FATTY ACID COMPOSITION OF VARIOUS DEPOT FATS OF LAMBS.

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INTRODUCTION

The type of feeding affects not only the amount of deposited fat, but also its physicochemical properties and fatty acid composition (7, 8, 10, 11). With intensive fattening of lambs with concentrates a softer and larger amount of fat is deposited (2,3). At passing from pasture to indoor rearing (feeding with concentrates) the relative amount of 18:1 is increased and that of 18:0 decreases. Considerable differences have been established in fatty acid (FA) composition of lipids from different tissues and muscles. In general lipids of organs located close to the body surface, contain more unsaturated fatty acids and have a lower melting temperature.

It is both of practical and theoretical interest to study the effect of level of nutrition on FA composition of different adipose tissues (AT) in ontogenic aspect.

MATERIAL AND METHODS

The experiment was conducted with three groups of male lambs (12 in each group) Frisian crosses. After weaning (at about 45 days of age) the animals were fed on rations of different energy and protein content during 6 months (table 1). Up till slaughter the animals were given free access to water and food. Samples of AT were collected immediately after weaning and 4 months and 6 months afterwards. The lipids of AT around the tail, around the kidney and the breast were analysed. The analytical procedures and statistical methods have been earlier described (2).

RESULTS AND DISCUSSION

The obtained results (table 2) show that there exists a direct ralationship between the energy in the ration and the liveweight of the animals, both at intermediate age and also at the end of the fattenning period. The same dependance was observed in respect to the effect of nutrition on the size the deboned carcass. The amount of deposited fat in heavier animals is greater in both ages. The opposite tendency is observed with the deposited protein. The amount of lipids in the kidney AT increases with the elevation of energy in the diet as well as with the advance of age of lambs. Immediately after weaning (table 3) 14:0 is found in all fat-depots in considerable amounts. This is easy to explain since this FA represents a considerable proportion of milk fat. The kidney AT at this age contains the maximum amount of 18:0 and 18:2, and breast AT is the poorest in respect to these FA. Specific peculiarities are observed in regard to FA composition of investigated three AT. The tendencies are retained at the other two ages with some minor changes.

The differences in the composition of fat depots are most strongly evident at the intermediate age (table 4). The proportion of 14:0 decreases in all tissues in comparison with that after weaning. The kidney AT is poorest in unsaturated FA, which is mainly due to the lower lewel of 18:1. At the same time after weaning, the amount of this FA decreases (although at different degrees depending on the level of nutrition). On the contrary, in the remaining two depots an increase of 18:1 is found. The observed different changes in the amount of 18:1 in various AT from weaning till intermediate age are accompanied by opposite (compensatory) changes in the level of 18:0. The rest FA (especially 16:0) are characterized with a certain constancy in their levels. The observed changes are mainly connected with the changes in the relative amount of 18:0 and 18:1, i.e. with the desaturation of 18:0. Similar results have been obtained by other authors (6,7,11). It is noteworthy that the level of oleic acid in triacylglycerols (TG) of breast AT is more than 50 percents i.e. above 4 1/2 times more than stearic acid. The TG from this lipid depot are considerably more unsaturated than TG from kidney AT.

The fatty acid composition in fat depots at the end of fattenning period is close to that of intermediate age (table 5). This tendency is best illustrated in the kidney AT. In the breast AT a slight increase of 18:0 and decrease of 18:1 is observed. Generally the amount of stearic acid in all AT is increased after weaning. During the suckling period FA composition of neutral lipids in the body is influenced by the composition of milk fat. After weaning lipogenesis and biosynthesis

is intensified, as well as the desaturation of 18:0. The obtained results show that this process is changed with the advance of age and is not the same in the investigated depots. This process is strongly influenced by the level of nutrition.

The influence of different feeding patterns on FA composition of depots is best manifested at intermediate age. In all AT with the increase of concentrates in the diet, the amount of deposited 18:2 is elevated. With the simultaneous increase of protein and energy (groups I, II) no particular changes in FA profile are observed. With the increase of energy alone in the diet, not only 18:2 is increased but also 18:1. This is accompanied by a decrease of the level of 18:0. The changes in 18:1 and 18:0 under the influence of level of nutrition are observed in the kidney and tail AT. The feeding pattern does not influence FA composition of breast AT. The considerable constancy of breast adipose tissue in respect to its FA spectrum and its high unsaturation, is of interest from the biochemical point of view, in connection with the regulation of metabolism of different AT.

Having in mind the constancy of 16:0 and the lower levels of 14:0, 16:1, 18:2 (tables 4, 5) the unsaturation of tissue lipids will be determined mainly by the ratio of the relative amounts of 18:1/18:0. This ratio is the highest in breast AT and lowest in the kidney AT (table 4). L'Estrange and Milvihill (7) claim that the investigated by them lamb subcutaneous and kidney fats are extremes in respect to the unsaturation of the various AT. The obtained results, however, show that the breast and tail AT considerably differ in their unsaturation in spite of their similar location to the body surface. The very high unsaturation of breast AT is difficult to expline by only its anatomical location.

