RELATIONSHIPS BETWEEN OCCURRENCE OF HISTOPATHOLOGICAL MUSCLE FIBRES AND MEAT QUALITY IN PIGS OF A BREEDING STATION

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Key words: pig, meat quality, carcass composition, Longissimus muscle, fibre traits, breeding

Background and objective

Breeding programmes for pigs to maximise growth rate and to realize high meat content are associated with problems in muscle and skeleton of animals. The genetic relationship between muscle growth, stress susceptibility and the proportion of large white muscle fibres in ham and back muscles results in a contrary selection, which favours the more economically attractive characteristics. Sudden death as a result of lactacidosis and cardiac shock and poor meat quality are signs of myopathy. In musculature of some breeds this phenomen is shown in increased fibre sizes, high frequencies of glycolytic fibre types, and/or in occurrence of fibres, which are abnormal in shape and function (Fiedler et al., 1999; Walasik et al., 2000). It is desirable, that scientists, pig breeders, and veterinarians work together to recognize the causes of abnormalities in muscle and to develop practical methods for the improvement of resistance to disease and for a good meat quality. The objective of this study was to investigate the carcass composition, meat quality, and fibre characteristics in *Longissimus* muscle of five breeds of a breeding station in Northern Germany with special notice to histopathological changes.

Material and methods

Animals

A total of 598 pigs of the following breeds were investigated: Leicoma (n=110), Large White (n=174), Landrace (n=204), Duroc (n=14), and MHS negative Piétrain (n=96). The animals were kept and fattened in the breeding station of Jürgenstorf, Mecklenburg-Vorpommern. At a live weight of 105 kg they were transported to the slaughterhouse of Dummerstorf (50 km) and slaughtered after resting time.

Histological analyses

Samples were taken from *Longissimus* muscle 24 h *post mortem* at the $13^{th}/14^{th}$ rib and quickly frozen in liquid nitrogen. Fibre cross-sections were cut with a cryostat microtome (12 µm; – 20°C) and were stained with hematoxyline and eosine dye (Fiedler and Branscheid, 1998). Quantitative microscopic data were determined by counting the numbers of normal and giant muscle fibres per cm^2 and by measuring cross-sections of 400 fibres per animal with a semi-automatic image analyzer Quantimet 570 (IBSB, Berlin). Taking account of the special structure of muscle, primary bundles were randomly selected over the slides and completely analyzed.

Meat quality

The pH values of *Longissimus* muscle were measured at $13^{th}/14^{th}$ rib with a pH Star electrode (Matthäus, Pöttmes, Germany) 45 min *post mortem*. In the same region conductivity was measured 24 h *p. m.* described by Kuhn et al. (1997). Drip loss was determined by weighing of a 50 g muscle sample before and after storage at 4°C for 24 h. The muscle area was determined manually by planimetry.

Statistics

Results are expressed as means and standard divisions. Significant differences between Piétrain and other breeds were tested by the Student's *t*-test ($p<0.05$).

