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Study on the Type and Diameter of Muscle Fibres in Lambs of Some Breeds and Crosses

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The present work is aimed at testing some crossing schemes based on the widespread in this country Karakatchan and Merinofleisch sheep breeds, using prolific Romanov sheep and Il-de-France and Hampshire meat breeds.

Together with the fattening ability and carcass qualities which are reviewed in the first communication (under print), particular attention is paid in this study to the quality of production - meat of purbreds as well as of F_1 and F_2 crossbreds.

Animals and crossing scheme: The experiment was carried out in two successive years with a total of 65 male lambs according to the following scheme: purebred: - local Karakachan (K) - 10, Merinofleisch (MF) - 10, Romanov (R) - 5; F_1 Romanov x Karakatchan (R x K) - 10, F_1 Romanov x Merinofleisch (R x MF) - 10, F_2 Il-de-France (IF) x F_1 (R x MF) - 10, F_2 Hampshire (Hm) x F_1(R x MF) - 10.

The animals in each group (with the exception of purebred Romanov) were slaughtered at two stages depending on their live weight - at 25 and 35 kg.

Muscle analysis: Immediately after slaughter (20 min.) samples were taken from m.long.dorsi (m.l.d.) and m.supra spinatus (m.s.sp.), upon which, following deep freezing in liquid nitrogen, histochemical analyses were carried out to determine myofibrillar ATPases and succinodehydrogenase activities in successive sections made with a cryostat microtome, thickness 18-20 . On the basis of these histochemical analyses the percentage was determined of βR, αR and αW muscle fibres according to the classification of Ashmore (1974). At the same time the diameter of basic types of white (αW) and red (βR and αR) muscle fibres was measured.

Meat samples from the same muscles were taken 24 h post mortem for the following chemical and physicochemical analyses: pH_{24}; WBC - the percentage of exuded water from the total weight of the sample (300 mg) is determined; colour - reflectivity with a remissionary head piece at wave length 525 nm; myoglobin concentration in mg per gr tissue(Hornsey,1956) fat percentage - ether extract; collagen content (mg/g tissue) - by determining hydroxyproline using the method of Neuman and Logan (1950).

Results: Type and diameter of muscle fibres.
Data on relation between different types of muscle fibres and their diameter are shown in table 1. For technical reasons only the percentage of white fibres (αW) may be given for purebred Karakatchan lambs and crosses F_1(R x K) and F_1(R x MF).

While lambs of the Romanof breed have a significantly smaller percentage of red fibres (βR + αR), F_2 crosses with Il-de-France have considerably more βR ($P<0.01$) and less αW ($P<0.01$). F_2 crosses with Hapshire have more red fibres (βR + αR) at the expense of white fibres (αW). In other words the low percentage of red fibres in m.l.d as well as in m.s.sp. of Romanov lambs is to a great degree corrected in F_2 crosses with Il-de-France as well as with Hampshire. This phenomenon may be observed in 25 kg as well as in 35 kg live weight lambs. Data about MF lambs also show a favourable relation between white and red fibres, unlike purebred K and F_1(R x K and R x MF), in which αW fibres prevail in both investigated muscles at 25 as well as at 35 kg of live weight.

As for fibre diameter, one is impressed by the large size of fibres of both muscles in lambs of the Romanov breed at 25 kg live weight; besides, no difference exists between red and white fibre diameters. The same diameter is reached by fibres in F_2 crosses with Il-de-France, but at 35 kg live weight. It was found red fibres have smaller diameter than white ones in m.l.d. of animals at 25 kg live weight. To a certain extent this may be observed in m.s.sp. as well. But at 35 kg live weight these differences practically disappear in all groups but Karakatchan lambs, in which this difference of 3 μ is preserved in both muscles.

