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CAUSES OF PASTORAL FLAVOUR IN RUMINANT FAT

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Background

Meats and dairy products derived from animals raised on pasture have a characteristic flavour that sets them apart from products of equivalent animals raised on concentrates, which are typically grain-rich diets. Populations of consumers culturally adapted to one flavour – pastoral or grain-finished – often find the other flavour strong and distasteful (pastoral), or bland and oily (grain), an issue that has important commercial consequences. Pasture-finished beef, for instance, is poorly accepted and priced in the U.S. Although regular consumers of pasture-finished beef enjoy the stronger flavour, grain-finished beef is generally higher priced worldwide. Thus, pastoral flavour in meat is a problem rather than a positive attribute. Certainly, international traders of dairy products treat pastoral flavour as a fault.

Derogatory descriptions of pastoral flavour include 'grassy', 'milky', 'fishy', 'metallic', 'rancid' and 'barnyard'. The only quality these terms appear to have in common is possibly unpleasantness, and in researching the problem of flavour(s) specific to pasture-finished ruminants, one can only hope that the flavours represent a limited number of compounds that contribute to the flavour through a limited number of metabolic pathways.

As food is eaten, odours released by mastication are smelt by way of the retronasal passage at the back of the oral cavity. Thus in identifying the specific cause of pastoral flavor, much of the literature addresses odorous volatiles. While several fat-derived volatiles from linolenic acid are contenders as causal agents, several experiments – including three reported here – highlight the faecal-smelling compound 3-methylindole (skatole) as a leading contender. Another potential contender is 4-methylphenol, as first proposed by Ha & Lindsay (1991) and confirmed by Young *et al.* (1997). These latter authors showed that these two compounds were statistically associated with an 'animal' odour/flavour that was dominant in pasture-finished sheepmeat but not in grain-finished equivalent. The three experiments summarised here extend these relationships for beef and sheepmeat.

Experiment 1: Odour profile, indoles and 4-methylphenol in beef fat from two cattle diets

Subcutaneous fat, obtained from three cattle finished for 100 days on a grain diet dominated by barley and maize silage, and compared with fat from three ryegrass/clover-finished cattle of the same age, 2 years. Fat samples were rendered by microwave. Aliquots of rendered fat (1 g) were presented warm in 25 ml round-bottom, wide-necked flasks to 12 panellists who described the odours with nine primary descriptors (Table 1a) or any other descriptor if the primary descriptors did not suit. Primary descriptors were developed in panel training. The rendered fat was also analysed for 4-methylphenol and indoles by conventional distillation-extraction and chromatographic mass spectrometry (Table 1b).

The most obvious odour differences were in the 'barnyard', 'milky', 'sweaty' and 'other' descriptors. 'Other' included a diverse range of descriptors, many often associated with fat oxidation products (not shown). Their greater frequency in the grain treatment is consistent with the softer, more unsaturated fat from a grain diet. 'Milky' refers to a smell associated with New Zealand dairies, and is closely allied to 'barnyard'. Both descriptors were undoubtedly higher in the pasture treatment and may be related to the indoles and 4-methylphenol dominating that treatment (Table 1b). Panellists avoided the descriptor 'faecal'. Nonetheless, the overall data confirmed a possible causal link (Young *et al.*, 1997) between skatole, 4-methylphenol and important components of pastoral odour/flavour.

Experiment 2: Causal links between sheepfat volatiles and panel descriptions

Subcutaneous fat from eight-month lambs raised on pasture, maize and lucerne combinations was rendered and analysed as follows. Volatiles from heated fat were resolved on a DB5 gas chromatographic column, and the effluent was sniffed to identify the dominant odorous compounds among the hundreds in the profile. Of the 25 compounds picked, 20 were identified in parallel mass spectrometric analyses. The relative concentrations of these 20 in each diet treatment were measured. Meanwhile, 12 panellists smelt the fats and described the odours within a lexicon similar to that in Table 1a. The correlations between concentration and frequency were analysed for principal components to illustrate the relationship between volatiles and descriptors (Fig. 1). Correlations in the top left quadrant support a causal relationship between indoles and the 'barnyard' and 'faecal' notes. The concentration of skatole was 100-fold higher in the headspace above pasture-derived fat, and other compounds in this quadrant were also significantly more dominant in pasture treatments (not shown). We concluded that skatole is strongly implicated in pastoral odour/flavour. Moreover, this and related compounds may be the cause of 'sheep' and 'mutton' notes, as opposed to 'lamb', which occupies a different quadrant (Fig. 1). In this experiment, sheep-specific branched chain fatty acids (Wong *et al.*, 1975) were not detected in column effluent sniffing, but separate fatty acid analyses showed they were much less dominant in fat from pasture treatments. Thus, in sheepfat, pastoral odour/flavour can be distinguished from the species character of lamb. The former may be the greater problem in consumer acceptance.

