FATTY ACID COMPOSITION OF MEAT FROM ANIMALS SELECTED FOR LEANNESS

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SUMMARY

Examination of intramuscular lipid in livestock shows that there is a large total lipid content and a low ratio of polyunsaturated to saturated fatty acids in animals selected by man for rapid growth.On the other hand those animals that have arisen by natural selection,or in some cases have been selected by man for low energy requirement,have little intramuscular fat and high polyunsaturate to saturate ratios.Also it appears that by using certain genotype x diet interactions that it may be possible to alter the type of long chain fatty acid (e.g.C-18,C-20 and C-22) in meat from sheep and cattle.Some types of these acids are considered useful in affecting factors associated with coronary heart disease in humans.

INTRODUCTION

The breeding or selection of lean domestic animals has the obvious advantage of contributing less saturated fat to the human diet.Certain types of sheep in South Australia that have purposely been selected for not only high production and but also low maintenance requirement contain little body fat (Siebert and Howard 1984) and have muscular lipids that are similar to that of wild ruminant species (Sinclair et al. 1982).Rams of this type of sheep are being used in crossbreeding programs aimed at reducing the fatness of meat lambs.Another advantage of such animals lies in the fact that lean tissue contains a greater proportions of beneficial polyunsaturates,particular types of which vary in their capacity to lower blood cholesterol and triglyceride levels in man and in their conversion to prostanoid metabolites that may well have antithrombotic and vasodilatory effects (Goodnight et al. 1982).The study reported here examines the lipid content,the composition of the fatty acids and the type of unsaturated fatty acid present in meat from a type of lamb presently being used for meat in Australia and in a selected lean type.

ANIMAL TYPE, BODY FAT,AGE AND DIET

(i) Eight fat type (Dorset crossbred) and eight lean type (selected South Australian Merino) wether lambs were weaned at three months of age and raised at pasture for a further four months.Near the end of that period estimates were made of the total body fat by indirect body water measurment.The fat type animals contained 22.5% fat and the lean 5.4%.When lean meat was removed from the carcasses following slaughter soon after,minced tissue contained 14.0% and 8.0% fat respectively.

(ii) Six lean type wether lambs were raised at pasture from birth to six months of age with their dams. After three months they were weaned and the ewes removed from the paddock. Each month small samples of the L. dorsii muscle were taken by biopsy technique and later analysed for their fatty acid composition. Similar samples were taken from animals of the same type at slaughter after being raised for three months indoors on a feed consisting of alfalfa (50%) and oat-grain (50%).

Fatty acid composition of intramuscular lipid.

(i) Samples of muscle taken from eight animals of each type at slaughter were analysed for total lipid content. This component and the phospholipid fraction were then analysed for their fatty acid composition. The proportions of the major fatty acids present in those fractions is shown in Table 1, together with the ratio of polyunsaturates to saturates (P/S) and the ratio of the n-6 to n-3 polyunsaturates.

TABLE 1
Relative concentrations of the saturated (S) and polyunsaturated (P) fatty acids present in the phospholipid (P/L) and total lipid (T/L) fractions of muscle from fat and lean lambs

Animal type		Fat		Lean	
Body weight (kg)		34.6		31.9	
Total body fat (% body weight)		22.5		5.4	
Intramuscular fat (% wet tissue)		3.8		2.4	
Triglyceride (% wet tissue)		2.9		1.3	
Phospholipid (% wet tissue)		0.9		1.1	
Cholesterol (mg/100g tissue)		53.0		49.5	
Fatty acids (% total present) (C - chain length)		P/L	T/L	P/L	T/L
S	16:0	11.9	21.3	10.5	19.1
S	18:0	11.7	18.2	12.2	21.0
P	18:2 (n 6)	9.6 a	3.1	12.4 a	4.8
P	18.3 (n 3)	4.0	1.6	3.9	1.8
P	20:4 (n 6)	5.7 a	0.8	7.6 a	2.2
P	22:5 (n 3)	3.8	0.7	3.7	1.3
	P/S	0.86	0.15	0.96	0.25
	n 6/n 3	1.90		1.22	

a Significantly different within same line $P < 0.05$

The results show that the fatter animals contained approximately 50% more intramuscular fat than the lean animals and most of this difference was triglyceride. The remainder, phospholipid, was relatively constant. The difference in cholesterol content was not significant. There was little difference in the proportions of saturated fatty acids in the phospholipid fraction but there was greater concentrations of the n-6 type (18:2 and 20:4). The concentration of longer chain acids was somewhat lessened in the total lipid analysis as the additional triglyceride contained little or no unsaturated fatty acids. The diet under these circumstances contained both n-6 and n-3 acids.

