RELATION OF FIBRE TYPES IN SIX LARGE MUSCLES OF PIG

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INTRODUCTION

Body muscles differ one from another in lenght, width, thickness, shape and mass, depending on their position and function. These differences are related to differences in physical characteristics and chemical composition. There are many data in literature about the chemical composition of muscle which prove these differences. It will be mentioned some of them determined by Rahelić and Rede (1969) between some characteristics in eight ham muscles: fat content in M.rectus femoris is 1,9%, in M.biceps femoris 3,2% and in M.semimembranosus 4,2%; content of connective tissue, as hydroxyproline, in M.semimembranosus is 0,37% and in M.gastrocnemius 0,80%. Similar data are quoted by Topel et al. (1966), Rejt et al. (1975) and others.

However, about the differences in relation of fibre types between muscles there are only few data. Rahelić and Puač (1980,a) found that number of red fibres in muscles is decreasing in relation to degree of selection of pigs, and number of white fibres is changing in opposite sense. Merkel (1971) determined by investigation of "normal" Mm.gluteus and rectus femoris in three of four breeds of pigs that there are more red fibres in first muscle than in second one. Rahelić and Puač (1980) found the smallest number of red fibres in M.semimembranosus, bigger in M.biceps femoris and the biggest in M.rectus femoris. The presence of these fibres in muscles expressed in percentage is as follows: 31,2; 42,8 and 54,4 in relation to total number of counted fibres.

Due to the differences in biochemical activity of different fibre types the characteristics of these fibres will be different. It is logical that these differences will result as the difference in technological properties of muscles in relation to content of different types of fibre in them. To provide some more knowledge about the quantity of these differences it was decided to examine the relation between types of fibres in six large muscles in pig carcass.

MATERIAL AND METHODS

Following six muscles from pig carcass have been histologically examined in this work: longissimus dorsi (LD), semimembranosus (SM), biceps femoris (pale and dark portions) (BF), gastrocnemius (Ga). rectus femoris (RF) and supraspinatus (SU).

Muscles were excised from 24 hr chilled carcass of Swedish Landrace pig, of about 100 kg live weight.

Samples for histological examination were cut to a size of 1 x 1 x 1 cm and immediately frozen by dipping in liquid nitrogen. After freezing they were cut with Cryo-cut-microtom, produced by the American Optical Co., at -20°C. Slices were 20 nm thick and were stained for succinodehydrogenesis according to Gerebtzoff method (1970).

Fibre thickness was determined by measuring their greatest and smallest diameter, expressed finally as mean value. Fibre types were determined by colour: red fibres are of dark blue colour, white of very light and intermediate of light blue.

Diameter and number of types of fibres were determined by examination of fibres in several primary bundles.

RESULTS AND DISCUSSION

Results of investigation of the relation of fibre types and diameter in mentioned six muscles are presented in Table 1. For more expressive demostration of fibre types in these muscles there are given six pictures of histological preparations from these muscles. One can see from these data that the least red fibres were found in muscle LD, i.e. 28,8%, and the percentage of them is increasing in muscles as follows: SM, BR, Ga, RF and SU. On the majority of microscopic fields on preparations from muscle SU were found only red fibres, but at some spots there are and white ones. The number of white fibres at these spots was not higher than 30%. On the contrary to the finding of red fibres, the white ones were found in the greatest number in muscle LD, i.e. in 62,1%, and the number was decreasing in muscles as follows: SM, BF, Ga, RF. White fibres were found in muscle SU only at some spots. This state can be obviously seen at Fig. from 1. to 6. The number of intermediate fibres varied from 7,6 to 17,9%.

As already mentioned, the types of fibre are not evenly distributed in muscles. Namely, at some spots on preparations from muscle SU there were present only red fibres, and at some were present and white fibres. Difference in number of type of fibres in the same muscle can be obviously seen from results obtained by examination of pale and dark portions of muscle BF (Table 1), because in pale portion there are for about 15% less red fibres than in dark one. Relation of white fibres between muscles is vice versa expressed.

Besides the difference in number of types of fibres in two portions of this muscle it is obviously seen at Fig. 3. and 3.a that all types fibre are, also, brighter in pale portion of muscle.

