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STUDY ON BOTH METABOLIC TYPE OF MUSCLE FIBRES, SIZE OF MUSCLES AND FAT CELLS AND CARCASS COMPOSITION IN LAMBS OF DIFFERENT PRE-SLAUGHTER WEIGHT

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INTRODUCTION

Investigation carried out on fattening of lambs to reach higher live weight revealed that carcass fat content increased with increasing slaughter weight. That determines the interest of a number of investigators to both post-natal growth and evolution of muscles and adipose tissue, bearing also in mind the genetically determined number of muscle fibres in sheep.

Factors having an effect on muscle growth are of both genetic and non-genetic character, comparative studies on different breeds and crosses being predominant. Within a certain genotype of animals, dynamics of the growth process reflects potential meat producing abilities of animals. This allows determination of pre-slaughter weight, in response to market needs, which this production is destined for.

The aim of this study was to study both the growth, evolution of muscles and fat cells, as well as carcass composition in lambs of the Thracian fine-fleeced breed at different pre-slaughter weights.

MATERIAL AND METHODS

A scientific-economic experiment has been carried out on 45 male lambs, weaned at 37 to 45 days of age with an average live weight of 14.5kg. Animals were reared in pens and fed *ad libitum*. Input of nutrients was measured daily and the weight every 15 days. Animals were slaughtered when they reached 25, 30 and 40kg. A full slaughter analysis has been carried out on eight animals of each pre-slaughtering weight, working procedure and methods of analysis being described in other publications of ours (Marinova, 1993; Pinkas and Marinova, 1983). Samples for histochemical analysis were taken from the muscles: *longissimus dorsi* (LD), *semimembranosus* (SM) and *supra spinatus* (SP). Determination of the size of subcutaneous fat cells was made on samples taken from tail-base area. For determining the metabolic type of fibres, the nomenclature of Peter *et al.* (1972) has been used : slow, oxidative (So), fast, oxidative glycolytic (FoG) and fast, glycolytic (FG).

Results obtained were treated to analysis of variance procedures.

RESULTS AND DISCUSSION

Histochemical characteristics of muscle cells for all three pre-slaughtering weights are presented in Table 1. Comparing the size of single metabolic types, the slow oxidative type was established to be of less size than the fast one, both for single weights and for each one of muscles studied. The differentiation in the size of the types of muscle cells has been reported by a number of authors, which include as one of the characteristics of So fibres, their less size (Ashmore, 1974; Lacourt and Arnal, 1974; Suzuki, 1971). Greater sized FoG and FG fibres are of close values in within the range of the same live weight for all three muscles studied. The established differences between slow and fast types of muscle cells are significantly less in sheep compared to pigs, this being also observed in previous experiments by us (Lefaucher,

1986; Marinova, 1990). Dynamics of changing the size of fibres (without their separation in types) shows that by increasing the live weight from 25 to 30kg, average diameter of the cells in LD and SP is nearly unchanged, or it trends to increase, while in SM it trends to reduce. Evolution of single types of fibres between 25 and 30kg shows that on the decrease of differences in the values of average diameter, a main effect has the size of So fibres. Between 30 and 40kg, the size of So fibres increases, but whether this is due to compensatory processes or it is necessary to work on the greater mass of the animals -- it is hard to say. About the reduction of the size in some types of fibres, (Hawkins *et al.*, 1985) the causes remaining unclarified. Data about changing the size of Fog and FG -- with few exceptions -- are one-way. With increasing the pre-slaughtering weight, the size of these fibres increases too, the growth rate in LD and SP being higher during 25 to 30kg. At 40kg of pre-slaughtering weight, highest sized muscle cells have been established in all three metabolic types, their growth rate being reduced compared to preceding period, since the reading time is longer. Data obtained by us both in this and in our other investigations on sheep show that post-natal evolution concerns the size of all three types of muscle cells, there being no significant differences in their growth capacity until a certain live weight or age of animals (Marinova, 1993; Pinkas *et al.*, 1983; White *et al.*, 1978). Maintained differences in the size of the types of muscle cells and of 40kg of live weight do confirm the standpoint of Ashmore and Vigneron (1988) that there are limited maximum limits for the size of muscle cells in each genotype, type of muscle and type of fibres.

Proportion ratios of the types of fibres in LD and SM are close to all three pre-slaughtering weights (Table 1). Compared to them, m.SP is of more marked oxidative feature. With increasing the weight from 25 to 30kg, the part of So fibres decreases at LD ($P<0.01$) and SM ($P<0.001$). While at 30kg of live weight in LD, the part of FG fibres increases, at SP it remains unchanged. At 40kg of live weight in LD the part of So fibres remains unchanged, the increase of FG fibres being at the expense of those of FoG type. At SM, changes in the proportions of fibres are similar to those at LD, but the increase of FG type cells has been observed later, when reaching 40kg of weight. Content of So fibres in SP remains unchanged during post-natal study period, while the percentage of FG fibres significantly increases at 40kg of live weight ($P<0.05$). A similar increase in the part of FG fibres with increasing the weight or the age of sheep has been established by Hawkins *et al.* (1985), Ashmore and Vigneron (1988), Pinkas *et al.* (1983), Marinova (1993). According to data of Lacourt and Arnal (1974) for sheep, an increase in the intermuscular differentiation occurred between birth and 16 weeks and Hawkins *et al.* (1985) suggested differentiation of the types of muscle cells is observed near the period of compositional maturity in market lambs. According to Suzuki (1971) and Talmant *et al.* (1982) at transformation of FoG in FG fibres, glycolytic and oxidative activities decrease with increasing the age of sheep.

