INVESTIGATIONS ON THE STRUCTURE OF ABDOMINAL MUSCLES IN PIG

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SUMMARY

The paper examines the structural characteristics of the abdominal muscles. In two partial experiments 24 h post mortem samples were taken from the abdominal muscles and typified into STO, FTO and FTG fibres and the diameter was determined. The fisrt partial experiment includes the comparison of the structural characteristics of Mm. transversus adb., rectus a abd., obliqui internus and externus and cutaneus trunci. The cutaneous muscle with > 70 % of FTG fibres and signficantly smaller fibre diameters differs widely from the abdominal muscles indicating slight differences between each other. In the second experiment the comparison between M. rectus abd. and M. obliquus abd. externus brought about significant differences in respect of the fibre type profile and the diameters. A direct comparison with M. longissimus was impossible (sampling in vivi ; fibre typifying in "red", "intermediary", "white"). The simple comparison of the fibre type fractions suggests great differences concerning the portions of oxidative and lglycotitic fibres between M. longissimus and both abdominal muscles.

The comparison between halothan positive and negative reagents showed that at positive reaction Mm. rectus abd. and obliquus abd. externus tend to greater fibre diameters analogous to M. longissimus.

INTRODUCTION

Over the last years the question of quality of the abdomen in pig has been more and more in the limelight of scientific interest. With an increasing flesh part the proportion of muscle in the abdomen is growing overproportionally which so becomes a value determining part (BRANSCHEID et al., 1988). But besides flesh proportion the "abdomen quality" comprises also its state and the quality of fat. Whereas in literature data of the growth and composition of adbomen are given, they are lacking for the ultrastructure of muscles. For this reason it seems to be useful to investigate these problems. The structure of the musculature depends mainly from its function. The abdomen musculature forms a complex tenseness system representing so a constructive unit. First of all it has carrying and holding functions for the entrails, regulates the tonus of the abdominal wall and cares so for the adaptation to variations of pressure and volume (NICKEL et al., 1984 ; STARCK, 1982).

MATERIAL AND METHODS

The investigation is divided into two partial experiments. In the first experiment in 10 sows of 110 kg in weight 24 h post mortem samples were taken from the four abdominal muscles as well as the M. cutaneus trunci between the 12th/13th rib in order to determine the muscle structure. In the second experiment sample was carried out analogously from the m. transversus abd. and the M. obliquus abd. externus. This random sample comprised 40 animals of the genotypes German land race x German land race, German land race x pedigree pig, rotation hybride x Pietrain, German land race x Pietrain with 10 probands each. The animals were slaughtered on the 196th day of life. The types of halothan reaction, the logarithmiqcally taken values of creatinkinase (log CK) and the part of lean meat (MF %) are given.

Collaborators from the Dept. of Anatomy and Histology of Veterinary Medicine determined the types and diameters of mucles fibres of the abdominal muscles. It was done in the following steps :

1 - Preparation of frozen cuts (10-15 µm)
2 - Application of the acid cross combination according to ZIEGAN (1979) to differentiate the fibre types (NADH-Tetraciolium-reductase combinated with Myosin ATP-ase).
3 - Morphometric treatment of preparations by determining two orthogonal maximum diameters.

Every 200 fibres were evaluated.

The muscle fibres were divided into STO (slow twitch oxydative) , FTO (fast twitch oxydative) and FTG (fast twitch glycolitic) .

The samples were taken on the 180th day of life from the M. longissimus by the help of shot biopsy according to SCHÖBERLEIN (1976 1989) at the height of the 13th dorsal vertebra in living animals. The diameter and type of muscle fibres were determined at the Institue for Biology of Domestic Animals at Dummerstorf Rostock. It was carried out in three steps:

1. Preparation of frozen cuts (10-15 µm)
2. Detection of NADH-Tetraciolium-reductase (FIEDLER et al.1981)
3. Evaluation of the preparations by a semi-automatic muscle fibre analyzer.

The evaluation included 500 fibres of each preparation. A continuing description of the methods can be found in REHFELDT et al. (1987). The fibres types were divided into "red", "intermediary" and "white".

RESULTS AND DISCUSSION

In the first experiment the distribution of fibre type and the fibre diameter of abdominal muscles and the cutaneous muscle were analyzed.

The mean values were compared by the help of the U-test of MANN and WHITNEY because there was no normal distribution (Chi-Square-test). In Figure 1 these results are shown.