Most probably the different unsaturation of various lipid depots are connected with the activity of steroyl-CoA desaturase. The higher activity of this enzyme in subcutaneous AT in comparison with the abdominal (9, 13) is maybe the reason for the different values of unsaturation in these lipid depots. This is in agreement with the obtained results for the tail and kidney AT (table 4). The high level of 18:1 in breast AT could also be explained by the higher activity of the enzyme in this AT. There are other data that the location of AT is related to the degree of unsaturation by the activity of steroyl-CoA desaturase (9, 13).
FA composition of depots is determinated not only by the synthesis of FA de novo,but also by the assimilation of exogenous ones. The deposition of plasma lipids is controlled to a great extent by the activity of lipoprotein lipase in corresponding AT. The highest activity of this enzyme is found in the breast AT (1) and the lowest in kidney AT (5).

The mechanisms controlling the FA composition of various lipid depots under different feeding patterns are still subject of discussion. The higher plasma level of insulin stimulates the desaturation of long chain FA (4). Feeding with high amounts of concentrates causes the elevation of insulin concentration in the circulation (12). The high level of insulin stimulates the desaturation of 18:0 in the tail and kidney AT in the animals of group III. In the breast AT the relative amount of 18:1 does not change, independent of the elevated level of this hormone. The constant degree of unsaturation of breast AT lipids shows that steroyl-CoA desaturase in this tissue is not influenced by the composition of the diet. On the other hand, the very high degree of unsaturation in breast AT indicates that this enzyme takes an active part in the formation of the FA spectrum. It can be assumed that the mechanism of regulation of enzyme activity in breast AT is different from those in the other two lipid depots.

In conclusion, it can be said that, the unsaturation of reserve lipids in the body of intensively fattened lambs depends on the anatomical location of AT. Feeding conditions exert a different effect not only on the amount of lipids but also on their composition in various depots. This is an additional proof for the complicated and tissue-specific control of lipid metabolism in different AT.

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Table 1

Diet composition

Ingredients (%)	Groups I	II	III
Corn	10,0	12.0	23.6
Barley	10.0	13.0	20.0
Sunflower (oil) meal	17.6	40.5	42.6
Limestone	0.8	0.9	1.2
Salt	0.7	0.7	0.7
Trace element mixture	0.4	0.4	0.4
Vitamins, ADE	0.5	0.5	0.5
Prairie hay	60.0	32.0	11.0
Net energy (MJ/kg)*	4.3	5.1	6.0
Crude protein (g/kg)	140.0	196.0	200.0
Roughage/concentrate	60.0	32.0	11.0
ratio, %	40.0	68.0	89.0

* Kellner, O.

Table 2

Liveweigth (kg), carcas data (kg) and kidney fat (gr) from lambs

Groups	Liveweigth	Deboned carcas	Protein	Fat	Kidney fat
		After weaning			
	11,6 ± 0.5	3.2 ± 0.4	0.6 ± 0.1	0.4 ± 0.1	6.3 ± 0.8
		Intermediate age			
I	30.7 ± 1.1 [1]	8.3 ± 1.3 [1]	1.5 ± 0.2 [1]	0.7 ± 0.1 [1]	24.5 ± 9.2 [1]
II	37.9 ± 1.1 [4]	12.6 ± 0.8 [2]	2.3 ± 0.1 [2]	1.2 ± 0.2 [1,3]	64.0 ± 12.3 [2]
III	44.8 ± 1.0 [7]	13.4 ± 0.8 [2]	2.3 ± 0.1 [2]	2.2 ± 0.2 [4]	100.0 ± 15.6 [3]
		Final age			
I	35.5 ± 1.3 [1]	9.9 ± 1.2 [1]	1.9 ± 0.2 [1]	0.9 ± 0.1 [1]	68.3 ± 10.0 [1]
II	45.4 ± 1.3 [4]	13.6 ± 1.2 [1,2]	2.4 ± 0.2 [1]	1.9 ± 0.3 [2]	227.3 ± 58.9 [2]
III	59.1 ± 1.2 [7]	17.5 ± 1.6 [2]	2.9 ± 0.2 [2]	3.3 ± 0.3 [4]	282.5 ± 78.6 [2]

If the smallest possible difference between the superscrips (D) is:
D=1, P < .05; D=2, P < .01; D=3, P < .001

