S2P08.WP

EFFECT OF TIME OF YEAR ON FATTY ACID COMPOSITION AND MELTING POINT OF UK LAMB FAT

M. ENSER and J.D. WOOD

Department of Meat Animal Science, School of Veterinary Science, University of Bristol, Langford, Bristol, United Kingdom

Please refer to Folio 9.

INTRODUCTION

It is generally accepted that the major quality problems of sheep meat are high fat levels in cuts and the saturated nature of the fat. The latter causes lamb fat to congeal in the mouth and on cooking utensils. It is perceived as unhealthy because of the public's association of hard fats with cardiovascular disease although current information does not link high stearic acid intake with hypercholesterolaemia. Although the highly saturated nature of lamb fat is believed to stem from extensive hydrogenation of unsaturated fatty acids in the rumen, feeding treatments can change the fatty acid composition. By-passing the rumen with "protected" unsaturated fatty acid supplements produces marked changes in fatty acid composition but is ruled out by its cost. Limited evidence (Cramer and Marchello, 1964; L'Estrange and Mulvihill, 1975) suggests there is significant natural seasonal variation which results from differences in feeding regimes. This study was done to provide more information on this seasonal variation in the UK flock and to suggest its cause with a view to controlling fat quality through future feeding strategies.

MATERIALS AND METHODS

Samples of subcutaneous fat were obtained from the base of the tail of lamb carcasses during five visits, approximately ten weeks apart, to each of four abattoirs in different parts of England and Wales. Collections were centred on February, May, July, October and December. Carcasses were selected randomly and sex, weight and classification (MLC) were recorded. Lipid was extracted with chloroform in the presence of anhydrous sodium sulphate from the whole thickness of adipose tissue to eliminate effects of variation in composition with depth of fat from the skin. After solvent removal, melting (slip) point was determined in duplicate. Fatty acids were obtained by saponification of the lipid, extracted and converted to methyl esters with diazomethane. Methyl esters were analyzed by gas-liquid chromatography on a 50mx0.25mm CP Sil 88 column.

RESULTS AND DISCUSSION

Samples were taken from 463 (44.4%) female lambs and 579 (55.6%) male lambs with overall mean carcass weights (±SD) of 17.3±2.9kg and 17.7±2.8kg respectively. Since there were no significant differences between the sexes for fat consistency and fatty acid composition the results have been pooled. Although there were significant differences in carcass weights, conformation and fatness scores between abattoirs and between sampling dates within companies, there was no consistent pattern and taken overall the lambs sampled had a fatness and conformation score representative of UK slaughtered lamb (Table 1).

The melting points of the fat samples ranged from 30°C to 49°C with an overall mean of 39.5±3.3°C. There was a significant effect of sampling date ($P<0.001$) on melting points which were 40.1°, 37.2°, 37.9°, 40.7° and 41.9°C for February, May, July, October and December samples respectively. The distribution of fat melting points is shown in Figure 1.

The fatty acid composition of the samples is shown in Table 2. As expected, palmitic acid and stearic acid were the major saturated fatty acids followed by myristic acid. Oleic acid was the major monoenoic acid followed by trans 18:1, mainly trans-vaccenic. Palmitoleic, linoleic and a-linolenic were present in small amounts. Only two lambs had high concentrations (more than 10%) of branched-chain fatty acids which has been associated with cereal feeding (Duncan *et al.*, 1972). All the fatty acids reported varied significantly ($P<0.001$) with date of sampling (Table 2).

Myristic acid and stearic acid varied most, with the former increasing toward the middle of the year whereas the latter moved in the opposite direction. Palmitic acid, palmitoleic acid and trans-vaccenic acid followed myristate although the differences between sampling dates were much less. Linoleic acid was similar but peaked at the second visit. The changes in oleic acid and the branched-chain fatty acids resembled stearic acid with a fall in the middle of the year.

Our findings highlight and extend previous knowledge of seasonal effects on the consistency and fatty acid composition of lamb adipose tissue. The variation in melting point of the lipid between visits is clearly a specific effect which occurred at all abattoirs. The findings agree with more limited studies by Cramer and Marchello (1964) and L'Estrange and Mulvihill (1975) with a similar range in melting points. Although there were differences between abattoirs in mean melting points within and between sampling dates, the overall seasonal effect was not obscured, despite differences in geographical site, breeds and husbandry practices.

Overall, the fatty acid composition of our lambs was within the range reported by L'Estrange and Mulvihill (1975), Kemp *et al.* (1981) and Solomon *et al.* (1990) with myristic acid at the upper end of its range and linoleic acid at its bottom end. Analysis of the relationship between lipid melting point and fatty acid composition revealed that the level of stearic acid in the fat was the most important component (Figure 2) in line with other studies of lamb, pork and beef. Adding in palmitic acid, the next best predictor of melting point, only increased the variance explained from 78.3% to 81.7%. Surprisingly, myristic acid which altered in a reciprocal manner to stearic acid was a poor predictor of melting point.