The cutaneous muscle differs considerably from the abdominal muscles in its composition. It consists in two thirds of FTB but only at 10 % of STO-fibres. The fibre diameters appear to be much smaller than in the other muscles under consideration. These structural characteristics permit the M. cutaneous trunci to have rapid short -time contractions for the movement of the skin in the abdominal and flank regions.

As to the abdominal muscles there seem to be some tendencies . The percental portions of the fibres are obviously quite similar and only the content of the STO-fibres in the M. transversus abd. is some more deviating. The fibre diameters appear more differentiated at a high variability of the values. It is highly probable that the Mm. obliqui abd. resemble each other more than the other both abdominal muscles. In tendency all three types of fibre of the M. transversus abd. showed the greatest diameter followed by M. rectus abd. and the Mm. obliqui abd. The relation of the muscle fibre types in the abdominal muscles is obviously conditioned by the combination of the respiratory functions, the maintenance of tonus and the trunc movement. Therefore these muscles are likewise able to work slowly and persistently as well as to contract rapidly and in short time. These observations were deepened in the second experiment by the Mm. rectus abd. and obliquus abd. externus . Because a normal distribution wasn't given again, the U-test by MANN and WHITNEY was used to compare the mean values. Table 1 shows the results of the comparaison between both muscles. The percental portions of the STO- and FTG-fibres differ widely in contrast to the first experiment.

	M. rectus abd.			M. obl. abd. externus		
	n	$\overline{x}$	s	n	$\overline{x}$	s
STO %	27	43.204	6.683	21	35.123	6.369 ***
FTO %	27	18.122	4.739	21	17.937	3.881 N.S.
FTG %	27	38.661	5.269	21	46.923	7.254 ***
STO $\overline{x}$	27	81.911	9.401	21	75.234	9.818 **
FTO $\overline{x}$	27	75.479	11.178	21	67.604	11.432 **
FTG $\overline{x}$	27	88.201	12.466	21	77.831	9.469 ***

** $P< 0.05$ *** $P < 0.01$
N.S. $P > 0.10$

Table 1 : Means ($\overline{x}$) and standard deviations (s) of the portions (%) and diameters (μm) of muscle fibres of the Mm rectus abd. and obliquus abd. externus.

At nearly same contents of FTO-fibres, the M. obliquus abd. externus has significantly more FTG- and less STO-fibres than the M. rectus abd. As it has already been indicated in the first experiment, the diameters of the muscle fibre types differ between M. rectus abd.the investigated muscles. The fibres of M. rectus abd. are much thicker. Concerning the structural results, secured differences between M. rectus abd. and M. obliquus abd. externus could be proved by these random samples.

A direct comparaison between the structural characteristics of the abdominal muscles and the M. longissimus is not possible by this data material, because different procedures were used for sampling and fibre typifying. But it is tried to compare some characteristics. Figure 2 shows the structural characteristics of M. longissimus and both abdominal muscles. The greatest difference between M. longissimus dorsi and Mm. rectus abd. and obliquus abd. externus appears in the dstribution of fibre types. Whereas in M. longissimus two thirds of the muscles consist of white fibres and only 10 % are red, the proportions of STO- and FTG-fibres of the examined abdominal muscles are relatively balanced. The fibre diameters can't be compared because the abdominal muscles were taken 24 h post mortem and the muscle fibres were exposed to a shrinking process in contrast to the samples of M. longissimus taken in vivo (ACKERMANN 1990).

The comparaison between animals with genetic predisposition to stress sensitivity and insufficient meat quality and strees stable probands lead to analogous results in the three examined muscles. Figure 3 shows the mean values and standard deviations of structure characteristics for halothan positive and negative probands. Concerning the fibre distribution no significant differences between the reaction types could be found contrary to M. longissimus where the contents of white fibres are differing. The M. rectus abd. shows a thickening of fibres in halothan positive reagents which are partially statistically secured. In tendency the same applies also to M. obliquus abd. externus but due to the low number of animals no significance could be achieved. For M. longissimus a corresponding result was determined. In this random sampling the halothan positive reagents have clearly greater diameters in red and intermediate fibres than the negative ones.

In literature the connection between the changes in muscle fibre structure and genetic disposition to stress sensitivity and deficiencies in meat quality has been described for the M. longissimus already in the seventies (ASHMORE et al. 1972, 1974; KALLWEIT et al. 1978; WENIGER et al. 1975). The present investigation indicates that also the muscles in the ventral region tend towards changes in structure. Analogous to M. longissimus (WICKE 1989; ACKERMANN 1990), M. rectus abd. and obliquus abd. externus tend towards greater fibre diameters if there is a positive halothan reaction.