Within the phospholipid fraction the P/S ratio was very similar but the n-6/n-3 ratio was significantly different indicating a difference of the animal types in there handling of the plant fatty acids. Because of the greater amount of triglyceride present in the fat type animals the P/S ratio was considerably greater than in the lean animals.

(ii) The relative proportions of the major fatty acids in the phospholipid fraction of muscle taken from six lean type sheep from one month to 26 months of age is shown in Table 2 together with the ratios of P/S and n-6/n-3.

Table 2
Relative concentrations of the saturated (S) and polyunsaturated (P) fatty acids present in the phospholipid fraction of muscle from lean lambs

Fatty acids (% total present in phospholipid)					
Age (months)		1	4	6	26
Situation		unweaned	pasture	pasture	alfalfa-oats
	(C - chain length)				
S	16:0	10.3	10.6	10.5	9.1
S	18:0	13.0	13.8	12.2	13.1
P	18.2 (n 6)	11.0	12.4	12.4 a	14.8 a
P	18:3 (n 3)	4.2	4.3	3.9	1.5
P	20:4 (n 6)	6.2	6.5	7.8 a	12.4 a
P	22:5 (n 3)	4.3	5.5	3.7	3.1
	P/S	1.08	1.01	0.96	1.06
	n 6/n 3	1.18	1.38	1.90	3.80

a Significantly different within same line $P < 0.05$

There was little change in the fatty acid composition over the first four months although at six months there appeared an alteration in the type of unsaturated acid present. At 26 months when fed indoors on a legume and grain diet a marked change took place in this respect. The ratio of P/S however showed little change throughout the period of measurement indicating that within an animal type this remained constant in the phospholipid fraction. The change in long chain fatty acid type however could be attributed to age or diet since even at pasture there may have a change in the type of fatty acid in the diet.

GENERAL DISCUSSION

The results of the first experiment demonstate that the additional triglyceride laid down in fat animals lowers the P/S ratio in intramuscular lipid. The animals used in these experiments are only examples of what the nature of meat is that humans consume. Lean muscle often only contains 1-2% fat whereas sausage or hamburger may contain 20-25% fat. In the latter case the P/S ratio may be 0.03 or less. The results do show however that marked differences can be achieved by selection for animals on efficiency grounds. The other major point that arises from the measurements is that significant differences occur in the type of long chain fatty acid between different types of animals within a species, so that the ratios of one type to another (n-6/n-3) vary markedly.

The major difference from the human dietary point of view however is that the meat from the lean animal surplies less saturated fat. Since the cholesterol content of both tissues was very similar the ratio of triglyceride to cholesterol in meat from fat animals was two three times that of that in lean animals. When meat from both types was incorporated into diets and fed to pigs it was found that those on the low fat diet had plasma cholesterol levels 30% lower than those on the high fat diet.

In the second experiment it was clear that little change took place in the n-6/n-3 ratio from one to four months of age although it is known that major changes take place between the foetal and newborn state. What was clear however is that at a later age particularly when changed to a different diet there was a large increase in the n-6/n-3 ratio. This value was quite similar to that reported for wild herbivore species (Sinclair et al. 1982) and much greater than that normally seen in meat from domestic livestock.

CONCLUSIONS

The results demonstrate that there is quite a diversity in both the amount of fat deposited within a species and of the nature of the fatty acids that make up that tissue. Also the type of fatty acid present may be altered by situation, particularly diet. Low saturated fat meat diets would appear to be just as effective in lowering blood cholesterol as plant based diets and indeed if the type of fatty acid can be altered simply, they may be more effective.

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