Relationship between stuctural traits of longissimus muscle, MHS-genotype and meat quality in pig

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Background

The stress susceptibility of pig is generally accepted as the genetic basis for the development of deviations in meat quality (PSE meat). The underlying physiological mechanism is thought to be based on dysregulations of several functional systems, especially the skeletal muscle cells. Therefore, structural traits of the skeletal muscle are of growing interest as potential selection criteria for the improvement of meat quality. Since the structure of the muscle influences its function as well as its mass a selection for improved meat quality under consideration of the reverse impact of this selection on lean meat content seems to be feasible.

Objectives

The objectives of this study were

- to investigate the potential relationship between microstructural parameters in live pigs and the post-mortem meat quality
- to test the cross relationship between stress susceptibility (MHS genotype) muscle structure and meat quality.

Methods

Biosy samples were taken at 2nd/3rd last rib of *M. longissimus* of 136 crossbred sows and barrows (Schwerfurter Fleischrasse * Pietrain) at a liveweight of 90 kg (age about 177 d). All pigs were slaughtered at a live weight of 104 kg. The muscle samples were immediately frozen in liquid nitrogen for further analysis. Twelve µm thick freezer cuts across fibre direction were made and the enzymes diaphorase and ATPase were determined histochemically for fiber type differentiation. The percentage and the mean diameter of the different fibre types (STO=slow-twitch oxidative; FTO=fast-twitch oxidative; FTG=fast-twitch glycolytic) were determined with a semi-automatic video image analysis system. According to the method of FUJII et al (1991) the MHS genotypes were determined and the pigs were assigned to the groups NN=homozygous negative, Nn=heterozygous negative and nn= homozygous positve. The pH and the electric conductivity (EC) was measured in M. longissimus 120 min post mortem. The limits for the classification of PSE meat were pH < 5.7 and EC > 4.5. The data were analyzed with the GLM procedure of SAS (SAS Institute, 1987).

Results and discussion

In pigs with the MHS genotype „nn“ the lean meat percentage is increased and the meat quality is inferior to the „NN“ and „Nn“ genotypes, respectively (table 1). There were no differences in daily gain between all genotypes. In intramuscular fat content only „nn“ genotypes differed significantly from the others. MHS-heterozygotes take an intermediate position in meat quality traits be-tween the respective homozygous genotypes.

Homozygous stress susceptible pigs have an increased diameter of all fiber types and a lower percentage of STO fibers compared to their homozygous counterparts. Interestingly, heterozygotes do not differ in structural traits from „nn“-pigs (table 2).

Pigs developing PSE meat condition after slaughter have a generally increased fiber diameter independently from their MHS genotype in comparison with pigs with normal meat quality (table 3). No differences were found in fiber type composition in this respect. This indicates that the metabolic alterations which lead to PSE meat are due to the increased fiber diameters rather than to changes in the composition of the muscle. Obviously, thick fibers loose their ability to respond in a physiological way to the stress at slaughter.

As shown in figure 1 in most cases a high lean meat percentage is realized by fiber hypertrophy accompanied by inferior meat quality indicated by the low pH values of the muscle. However, the data points in the lower right of the diagram represent pigs which combine low fiber diameters with high pH values and acceptable lean meat percentage. This points out the general possibility of a breeding selection towards this desirable combination.

Conclusions

- There are significant differences in structural traits of the skeletal muscle between pigs with different MHS genotypes as well as with different meat quality.
- On the basis of a selection for correlation breakers the combination of high lean meat yield with good meat quality seems to be possible.

Table1: Fattening performance, carcass composition and meat quality in pigs with different MHS-genotypes

parameter	MHS - genotype					
	NN (n=22)		Nn (n=64)		nn (n=50)	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
average daily gain (g)	776.7	66.6	789.8	97.4	796.2	89.9
meat percentage (%)	49.9[a]	3.3	52.8[b]	3.3	57.0[c]	4.5
pH_1	6.43[a]	.43	5.91[b]	.39	5.58[c]	.32
EC_1 (mS/cm)	3.37[a]	.62	4.29[ab]	2.29	15.49[b]	9.61
IMF (%)	2.1[a]	.8	2.0[a]	.9	1.6[b]	0.5

different superscripts: significant at $p < .05$

Table 2: Structural traits of M. longissimus in pigs with different MHS genotypes

parameter		MHS-genotype					
		NN		Nn		nn	
		$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
(%)	STO	12.0[a]	3.5	10.9[ab]	3.5	9.9[b]	3.2
	FTO	15.1[ab]	4.8	14.7[a]	3.4	16.3[b]	4.3
	FTG	66.1	8.4	68.9	7.1	67.9	6.1
(µm)	STO	60.2[a]	6.8	69.3[b]	11.4	72.7[b]	10.0
	FTO	61.6[a]	10.2	73.1[b]	13.3	75.6[b]	10.5
	FTG	81.2[a]	9.0	93.2[b]	12.1	92.7[b]	11.0
	total	74.2[a]	8.7	85.8[b]	10.3	86.3[b]	10.2

different superscripts: significant at $p < .05$

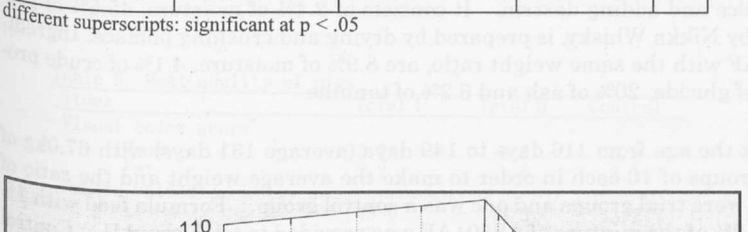

Figure 1: Relationship between fiber diameter, lean meat percentage and meat quality

Table 3: Muscle structure of pigs with normal and PSE meat

parameter		meat quality			
		normal (n=98)		PSE (n=38)	
		$\bar{x}$	s	$\bar{x}$	s
meat percentage (%)		52.1[a]	3.4	57.4[b]	4.5
(%)	STO	11.0[a]	3.4	10.1[a]	3.4
	FTO	14.9[a]	3.7	16.2[a]	4.2
	FTG	68.4[a]	8.4	67.4[a]	5.7
(µm)	STO	65.7[a]	9.5	73.5[b]	9.0
	FTO	68.5[a]	12.0	77.2[b]	9.8
	FTG	88.6[a]	11.8	94.6[b]	10.1
	total	81.4[a]	10.4	87.9[b]	9.4

different superscripts: significant at $p < .05$

Literature

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