FIBER-TYPE DISTRIBUTION IN PORCINE MUSCLES

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SUMMARY

The purpose of this study was to determine the fiber-type distribution histologically with myosin-ATPase method of two porcine muscles the *M.adductor* and the *M.longissimus dorsi* and to compare the fiber-type distribution of individual pigs. A fiber-type classification of red, white and intermediate was used to determine the fiber-types. In this study 111 Finnish and 45 German pigs were used.

The *M.adductor* of Finnish pigs (N=111) contained an average percentage of 22.2<1454.7% red fibers, 11.7<1454.2% intermediate fibers and 66.1<1455.4% white fibers and of German pigs (N=45) 20.5<1454.9, 11.7<1455.0 and 67.8<1456.8%, respectively. The *M.longissimus dorsi* of Finnish pigs (N=98) contained an average percentage of 6.3<1454.1% red fibers, 13.9<1453.4% intermediate fibers and 79.8<1455.7% white fibers and the German pigs (N=26) 5.8<1452.5, 10.3<1453.3 and 83.9<1454.4%, respectively. The difference in fiber-type distribution between individual pigs was in this study more significant than the difference in fiber-type distribution between the pigs from the two countries.

INTRODUCTION

In the muscles there are at least three different fiber-types: red, white and intermediate. PSE-meat is found mostly in the most valuable parts of the carcass, in those parts where there are more glycolytic white fibers than red oxidative fibers (Bader 1982).

Pig breeding has enhanced meat producing capacity, but at the same time it has also produced a trend towards to PSE-meat. PSE-meat is pale, soft and exudative and its water binding capacity is weakened. The enhanced rate of glycogenolysis and glycolysis cause a rapid fall in pH-value, which together with the increase of the body temperature cause protein denaturation. When pigs are bred for the purpose of producing the greater amounts of meat, the amount of white fibers increases and the amount of red fibers decreases. So the larger diameter of white fibers is the reason for the increased amount of meat in the carcass (Bader 1981).

Pigs differ quite a lot from each other in post mortem metabolic rate. During stress only white fibers metabolize glycogen. Muscles with large proportion of white fibers are more sensible to PSE-meat than the muscles with large proportion of red fibers. The purpose of this study was to compare the fiber-type distribution between individual pigs, pigs from different parts of Finland and pigs from different countries.

MATERIALS AND METHODS

The study material used consisted of 111 Finnish pigs. Two Finnish areas were investigated. Samples were taken from 46 pigs in area one (South-Finland) and from 65 pigs in area two (Central-Finland). Puonti (1987 unpublished data) has pointed out that pigs from area two differ most from the pigs of other parts of Finland, as this area has its own genetic pool of pig material. The 46 German samples were collected from West Germany from Baden Würtenberg.

The samples for fiber-typing were taken from the *M.adductor* and the *M.longissimus dorsi*. The muscles were chosen from the parts of the carcass were PSE-meat is most frequently found. The samples were taken 25 - 35 minutes after slaughter. The sample was from the *M.adductor* taken from the part of the muscle which is to be seen after the carcass is cut in two along its long axis and from the *M.longissimus dorsi* of the 6th-7th vertebrae. The muscle samples were frozen in liquid nitrogen and stored in CO_2-ice until cut using a cryostat into 10 micrometer thick slices.

The pH1-value was measured from *M.longissimus dorsi* 45 minutes post mortem with a Knick portamess 651-meter (Knick Elektronische Messgeräte, BRD).

Table 1. Fiber-type distribution in **M. adductor** and **M. l. dorsi** of Finnish pigs, means, standard deviations (SD), range and the significant differences in the fiber-type distribution between the two areas.
Area 1=South-Finland, area 2=Central-Finland.

FIBER - TYPE	N	MEANS %	SD	RANGE %	SIGNIFICANT DIFFERENCES BETWEEN THE TWO AREAS
M.ADDUCTOR					
		AREA 1 + 2			
RED	111	22.2	4.7	6.3-38.5	
INTERMEDIATE	111	11.7	4.2	1.9-23.2	
WHITE	111	66.1	5.4	51.5-84.6	
		AREA 1			
RED	46	20.3	4.5	2.8-30.6	
INTERMEDIATE	46	12.3	3.7	4.3-20.7	
WHITE	46	67.4	5.8	48.6-87.4	
		AREA 2			
RED	65	23.6	4.6	12.2-38.5	1)***
INTERMEDIATE	65	11.2	4.5	1.9-22.5	2)*
WHITE	65	65.2	5.3	51.5-80.1	1)***
M.L.DORSI		AREA 1 + 2			
RED	98	6.3	4.1	0-19.2	
INTERMEDIATE	98	13.9	3.4	4.6-22.8	
WHITE	98	79.8	5.7	63.9-93.5	
		AREA 1			
RED	38	6.5	4.4	0.0-18.7	
INTERMEDIATE	38	13.4	3.4	4.6-22.2	
WHITE	38	80.1	5.7	66.9-93.5	
		AREA 2			
RED	60	6.1	4.0	0-19.2	3) N.S
INTERMEDIATE	60	14.3	3.4	6.4-22.8	2) *
WHITE	60	79.8	5.7	63.9-93.5	3) N.S

1) *** P<0.001
2) * P<0.05
3) N.S. NOT SIGNIFICANT

Table 2. Fiber-type distribution in the M. adductor and in M. l. dorsi of the German pigs.