Red fibres are of the smallest diameter, intermediate are larger and white are of the largest. In the muscles with the largest number of white fibres (LD and SM) their diameter is the smallest (average thickness 83 and 86 nm), and larger is in those with smaller number of these fibres. The largest fibres diameter in muscle BF was 119 nm. It should be mentioned that the diameter of all types of fibre was expressively the largest in both portions of muscle BF, regarding to other muscles, and these white are, in average, thick even 113, and 119 nm respectively.

When analyzing the diameter of fibre types it should be pointed out that the thickness of some individual, especially white fibres, is significantly larger than average. In pale portion of muscle BF it was found white fibre of 185 nm in diameter, and in red one even 191 nm. The diameter of the thickest red fibre in pale portion of this muscle was 100 nm thick, and in dark portion 120 nm, while of intermediate type 133 nm.

If one compares the content of basical chemical compounds of these muscles (Table 2) to the relation of fibre types in them, it can be recognized only that muscle SU, with the largest number of red fibres, contains the largest quantity of fat (6,54%). However, the content of total pigments varies, in general, in correlation to the change of fibre types, because, in the muscles with low percentage of red fibres (LD, SM, BR) the total pigments content is expressively the lowest. Higher is in the muscles RF and Ga which contain more red fibres, and the highest is in the muscle SU in which there are almost only red fibres.

pH muscle increases, also, in correlation to increase of red fibres - from 6,2 in muscle LD to 6,7 in SM, excluding muscle BF with the highest pH 7,1. If one compares the results obtained by this investigation to findings quoted by Rahelić and Puač (1980), who investigated types fibre relation in muscles SM, BF and RF of the same breed of pig, one can see complete congruity, because in both examinations the number of red fibres increases parallelly in the same muscles. Findings cited by Merkel (1971) can be mentioned as a prove that exists the difference in quantity of fibre types between the muscles of the same animal.

The finding of giant cells is interesting. From data presented in Table 1. one sees thatthe largest number of these cells was found in muscle with the lowest percentage of red fibres (LD) and that the number of them is decreasing in muscles as the percentage of red fibres

Chemical composition and pH_{24} of six muscles

Table 2.

Muscles	Content (%)			Total pigments (ppm)	pH_{24}
	Water	Proteins	Fat		
Longissimus dorsi	74,94	21,91	1,88	39,44	6,20
Semimembranosus	75,64	21,75	2,16	53,04	6,55
Biceps femoris	75,74	18,87	2,52	65,96	7,10
Gastrocnemius	75,04	22,62	1,31	104,72	6,65
Rectus femoris	76,36	19,31	1,17	93,84	6,90
Supraspinatus	74,40	18,28	6,54	144,16	6,70

is increasing. Consequently, in dark portion of muscles BF and SU the giant cells were not found. It is evidently from presented results that these cells are of smaller diameter in muscles with higher number of them: of the smallest diameter are the giant cells in muscle LD and of expessively larger in muscles Ga and BF. In this last muscle the giant cells are 147 nm in diameter. However, the thickest giant cell thick 194 nm was found in muscle Ga. The diameter of the thickest cell in muscle BF was 165 nm and of the thinnest in muscle LD was 68 nm.

In previously mentioned work Rahelić and Puač (1980) found, also, that the number of giant cells is decreasing as the number of red fibres is increased: the highest number was found in muscle SM, lower in BF and the lowest in RF. The authors found in this work that the cells were of smaller diameter, but the diameter of fibres of all types was smaller, too, comparing to the results presented in this work.

Finding that the number of giant cells increases in muscles with lower number of red fibers, i.e. that is higher in white muscles than in red ones gives emphasis to presumption quoted by Cassens (1971) and by Cassens et al. (1975) that these cells apper more frequently in muscles in stress-susceptible pigs.