Meat quality characteristics: Data reflecting quality characteristics of meat in different groups are given in table 2.
In relation to pH_{24} no statistically significant differences were found. Only pH_{24} of m.s.sp. from Romanov lambs show a higher value (5.97). At the same time the colour of meat is a little darker, not beyond standart limits however. In the same lambs the meat of m.long.dorsi is still darker, with no differences, however, in pH_{24}, nor in pigment concentration. This may hardly be explained having in mind the circumstance that the animals suffered no stress precceeding slaughter.
The meat of F_2 crosses is darker than that of F_1 crosses, too. Probably this is also due to the influence of the Romanov breed, but why this phenomenon is not manifestated in F_1 crosses is inexplicable so far.
WBC of meat, expressed in %, is highest in lambs (25 kg) of the Romanov breeds. At 35 kg live weight an appreciable difference appears between the two types of F_2 crosses. Crosses with Il-de-France have a considerably lower WBC in m.l.d. as well as in m.s.sp.
Collagen content (mg/g tissue) was found to be significantly ($P<0.01$) greater in both

muscles of Romanov lambs; however this is not manifested in F_2 crosses. A tendency towards increasing collagen content as animals grow was observed and proved ($P < 0.05$) in m.s.sp. Such a tendency was not observed in m.long.dorsi.

Correlations: In studies with pigs Cassens and Coopes (1971), Anderson and Parrish (1972), Ashmore (1974) found definite correlations in the relation of types of muscle fibres and meat quality. In our studies)table 3) also certain correlations were set up with objective traits, characterizing meat quality, mainly pH, colour, WBC, which are at a relatively average level (0.3-0.4). Only the correlation of colour to αW fibres percentage is of the order of 0.63. These data confirm Ashmore's view-point (1974) that fibre type plays part not only in relation to quantity, but also in relation to lamb meat quality.

Discussion: The trend towards improving meat qualities of animals in swine and cattle leads to an increase of white - glycolitic type αW fibres (Ashmore and Robinson, 1969; Dildey et al, 1970). This in turn leads to an increase in stress-susceptibility (Ashmore, 1974). Karakatchan as well as Romanov lambs are primitive breeds with low meatiness , while MF lambs and F_2 crosses have markedly good qualities. However, in the first two breeds, created and reared under very primitive conditions, white αW fibre percentage is considerably higher. Nevertheless these breeds are very resistant to unfavourable conditions, including stress. It may be assumed that Ashmore's assertion (1974) that stress susceptibility in swine and cattle increases with increasing αW muscle fibre percentage, is not relevant to sheep. We even think that primitive rearing conditions have inflicted the increase of quick-contracting αW fibres, which correspondingly assure quicker response of animals under stress conditions.

It may be seen in this study that in cattle (Cornfoth and collegues, 1980; Spindler and coll., 1980) as well as in sheep the breed plays an essential part in interrelationship of different fibre types as well as in dynamics of their changes as animals grow; besides, a certain increase was established of the αW fibres percentage in m.long.dorsi, which confirms the data of Hende and coll.,(1972) and Moody (1980). But no similar phenomenon was observed in m.s.sp.

Studies on the diameter of red (βR + αR) and white fibres show that at 25 kg live weight some difference does exist, i.e. white fibres diameter is 2 to 3μ greater. Data on 35 kg live weight lambs however show that at this age the difference in the diameter of the two types of fibres practically disappears. Proceeding from our data and those of Valin and coll.,(1981) we reckon that with the growth of sheep, unlike cattle)Holmes and Ashmore, 1972) the difference in white and red fibre diameters gradually decreases, which suggests more intensive growth of red muscle fibres. In the Romanov breed no such difference was found even at 25 kg live weight.

The results of the present experiment show that the final F_2 crosses in the crossing schemes we used posses not only good meatiness (established in the first part of the work), but also good results in the interrelationship of different fibre types and meat quality.

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Table 1.Type and diameter of muscle fibers of m.long.dorsi and m.supraspinatus