FIBER-TYPE	N	MEANS %	SD	RANGE %	SIGNIFICANT DIFFERENCES BETWEEN THE TWO COUNTRIES
M. ADDUCTOR					
RED	45	20.5	4.9	8.3-33.9	2) ***
INTERMEDIATE	45	11.7	5.0	1.2-28.3	1) N.S.
WHITE	45	67.8	6.8	48.6-86.8	2) ***
M.L.DORSI					
RED	26	5.8	2.5	0.9-13.3	1) N.S.
INTERMEDIATE	26	10.3	3.3	3.0-19.7	2) ***
WHITE	26	83.9	4.4	73.6-92.6	2) ***

1) N.S. NOT SIGNIFICANT

2) *** p<0.001

Fiber-typing was made histologically using the myosin-ATPase method after alkaline preincubation (Szentkuti and Eggers 1985).

RESULTS

Finnish samples

The amount of red fibers in *M.adductor* ranged from 15 to 30% in 103 samples, that of intermediate fibers ranged from 5 to 20% in 103 samples and the amount of white fibers ranged from 60 to 75% in 94 samples out of a total of 111 samples. The amount of red fibers in *M.longissimus dorsi* ranged from 0 to 10% in 83 samples, that of intermediate fibers ranged from 10 to 20% in 86 samples and the amount of white fibers ranged from 65 to 85% in 94 samples out of a total of 98 samples (Table 1).

The pH1-values ranged from 5.33 to 6.10. There was a slight positive correlation for the *M.adductor* between the pH1-value and the amount of red fibers ($N=102$) $r=+0.12$ ($p<0.25$). This correlation was not found in the *M.longissimus dorsi* ($p>0.25$).

Differences in the fiber-type distribution between different areas of Finland

The *M.adductor* samples from area two contained significantly more ($p<0.001$) red fibers but significantly less ($p<0.05$) intermediate and white ($p<0.001$) fibers than the samples from the area one (Table 1). There were no significant difference in the *M.longissimus dorsi* between the two areas in the amounts of red and white fibers (Table 1). The samples from area two contained significantly more ($p<0.05$) intermediate fibers than the samples from area one.

German samples

The percentage of red fibers in the *M.adductor* ranged from 15 to 30% in 38 samples, the percentage of intermediate fibers ranged from 5 to 20% in 42 samples and the percentage of white fibers ranged from 60 to 75% in 38 samples out of the total of 45 samples. The percentage of red fibers in *M.longissimus dorsi* ranged from 0 to 10% in 25 samples, the percentage of intermediate fibers ranged from 5 to 15% in 23 samples and the percentage of white fibers ranged from 80 to 90% in 21 samples of the total of 26 samples (Table 2). The larger the percentage of red or intermediate or white fibers in the *M.adductor* the larger was that in *M.longissimus dorsi*. The correlation coefficients were $r_{red}=+0.34$ ($p<0.05$), $r_{intermediate}=+0.27$ ($p<0.10$) and $r_{white}=+0.45$ ($p<0.05$).

pH1-values ranged from 5.41 to 6.68. There was a positive correlation between the pH1-value and the amount of intermediate fibers both in the *M.adductor* ($N=45$) $r=+0.45$ ($p<0.001$) and in the *M.longissimus dorsi* ($N=26$) $r=+0.44$ ($p<0.05$). There was a negative correlation between the pH1-value and the amount of white fibers both in *M.adductor* $r=-0.30$ ($p<0.05$) and in *M.longissimus dorsi* $r=-0.42$ ($p<0.05$). There was also a slight positive correlation for the *M.longissimus dorsi* between the pH1-value and the amount of red fibers $r=+0.2$ ($p<0.25$). This was not found in *M. adductor*.

Differences in the fiber-type distribution between pigs from different countries

There were significantly more ($p<0.001$) red fibers in Finnish than in the German pigs. There were no significant difference in the percentage of intermediate fibers between pigs from the two countries for the M.adductor muscles. The difference in the amount of white fibers between the Finnish and German samples was significant ($p<0.001$).

There were significantly ($p<0.001$) less intermediate fibers in the M.l.dorsi of German than in the Finnish pigs. The difference in the amount of white fibers between the Finnish and the German samples was significant ($p<0.001$) (Table 2).

DISCUSSION

The fiber-type distribution has often been used to describe the metabolic character of a muscle. According to the literature the amount of red fibers in *M.longissimus dorsi* ranges from 2% (van den Hende 1972) to 30.2% (Swatland and Cassens 1973). The amount of white fibers ranges from 52.9% (Swatland and Cassens 1973) to 87% (Essen-Gustavsson and Fjelkner-Modig 1985). The amount of intermediate fibers ranges from about 5.6% (Miller et al. 1975) to about 22.5% (Schlegel 1982). The percentage values of the fibers in this research are between those values. The variations between individual pigs are large both in this research and in the literature. For example both the age and the breed of the animal have an effect on the fiber-type distribution. Different methods may give slightly different results. The most common breeds of pigs in Finland are Finnish Landrace or Yorkshire. This research has shown that Finnish pig material is homogeneous when fiber-type distribution is considered. The largest differences are between individual pigs.

The pH1-value has often been used as one of the measures of meat quality. When the pH1-value is less than 5.8 the meat is PSE-meat. Bader (1981) observed that in the *M.longissimus dorsi* the amount of white fibers increased as the diameter of a muscle increased with breeding for increased meat-yields. It was not observed in the Finnish samples that when the pH1-value in *M.longissimus dorsi* decreases the amount of white fibers in the muscle increases. This effect was found in the German samples. According to many researchers the pH1-value cannot be used to predict the properties of PSE-meat (Barton-Gade 1981). In addition to the pH1-value the values of the R-value, the Göfo-value and the activities of different glycolytic enzymes should also be measured. We used only the pH1-value as meat quality criterion. This may partly explain why no relationship between meat quality and fiber-type distribution was found.

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