The correlation between the log CK value and the fibre structure was also examined. In contrast to M. longissimus, the correlations for Mm. rectus abd. and M. obliquus abd. externus are only between indifferent and poor.

In the present investigation significantly increasing CK-activities could be found for M. longissimus with rising diameters of the red and intermediary fibre (corresponding to WICKE 1989). For both of the abdominal muscles this relation could not be found although there was the tendency towards increasing fibre diameters with halothan positive reactions.

CONCLUSION

The structure of the abdominal muscles was examined by two random samples. The following results can be summarized.

1. Appearing differences between the abdominal muscles could be confirmed in respect of M. rectus abd. and obliquus abd. externus. The cutaneous muscle is clearly deviating in it's structure from the abdominal muscles.

2. Concerning the distribution of fibre types clear differences are indicated between M. longissimus and both of the abdominal muscles. However, a direct comparaison with corresponding sampling and fibre typifying is recommended.

3. In halothan positive reagents the Mm. rectus abd. and obliquus abd. externus tend toward a thickening of the fibre diameters analogous to the M. longissimus. A continuation with an increased volume of random samples seems to be necessary in order to confirm these tendencies.

There is no connection between the log CK-value and the structure of the abdominal muscles.

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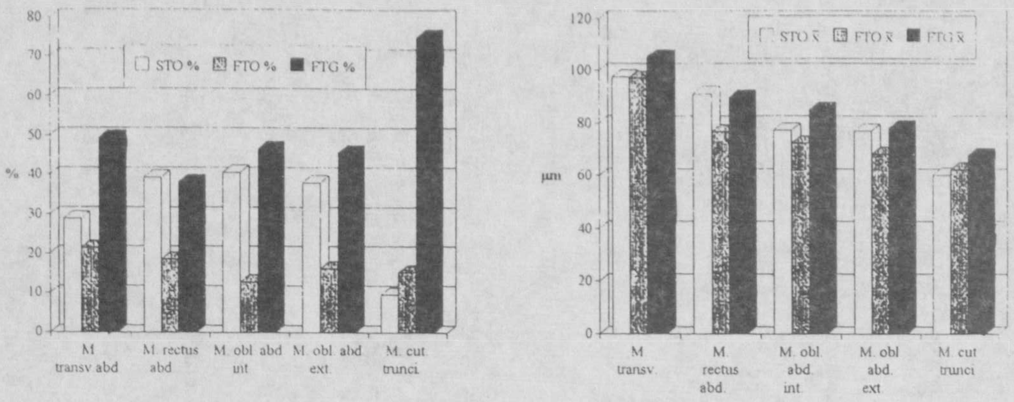
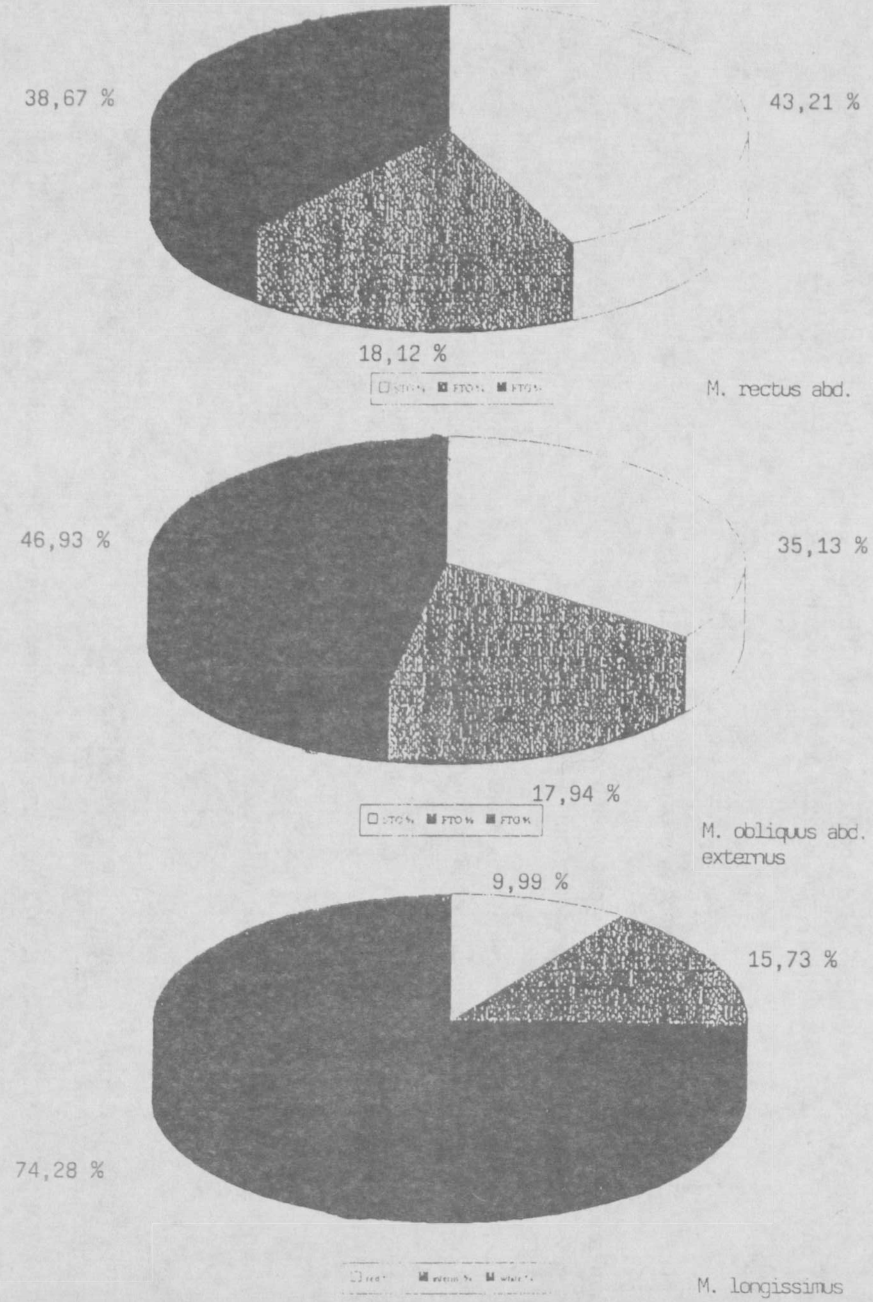