Breeds and crosses	25 kg liveweight					35 kg liveweight				
	Type of fibers			diamet.of fibers		Type of fibers			diamet.of fibers	
	βR	αR	αW	βR+αR	αW	βR	αR	αW	βR+αR	αW
				m. long. dorsi						
K	-	-	39,28	38,86	42,33	-	-	45,46	36,73	39,29
MF	31,52	35,21	38,26	35,77	37,61	31,54	37,97	31,74	44,41	44,26
R	25,89	33,16	40,93	49,19	49,87	-	-	-	-	-
F_1(RxK)	-	-	36,56	37,79	41,18	-	-	39,18	39,34	40,42
F_1(RxMF)	-	-	41,70	30,93	32,05	-	-	46,17	35,12	36,42
F_2IFxF_1(RxMF)	33,45	32,07	34,46	40,24	42,51	28,80	34,33	36,16	49,21	49,09
F_2HmxF_1(RxMF)	31,02	35,42	33,85	35,43	37,24	31,21	33,72	35,08	38,96	39,41
				m. supraspinatus						
K	-	-	45,01	42,58	43,34	-	-	40,88	40,71	43,31
MF	26,96	41,06	31,98	37,27	39,94	24,29	44,53	30,62	53,48	51,62
R	24,54	35,37	40,11	52,10	52,34	-	-	-	-	-
F_1(RxK)	-	-	45,32	39,67	41,60	-	-	39,83	38,60	40,72
F_1(RxMF)	-	-	39,43	34,38	33,78	-	-	45,81	36,10	36,97
F_2IFxF_1(RxMF)	29,92	42,27	27,80	45,44	45,91	24,09	43,89	32,01	50,52	49,38
F_2HmxF_1(RxMF)	28,97	35,28	35,75	35,77	37,57	29,04	40,13	30,83	41,11	40,60

Table 2. Meat quality measurements

Breeds and crosses	25 kg liveweight						35 kg liveweight					
	pH	color	Mb	WBC	fat	collagen	pH	color	Mb	WBC	fat	collagen
					m. long. dorsi							
K	5,61	21,14	2,02	39,65	2,28	-	5,66	20,19	2,49	38,44	2,28	-
MF	5,62	18,55	1,56	40,73	1,90	4,13	5,58	17,05	2,00	41,91	2,53	4,37
R	5,49	16,22	2,07	37,60	2,34	5,37	-	-	-	-	-	-
F_1(RxK)	5,52	21,58	2,11	41,05	2,97	-	5,67	21,17	2,30	40,00	3,75	-
F_1(RxMF)	5,83	21,49	1,89	39,46	2,28	-	5,64	21,29	2,25	39,75	2,70	4,51
F_2IFxF_1(RxMF)	5,61	17,53	1,62	40,09	1,76	4,46	5,57	17,45	1,89	42,87	2,58	4,23
F_2HmxF_1(RxMF)	5,66	17,38	1,70	40,53	2,14	4,20	5,60	17,04	1,91	38,42	3,13	-
					m. supraspinatus							
K	5,71	22,40	2,01	36,98	2,68	-	5,75	21,90	2,52	36,31	2,72	6,39
MF	5,81	19,27	1,81	36,42	2,10	5,45	5,78	17,57	2,04	38,15	3,09	-
R	5,97	18,83	1,82	36,93	-	6,54	-	-	-	-	-	-
F_1(RxK)	5,71	23,00	2,15	35,11	2,99	-	5,78	22,83	2,10	37,64	3,21	-
F_1(RxMF)	5,89	22,82	1,90	34,69	2,46	-	5,79	22,76	1,94	37,13	3,05	7,20
F_2IFxF_1(RxMF)	5,79	19,00	1,73	35,89	2,32	5,38	5,85	19,19	2,03	38,18	3,40	6,93
F_2HmxF_1(RxMF)	5,82	18,25	1,83	35,31	2,35	5,41	5,78	18,18	2,07	34,36	3,28	

Table 3. Correlation between type of muscle fibers and objective traits of meat quality

Traits	m. long. dorsi			m. supraspinatus		
	ΣR	αR	αW	ΣR	αR	αW
pH_{24}	0,493^{xx}	0,328^{xx}	-0,142	0,166	0,215^{x}	-0,255^{x}
color	-0,325^{xx}	0,105	0,356^{xx}	0,190	-0,113	0,627^{xxx}
Mb	-0,019	0,343^{xx}	-0,056	0,054	0,163	-0,145
WBC	-0,189	-0,352^{xx}	0,173	-0,469^{xx}	0,336^{xx}	0,023
collagen	-0,287^{x}	0,025	0,354^{xx}	-0,171	0,135	0,069
fat	0,079	0,122	0,028	0,081	0,013	0,063
αR,%	-0,056	-	-	0,056	-	-
αW,%	-0,733^{xxx}	-0,234^{x}	-	-0,631^{xxx}	-0,653^{xxx}	-

x - P< 0,1; xx - P< 0,05; xxx - P<0,01.