0·239	19·3

† Quantity of beta carotene (mg/kg fat) required to give the same absorbance at 400 nm.

ryegrass/white clover sward. The swards were established at Craibstone, Aberdeen in 1983 in order to compare low input and conventional beef production.

The grassland farmlets were established on adjacent sites with the same varieties, but different proportions of perennial ryegrass, timothy and white clover. The organic system was managed according to Soil Association Standards (Soil Association, 1989) and had a high clover content (approx. 30% clover, 70% ryegrass and 10% clover, 90% ryegrass for the organic and conventional systems respectively). At the end of the grazing period the animals were housed and continued on organic and conventional systems until they were slaughtered during spring and early summer of 1992 (approx. 18 months of age) when their average weights were 483 kg.

Samples of internal depot fat from around the kidney were taken at slaughter and stored at –20°C until required for analyses. A rapid assessment of colour was obtained by Roche fan and by scanning spectrophotometry (350 to 500 nm) using a dual beam spectrophotometer. Fat was dissolved in a mixture of chloroform and methanol (2 : 1v/v) using ultrasonic vibration prior to centrifugation (500 **g** for 10 min) and spectroscopy of the supernatant liquid. Peroxide values were obtained according to the method of the Association of Official Analytical Chemists (1984). Accelerated 'ageing' (oxidation) of fat samples was conducted by a modification of the method of Warner, Frankel and Mounts (1989) where about 5 g fat was heated in a 250 cm^3 Erlenmeyer flask for 24 and 168 h at 80°C. Data were subjected to statistical analyses (*t* test) using a Minitab statistical software package (Minitab Inc., PA, USA).

Results

The mean proportions of clover in the herbage (dry-matter basis) were in grazed herbage, 0·17 and 0·10, and in silage 0·15 and 0·05, for organic and conventional pasture respectively.

The beta-carotene retinol and alpha-tocopherol contents of blood of the animals have been presented elsewhere as have the beta-carotene and alpha-tocopherol concentrations in the pasture samples (Acamovic *et al.*, 1992). Carcasses after slaughter were not obviously visually different in colour.

The results of the analyses of the fat are shown in Table 1.

From Table 1 it is clear that the fat from both sets of animals was essentially white; no significant differences ($P > 0·05$) were observed with the Roche fan. The small amount of pigment present in some of the samples from both groups had absorption maxima of about 400 nm which is much lower than that for beta-carotene (450 nm) examined under the same system. There was no difference ($P > 0·05$) between treatments in colour or intensity of the colour. The peroxide values obtained for all samples were initially low and not significantly ($P > 0·05$) different between treatments. After 168 h of heat treatment both types of fat had large peroxide values which did not differ significantly ($P > 0·05$) from each other. It is notable, however that fat from the organic treatment had a slightly lower peroxide value than that from the conventional treatment before ageing. It is also worthy of note that the peroxide value of both types of fat increased slightly with ageing for 24 h but that the organic fat had a larger and significant ($P < 0·05$) increase.

Discussion

The beta-carotene and alpha-tocopherol contents of the pastures were not unusual (Acamovic *et al.*, 1992; Bieber-Wlaschny, 1988). Blood beta-carotene, alpha-tocopherol and retinol levels in the steers grazing organic pasture were lower than in their counterparts grazing conventional pasture. Before turn-out, on the other hand, there was little difference between the levels of these compounds in the animals (Acamovic *et al.*, 1992). It is therefore, perhaps reasonable that at slaughter there was little difference between carcass fat colour although

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slightly surprising that the intensity of the colour was marginally higher in the organically reared animals. The fact that the wavelength maximum for chloroform methanol solutions of the fats, in the visible region of the spectrum, are lower than that for beta-carotene suggests that the main pigment in the fat is not beta-carotene. It is possible that the low fat soluble vitamin status may increase red blood cell fragility (Kumar, George, Bai and Krishnamurthy, 1979; Siddons and Mills, 1981) and thus allow red cell contents and/or their metabolites to be deposited in the fat which may tend to catalyse oxidation (Buckley, 1990; Gordon, 1990; Blake, Merry, Stevens, Dabbagh, Sahinoglu, Allen and Morris, 1990). The influence of iron compounds in the oxidation of fat, and other tissue has been shown to be significant and ameliorated to varying extents depending on the supply of dietary vitamin E (Gordon, 1990; Buckley, 1990). It therefore seems reasonable that a reduction in uptake of dietary vitamin E, beta-carotene and other dietary antioxidants by animals under the organic regime (Acamovic *et al.*, 1992) may contribute to the increase in peroxide value observed during the short ageing period (Warner and Frankel, 1987; Buckley, 1990; Sheehy *et al.*, 1991). The slightly higher amounts of the pigment in the fat from organic animals may, in part, be responsible for the higher peroxide values if these had pro-oxidant properties (Thurnham, 1990). The fat from organic animals may also have a higher proportion of unsaturated fatty acids because of the increased clover content in the pasture (J. Vipond, personal communication) making it more susceptible to oxidation. The longer term ageing process indicates that, overall, there is little difference between the oxidative potential of the fats indicating that over longer periods the slight variation in pigmentation and the presence of pro- or antioxidants in both types of fat has little effect on excessive ageing. It therefore appears that the deficiency of fat soluble vitamins in the blood of animals grazing organic pastures has little effect on the oxidative potential of kidney fat (Acamovic *et al.*, 1992).

At this stage it is not possible to anticipate the adverse or beneficial effects on organoleptic properties of the meats due to oxidation of the fat (Frankel, 1991). The relative presence of other antioxidants in the pastures and their intake, uptake and deposition in the meat and fat require to be determined. If they are present in higher amounts in organic pasture and are absorbed efficiently, their effects may be negated by any disruption of red blood cells. These other antioxidants may not function in the same manner or be as effective as vitamin E in the cell membrane (Gordon, 1990; Bermond, 1990; Thurnham, 1990).

From the work reported here, although fat from organic animals is slightly more pigmented and more susceptible to oxidation in the short term, there are no significant differences in pigmentation and peroxide values of kidney fat obtained from organic and conventionally fed steers. Worthy of further study is the oxidative resistance of intramuscular fat from both groups of animals since this fat is more likely to undergo oxidation than kidney depot fat. Identification of the pigment(s) and the oxidation products as well as their effects on organoleptic properties of the meat and fat is also deserving of further work.

Conclusion

Animals feeding on organic pasture may have an increased requirement for and/or reduced ability to absorb and utilize beta-carotene, retinol and alpha-tocopherol compared with animals feeding on conventional pastures. The resultant deficiency of these lipophilic micronutrients within the animal may adversely affect its immune status and may be responsible for reduced storage and organoleptic properties of meat although this is not reflected in the oxidative properties of the kidney fat.

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