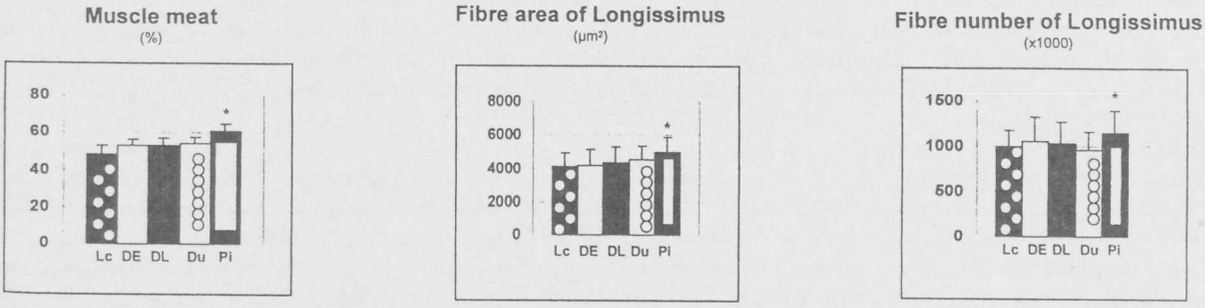
Results and discussion

The carcass composition and meat quality of the breeds are documented in Tab. 1. In muscle meat percentage and *Longissimus* area the Leicoma realized the lowest and the Piétrain the highest values. Between the other breeds no significant differences were found. The Leicoma was characterized by the biggest back fat thickness whereas that of the Piétrain was lowest. The data of meat quality showed that Leicoma and Duroc had the best meat quality, whereas the high meatiness of Piétrain was related with low pH value, high drip loss, and high conductivity. This result confirms the negative correlation between meatiness and meat quality found in earlier experiments (Kuhn et al., 1993; Larzul et al., 1997). The results of the fibre analysis are shown in Fig. 1. Similar to the meatiness the same ranking order was found from Leicoma to Piétrain. The *Longissimus* muscle area in Leicoma was build by a little number of fibres with a low cross-sectional area while the muscle area in Piétrain was the result of high numbers of fibres accompanied with big fibre cross sections. Earlier results have shown a positive correlation between total muscle fibre number and meat quality (Wicke et al., 1998; Rehfeldt et al, 1999). The fibre analysis of the breeds (Fig. 1) showed that in Piétrain the positive effect of a high fibre number on meat quality was not expressed. Probably, here the big fibre size plays a more important role than the fibre number. The numbers of giant fibres per muscle are shown in Tab. 1. In Leicoma, Large White, and Landrace pigs only a little number was found. This frequencies are is normally in pig *Longissimus* (Handel and Stickland, 1986; Wegner et al., 1992). Clear differences to other breeds were found in Duroc and Piétrain but the highest value was counted in Piétrain. The high frequency of giant fibres was accompanied with low pH value, high drip loss, and high conductivity. The same relationship was found by comparing the Schwerfurter and Piétrain breeds (Rehfeldt et al., 1995). The typical forms of histopathologically changed fibres in *Longissimus* muscle are "angular fibres" and "giant fibres". Cross-sections of giant fibres are conspicuous because their oval or round shape. They are hyper-contracted and also they can be pathological changed with intracellular disruptions (Sosnicki, 1987). While the angular fibres can be observed in biopsy and carcass samples, the giant fibres only to find *post mortem*. In biopsy samples of *Longissimus* muscle of breeds the following frequencies of angular fibres were determined: Hampshire: 0.40%, Duroc: 0.46 %, Landrace: 0.50 %, Settle pig: 0.63 %, and Piétrain: 0.52% (Fiedler and Wicke, unpubl.). Giant fibres were also found in pigs carrying the halothane gene (Essen-Gustavsson et al., 1994). Their muscles had lower glycogen, ATP, and CP concentration and higher IMP and lactate concentration than the halothane negative pigs.

Tab. 1. Carcass composition, meat quality, and giant fibres

Genotype	Muscle meat (%)		Longissimus area (cm²)		Back fat (cm)		pH_{45} value		Drip loss (%)		Conductivity (mS / cm)		Giant fibre number (per muscle)	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Leicoma	48,4	4,8	39,0	5,2	2,7	0,4	6,3	0,3	3,2	1,6	3,2	1,1	620	1557
Large White	52,6	3,5	41,9	4,9	2,4	0,3	6,2	0,3	3,5	1,9	3,9	1,7	617	1293
Landrace	53,1	4,1	42,6	5,9	2,2	0,3	6,2	0,3	3,5	1,8	3,4	1,4	636	1339
Duroc	54,3	3,1	41,0	5,0	2,2	0,3	6,3	0,3	2,2	1,2	3,4	1,2	1250	3110
Piétrain	60,7	3,8	55,3	7,0	1,9	0,3	5,9	0,3	4,1	2,1	5,3	2,4	2529	4312

Fig. 1. Comparison of the breeds



*significantly to the other breeds ($p \leq 0,05$)

Lc Leicoma DE Large White DL Landrace Du Duroc Pi Piétrain

Conclusions

- Fibre traits of *Longissimus* muscle can indicate breed related differences in meatiness and meat quality. The analysis of fibre size and total fibre number represent different kinds of muscle growth and meat quality.
- Giant fibres and angular fibres are important factors affecting the meat quality. High *post mortem* frequencies (>0.5 %) are correlated with low pH values, high drip loss, and high conductivity indicating a poor meat quality.
- Frequency of giant fibres in *Longissimus* muscle of pigs from breeding station kept under practical conditions is not higher than frequency in pigs from experimental station kept under more defined conditions.

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Acknowledgement

The authors thank Mrs Erika Nagel for her excellent technical assistance.