Literature

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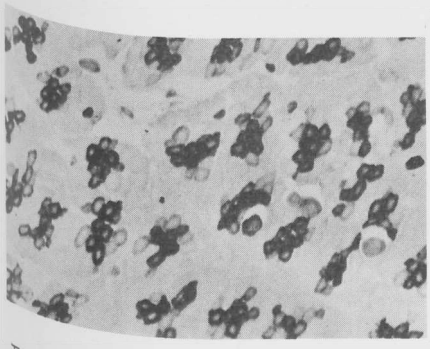

Fig. 1. Fibre types stained for SDH and giant cells in long.dorsi (x 60)

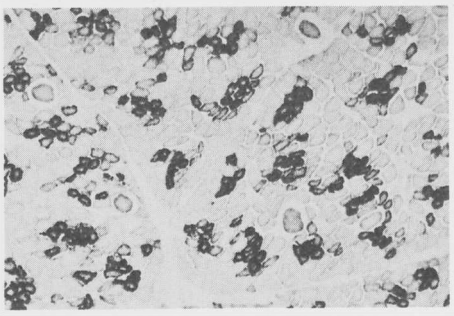

Fig. 2. Fibre types stained for SDH and giant cells in semimembranosus (x 60)

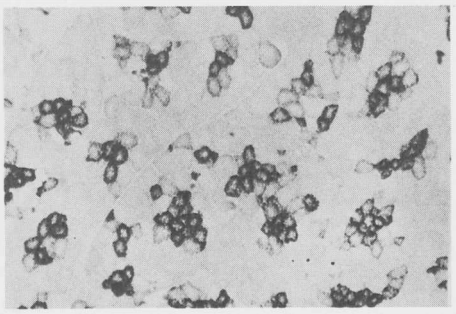

Fig. 3. Fibre types stained for SDH and giant cells in pale portion of biceps femoris (x 60)

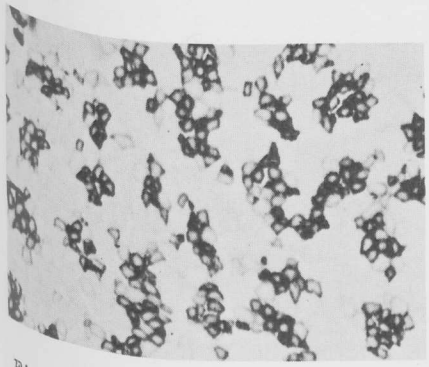

Fig. 4. Fibre types stained for SDH in dark portion of biceps femoris (x 60)

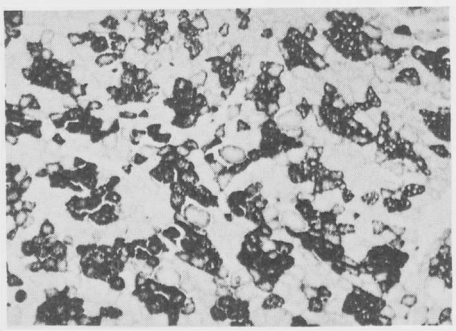

Fig. 5. Fibre types stained for SDH and giant cells in gastrocnemius (x 60)

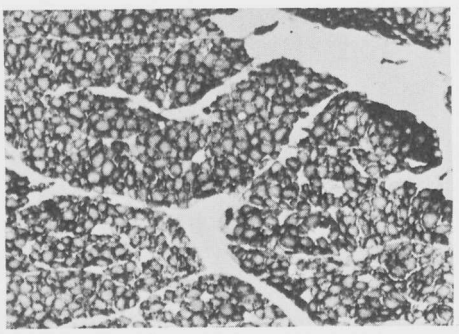

Fig. 6. Fibre types stained for SDH in supraspinatus (x 60)

Percentages and diameter of fibres types in six muscles

Table 1.

Muscles	Total number of fibres	Types of fibres: Red Percentage	Red Diameter (nm)	Intermediate Percentage	Intermediate Diameter (nm)	White Percentage	White Diameter (nm)	Giant cells++ Number	Giant cells++ Diameter (nm)
Longissimus dorsi	153	28,8	59	9,2	75	62,1	83	96	102
Semimembranosus	155	30,3	58	12,9	70	56,8	86	47	111
Biceps femoris pale portion	172	34,3	71	16,3	97	49,4	119	26	140
Biceps femoris dark portion	164	50,0	79	13,4	94	36,6	113	4	147
Gastrocnemius	145	44,8	61	7,6	84	47,6	87	17	135
Rectus femoris	177	47,0	65	17,9	84	35,1	104	-	-
Supraspinatus	175	100,0+	58					-	-

+Finding on more spots on preparations. On some other spots are found white fibres, but never more than 30%.

++These numbers were found on whole surface of preparation.