Experiment 3: Changes in indoles concentrations in beef fat due to diet

From 50 cattle grazing late summer ryegrass/clover pasture, 10 animals were slaughtered, and the remainder switched to a maize silage diet, then serially slaughtered in groups of 10 up to 72 days. Indole and skatole concentrations were measured in the subcutaneous fat (Table 2). Indoles were reduced to basal concentrations within 15 days of switching to the maize silage diet. A sensory panel described fat odour differences between the pasture and the 15-day treatment, but data were inconclusive. If indoles and like compounds were the only cause of pastoral flavour, the results in Table 2 imply that the problem could be solved in meats by a very short-term change in diet. Melton *et al.* (1982) showed that a total change in pastoral flavour to grain-finished flavour took much longer than 15 days. Certainly, conventional grain-finishing takes place over several months. Inspection of Melton's data suggests the gradual change in fatty acid profile towards increased monounsaturates (principally oleic acid) might also be causally involved in reducing pastoral flavour.

Table 1a. Descriptions of beef fat odours associated with two diets

Frequency of descriptor use by 12 panellists	Diet	
	Pasture	Grain
Sweet	9	6
Grassy	1	2
Fatty	2	1
Oily	0	0
Barnyard	4	0
Faecal	0	0
Milky	8	1
Hay	0	0
Sweaty	1	4
Other	9	17

Table 1b. Concentration of free indoles and phenols in beef fat[§]

Compound	Diet		
	Pasture	Grain	Significance[¶]
Indole	13.3	2.8	*
Skatole	17.5	5.4	*
Phenol	11.6	13.4	NS
4-Methylphenol	168	35	*

[§] Data are means, μg/g of fat. [¶] *, $P < 0.05$

Conclusions

Collectively the data indicate that skatole and probably indole and 4-methylphenol are among the causes of pastoral odour and flavour in meats. The indoles, at least, were rapidly eliminated from beef fat when cattle were taken off a pastoral diet (in less than 15 days), but the development of a clear grain-finished character takes many weeks. This suggests that the fat oxidation products play a dominant role in the grain-finished odour profile. Viewed this way, a pastoral flavour in fat would be determined by maximal skatole and like compounds with a minimal contribution from desirable fat oxidation products. A grain flavour would be characterised by minimal skatole etc. in the presence of maximal monounsaturate-derived oxidation products.

Finally, skatole and like compounds appear to be responsible for 'mutton' and 'sheep' flavour as opposed to 'lamb' flavour.

References • Ha, J.K.; Lindsay, R.C. Volatile alkylphenols and thiophenol in species-related characterizing flavors of red meats. *J. Food Sci.* 1991, *56*, 1197-1202. • Melton, S.L.; Black, J.M.; Davis, G.W.; Backus, W.R. Flavor and selected chemical components of ground beef from steers backgrounded on pasture and fed corn up to 140 days. *J. Food Sci.* 1982, *47*, 699-704. • Wong, E.; Johnson, C.B.; Nixon, L.N. The contribution of 4-methyloctanoic (hircinoic) acid to mutton and goat meat flavour. *N. Z. J. Agric. Res.* 1975, *18*, 261-266. • Young, O.A.; Berdagué, J.-L.; Viallon, C.; Russet-Aakrim, S; Theriez, M. Fat-borne volatiles and sheepmeat odour. *Meat Sci.* 1997, *45*, 169-181.

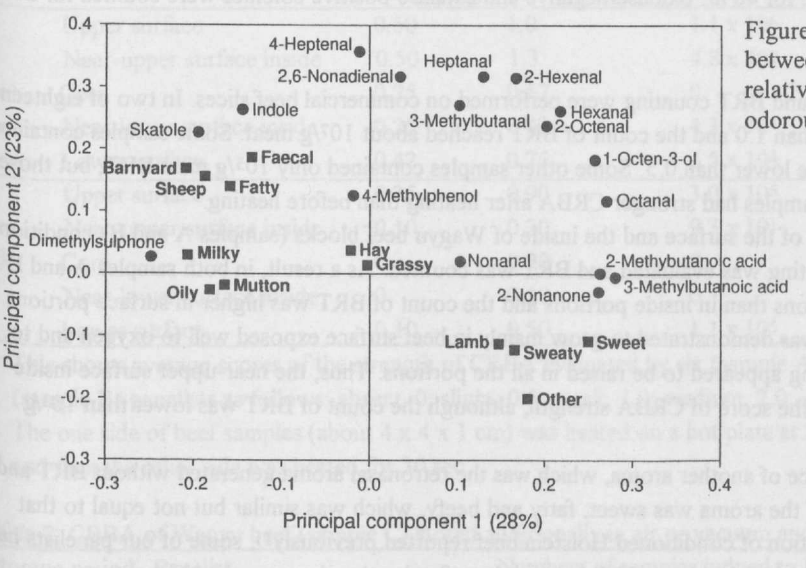

Figure 1. Principal components analysis of correlations between the frequency of panel descriptions and relative concentrations of compounds identified as odorous in sheepfat.

Table 2. Free indoles concentration in beef fat after changing from pasture to a maize silage diet

Diet	Indole (μg/g)	Skatole (μg/g)
Pasture	30 ± 21	57 ± 33
Pasture, then maize for		
15 days	7 ± 5	5 ± 7
31 days	5 ± 3	6 ± 2
43 days	6 ± 4	6 ± 4
72 days	15 ± 6	4 ± 2

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