The seasonal changes in fatty acid composition and hence melting point appear to stem mainly from dietary effects. The high concentration of myristic acid in spring and summer lambs results from fattening occurring whilst the lambs were suckling. Ewes milk is the main source of this fatty acid, in which it constitutes up to 10% of the total fatty acids. The concentration is lower in lambs slaughtered later in the season which are older and have probably lost myristate through turnover.

Stearic acid is low in suckling lambs because its content in milk is low compared with carcass fat and rumen hydrogenation is low in suckling lambs. The marked increase in stearic acid deposition as the season progresses can clearly be ascribed to the length of time the lambs are on grass, with the associated hydrogenation of unsaturated fatty acids in the rumen. The spring fall in stearic acid was much greater than the increase in myristic acid suggesting factors other than suckling were involved. Since linoleic acid was high in these May lambs they were probably finished on concentrates. The latter decrease the extent of rumen hydrogenation and hence stearate formation. They also act as a source of carbohydrate for *de novo* fatty acid synthesis which leads mainly to the synthesis of palmitic acid and oleic

acid, again helping to decrease stearic acid (Miller *et al.*, 1967).

There are apparently no studies relating the consistency of lamb fat to consumer acceptability. However, since the "greasiness" of lamb fat is a negative consumer reaction, the low melting point of fat in spring lamb may be an important component of its attractiveness. If mouth temperature is taken to be the critical temperature then overall 35% of the lambs had fat which melted below 38.4°C. However, in the spring up to 90% of the lambs slaughtered in one abattoir had fat melting below 38.4. The research challenge is to extend this to the whole year.

ACKNOWLEDGEMENT

We are grateful to the Meat and Livestock Commission for supporting this study.

REFERENCES

CRAMER, D.A., and MARCHELLO, J.A. 1964. Seasonal and sex patterns in fat composition of lambs. *J. Anim. Sci.* 23:1002-1010.

DUNCAN, W.R.H., ØRSKOV, E.R., and GARTON, G.A. 1972. Fatty acid composition of lambs fed on barley based diets. *Proc. Nutrition Society.* 31:19A-20A.

L'ESTRANGE, J.L., and MULVIHILL, T.A. 1975. A survey of fat characteristics of lamb with particular reference to the soft fat condition in intensively fed lambs. *J. Agric. Sci., Camb.* 84:281-290.

KEMP, J.D., MAHYUDDIN, M., ELY, D.G., FOX, J.D., and MOODY, W.G. 1981. *J. Anim. Sci.* 51:321-330.

MILLER, G.J., VARNELL, T.R., and RICE, R.W. 1967. Fatty acid composition of certain ovine tissues as affected by maintenance level rations of roughage and concentrates. *J. Anim. Sci.* 26:41-45.

SOLOMON, M.B., LYNCH, G.P., ONO, K., and PAROCZAY, E. 1990. Lipid compositon of muscle and adipose tissue from crossbred ram, wether and cryptorchid lambs. *J. Anim. Sci.* 68:137-142.

Table 1. Percentage distribution of carcasses by conformation and fat class.

Fatness Class	1	2	3L	3H	4L	4H	5	Total
Confor-mation class								
E	0.0	0.6	0.7	0.8	0.4	0.2	0.0	2.6
U	0.0	1.4	5.3	2.7	0.8	0.7	0.7	11.5
R	0.3	7.7	19.8	13.3	3.2	1.0	1.0	47.3
O	1.0	8.5	16.9	8.3	1.2	0.4	0.4	36.6
P	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Total	1.2	18.2	42.6	25.0	5.5	3.4	2.0	100.0

Table 2. Mean fatty acid composition (% by weight) of subcutaneous fat by visit over all companies and sex.

Visit:	1	2	3	4	5
Myristic C14	4.1	5.3	7.9	5.6	4.7
Palmitic C16	21.7	22.1	22.9	22.0	21.5
Stearic C18	20.2	15.7	16.1	20.0	21.4
Palmitoleic C16:1	1.9	1.9	2.0	1.7	1.7
Oleic C18:1	32.4	32.6	28.0	27.7	28.5
Trans-vaccenic C18:1t	5.7	6.4	6.5	7.1	6.6
Linoleic C18:2	1.4	1.9	1.1	1.0	1.1
Linoleic C18:3	0.9	0.8	1.0	1.1	1.1
Total branched	4.2	3.8	3.4	3.7	3.6