Fig. 1: Fibre type portions (%) and fibre diameters (µm) of the abdominal muscles and M. cutaneus trunci (n=8)



Fibre type portions (%) of the M. rectus abd. (n=27), M. obliquus abd. externus (n=21) and M. longissimus (n=30)

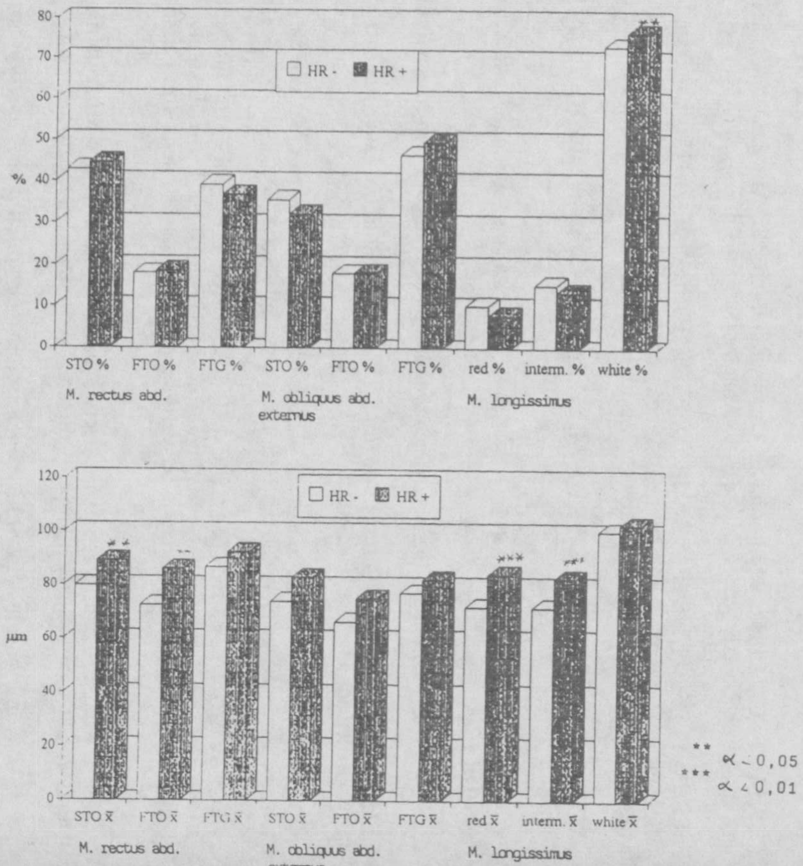


Fig. 3: Fibre type portions (%) and diameters (µm) of the