With increasing the pre-slaughtering weight an increase was established in the size of intramuscular and subcutaneous adipocytes, being of greatest diameter at 40kg of live weight (Table 2). Intramuscular adipocytes in SP have been of more accelerated growth during the whole study-period compared to those of LD and SM. Between 30 and 40kg of live weight, significant increases in the size of fat cells occurred in the LD only. Their slower growth in SM, according to Hawkins *et al.* (1985), seems to be connected with later physiological maturity of that muscle. Evolution observed by us concerning the growth and development of types of muscle cells in SM, in both this and in another study gives us reason for a similar standpoint too. Subcutaneous fat cells at the tail-base are of significantly greater size than intramuscular ones, these differences being maintained for the whole study period. Above 25kg of live weight, the size of fat cells increases, the difference being significant between 25 and 40kg only ($P<0.001$), because of large variability of the trait. A great variation in the diameter of adipocytes in calves was also reported by Robelin and Casteilla (1990), their distribution being close to Gauss's curve. According to the same authors, hyperplasia of fat cells would run in an earlier period-from birth until about 100kg. In a later post-natal period, the rate of adipocytes increases with a factor of about 30, while at the same time increasing factor of their number is about six.

Data obtained by slaughter analysis at 25, 30 and 40kg of pre-slaughtering weight show that higher content of fats in the carcass is due mainly to greater quantity of deposed subcutaneous adipose tissue, which increases significantly beyond 25kg of live weight (Table 2). The increasing size of adipocytes from subcutaneous tissue established in the same post-natal period gives us reason of accepting that with increasing the weight of animals, deposition of greater quantity of fats is due to hypertrophy of adipocytes. Similar results have been obtained by Vigneron *et al.* (1984) when studying adipose tissue and carcass characteristics in lambs. They reported that the rate of adipocyte growth is highly correlated with the weight of carcass and total quantity of separable fats but not to the number of adipocytes. From

results obtained in our previous investigations we have established once again that 84.08% of factors inducing variation in the quantity of deposed fats could be due to pre-slaughtering weight (Nedelchev *et al.*, 1980).

CONCLUSION

In post-natal evolution of muscle cells, differences have been established in growth capacity for single metabolic types of studied muscles. Higher growth intensity is characterized by both fast, oxidative glycolytic and fast glycolytic muscle fibres of *m.longissimus dorsi* and *m.supra spinosus* between 25 and 30kg and for *m.semimembranosus* between 30 and 40kg of pre-slaughtering weight. Proportion ratios of slow oxidative fibres significantly decreased in *m.longissimus dorsi* and *m.semimembranosus* until 30kg. Relative part of glycolytic fibres between 30 and 40kg increases through transformation of oxidative-glycolytic fibres, the differences being significant in *m.longissimus dorsi* and *m.supra spinatus*.

With increasing the pre-slaughtering weight, a hypertrophy was established for intramuscular fat cells, starting at higher weight of animals compared to that of subcutaneous fat cells and seems to be connected with decreasing of growth capacity in muscular cells.

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Table 1. Size and metabolic type of muscle fibres in *m.longissimus dorsi* and *m.semimembranosus*.

Pre-slaughter weight	25kg		30kg		40kg	
	dia. µm	type %	dia. µm	type %	dia. µm	type %
Muscle	X	X	X	X	X	X
LD						
So	31.42	3.50[c1]	30.07	9.50[a2]	33.91	9.50[b3]
FoG	33.58	65.00	34.56	66.00	34.61	63.50
FG	33.05	21.50	34.77	24.50	34.18	27.0[c3]
average	32.68		33.49		34.15	
SM						
So	32.05	15.5[c2]	31.15	12.0[a1]	32.57	12.80
FoG	35.08	64.25	34.79	67.40	35.89	63.60
FG	35.20	20.25	34.85	20.60	36.17	23.60
average	34.12		33.78		34.88	
SP						
So	33.40	29.25	34.12	29.00	35.48	29.10
FoG	34.67	57.6[c3]	35.69	57.2[b3]	35.51	43.2[c3]
FG	33.63	13.25	35.07	13.80	36.02	27.7[a3]
average	33.43		34.80		35.78	

Significant differences:

a = between 25kg and 30kg

b = between 30kg and 40kg

c = between 25kg and 40kg

1 $P<0.001$; 2 $P<0.01$; 3 $P<0.05$

Table 2. Size of the fat cells, μm, and some carcass characteristics.

Pre-slaughter weight	25 kg	30 kg	40 kg
intramuscular fat cells, μm			
LD	26.22	27.12	31.00
SM	28.19	30.34	31.83
SP	23.93	28.51	33.21
subcutaneous fat cells, μm			
tail-base	33.08	41.08	44.48
dressing percentage	41.74	42.28	40.96
muscle area of LD, sm	10.90	11.60	13.00
depth fat, sm tail-base area	0.62	1.13	1.65