Table 3

Fatty acid composition ot different adipose tissues after weaning

Fatty acid	Adipose tissues		
	Kidney	Tail	Breast
14:0	7.3 ± 1.9	13.0 ± 2.5	12.2 ± 0.4
16:0	21.7 ± 1.6	27.3 ± 1.5	26.8 ± 0.7
16:1	2.2 ± 0.1	3.0 ± 0.3	6.1 ± 0.8
18:0	24.3 ± 1.5	14.3 ± 0.7	8.8 ± 0.9
18:1	38.2 ± 2.4	37.8 ± 2.1	42.9 ± 1.6
18:2	6.3 ± 1.4	4.2 ± 0.1	3.3 ± 0.3

Table 4

Fatty acid composition (M%) of adipose tisues six months after weaning

Fatty acids	Groups III	II	VI
	Breast adipose tissue		
14:0	3.8 ± 0.4	3.6 ± 0.7	3.3 ± 0.4
16:0	23.4 ± 0.9	24.1 ± 0.8	23.6 ± 0.8
16:1	5.8 ± 0.2	5.3 ± 0.4	4.2 ± 0.5
18:0	12.8 ± 0.6	11.5 ± 1.7	11.6 ± 1.8
18:1	50.7 ± 1.1	52.6 ± 1.6	52.2 ± 1.9
18:2	3.5 ± 0.1[1]	2.8 ± 0.2[1]	5.2 ± 0.7[2]
	Kidney adipose tissue		
14:0	1.6 ± 0.3	1.4 ± 0.2	2.4 ± 0.3
16:0	21.0 ± 0.9	21.1 ± 0.8	22.6 ± 0.8
16:1	2.2 ± 0.2	2.0 ± 0.1	2.2 ± 0.1
18:0	42.1 ± 1.6[1]	40.9 ± 1.2[1]	30.6 ± 3.4[2]
18:1	29.3 ± 1.0[1]	28.4 ± 2.3[1,2]	35.7 ± 1.2[3]
18:2	3.8 ± 0.3[1]	4.7 ± 0.2[1,2]	6.5 ± 0.9[2]
	Tail adipose tissue		
14:0	1.9 ± 0.2	2.0 ± 0.1	2.5 ± 0.1
16:0	22.4 ± 0.6	23.3 ± 1.1	22.8 ± 1.1
16:1	2.6 ± 0.2	2.8 ± 0.2	2.9 ± 0.1
18:0	29.0 ± 3.6[1]	27.4 ± 2.2[1]	14.8 ± 1.8[4]
18:1	38.0 ± 2.2[1]	40.3 ± 1.5[1]	51.2 ± 2.4[4]
18:2	3.5 ± 0.5	4.2 ± 0.4	5.7 ± 0.9

If the smallest possible difference between the superscrips (D) is: D=1, $P < .05$; D=2, $P < .01$; D=3, $P < .001$

Table 5

Fatty acid composition (M%) of adipose tisues eight months after weaning

Fatty acids	Groups III	II	VI
	Breast adipose tissue		
14:0	3.6 ± 0.7 [1]	4.2 ± 0.3 [2]	3.6 ± 0.2 [1,2]
16:0	25.4 ± 1.1	28.2 ± 0.1	27.1 ± 1.3
16:1	4.9 ± 0.6	3.9 ± 0.2	4.1 ± 0.3
18:0	17.9 ± 2.6	18.9 ± 2.6	17.1 ± 1.7
18:1	46.9 ± 1.5	41.5 ± 2.2	44.7 ± 1.0
18:2	2.8 ± 0.2	3.3 ± 0.4	3.4 ± 0.2
	Kidney adipose tissue		
14:0	2.1 ± 0.7	2.4 ± 0.5	2.7 ± 0.2
16:0	21.3 ± 0.9	23.8 ± 1.5	24.3 ± 1.2
16:1	2.4 ± 0.2	2.1 ± 0.6	2.1 ± 0.1
18:0	41.2 ± 1.0 [1]	38.0 ± 1.0 [1,3]	35.2 ± 1.3 [3]
18:1	29.8 ± 2.1	30.4 ± 1.1	32.5 ± 1.1
18:2	3.0 ± 0.5	3.4 ± 0.4	3.2 ± 0.8
	Tail adipose tissue		
14:0	2.0 ± 0.5	3.0 ± 0.4	2.6 ± 0.4
16:0	25.3 ± 0.4	27.1 ± 1.4	26.1 ± 0.9
16:1	2.6 ± 0.2	2.8 ± 0.2	2.8 ± 0.4
18:0	26.0 ± 2.2 [1]	19.2 ± 1.1 [3]	19.0 ± 2.6 [2,3]
18:1	41.0 ± 3.4	42.3 ± 1.2	46.4 ± 2.2
18:2	2.9 ± 0.7	3.0 ± 0.2	3.2 ± 0.2

If the smallest possible difference between the superscrips (D) is: D=1, $P < .05$; D=2, $P < .01$; D=3, $P < .001$