THE INFLUENCE OF SLAUGHTER WEIGHT AND SEX ON THE MUSCLE FIBERS FORMATION IN PIGS

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Abstract

Muscle fiber characteristics can vary considerably in different muscle types depending on their function. There are many factors influencing the muscle fiber characteristics, such as the age, breed, hormones, sex, etc.

The aim of this study is to assess the effects of slaughter weight and sex on the muscle fibers characteristics in pigs. The study included a total amount of 216 pigs. After their slaughter the slaughter weight, lean meat share and the following muscle fibers characteristics were determined: the area, diameter, perimeter and circularity. All animals were divided into 3 groups (W1, W2, W3) according to their slaughter weight. The groups were characterised based on the carcass weight as W1 = 75.0kg, W2 = 87.4kg and W3 = 99.4 kg.

The observed lean meat share was higher in the gilts than in the barrows and this difference increased with increasing carcass weight. Regarding the muscle fiber characteristics, in both barrows and gilts the monitored parameters (area, diameter, perimeter, circularity) increased with increasing carcass weight. Concerning lower slaughter weights the monitored fiber area and diameter were higher in barrows. With increased carcass weight there was a significant difference in the area and diameter parameters between gilts and barrows, with gilts reaching higher values. Generally speaking the higher the lean meat share in animals, the higher the expected muscle fiber areas.

Key Words: Pig, rapeseed, food technology, muscle fiber

Skeletal muscle of farm animals is the most important part of the meat and forms the principal raw material obtained from their bodies (Bottinelli, Reggiano, 2000). The main morphological and functional unit of a striated skeletal muscle is a muscle fiber that is developmentally created by a fusion of a large number of muscle cells. Muscle fiber characteristics can vary considerably depending on the type and function of the muscle tissue (Klont et al., 1998). In addition, there are many other factors that can affect the muscle fiber characteristics, such as the sex (Ozawa et al., 2000), age (Candek-Potokar, et al., 1998), breed (Ryu et al., 2008) and hormones (Florin and al., 1996). Many published studies describe the effects of the sex of the animal on the carcass composition. Regarding this finding, the works of Ozawa et al.(2000) confirm a significant effect of the sex on the amount and size of the muscle fibers. One of the current opinions is that the differences in the number of muscle fibers between male and female pigs may be a result of a different hormonal activity (Rehfeldt et al., 2004). In the case of castrated males (barrows) the muscle fiber diameter is smaller, while in non-castrated animals the fiber diameters are higher (Miller et al., 1993).

Another important factor influencing the animal carcass composition is the slaughter weight. As the carcass weight increases, the carcass value and the proportion of meat and fatty parts change as well (Bee et al., 2007). The sex and slaughter weight also influence the diameter and number of muscle fibers in the MLLT muscle. The aim of this study is to assess the effects of slaughter weight and sex on the muscle fiber characteristics in pigs.

Materials and Methods

A total amount of 216 hybrid pigs was used for the needs of this study, out of which 144 pigs were of genotype PNx (LW_D xL) and 72 pigs of genotype (PNxLW_S) x(LW_D xL). They were fed *ad libitum* according to the published standards, with the use of complete feed mixtures (CFM) and continuous transitions. Animals were slaughtered after achieving an average live weight of about 107 kg. The slaughter analysis was performed on the following day. For each animal the right carcass half weight (kg) and lean meat share (% FOM) were determined.

The basic characteristics of the muscle fibers were determined with the use of the MLLT (*m.longissimus lumborum et thoracis*) muscle sample, of the size 5x5x20mm. All samples were frozen by submerging in liquid nitrogen and preceding their analysis they were all kept at a temperature of -80°C. The analysis process consisted of obtaining 10 μm thick slices of cross-cut muscle fibers.

To determine the muscle fiber cutting area (μm^2) and average muscle fiber diameter (μm) as well as the number of muscle fibers per 0.5 mm^2 (muscle area), a sample coloring according to Brooke and Keiser (1970) was used.

In order to assess the influence of weight and sex, all animals were divided into 2 separate sex groups - barrows (B) and gilts (G). For assessing the influence of live weight, the light, moderate and heavy pigs were selected according to the carcass weight. From the selected animals, 3 weight classes were then determined. The first weight

group (W1) contained animals with carcass weight below 80 kg, the second (W2) with weight between 85.1-90 kg and the third group (W3) contained animals weighing 95.1 kg and above.

The ascertained data were processed by customary mathematical and statistical methods (SAS 9.1, 2006) and expressed in a tabular array. As the fixed variables in the statistical processing the effects of sex and slaughter weight were used. The data in the tables are presented as least square means (LSM) and standard errors of the mean (SEM).

Results and Discussion

The obtained data concerning slaughter characteristics are presented in Table 1. As it is shown, the carcass weight in groups W1, W2 and W3 was 73.6, 87.8 and 99.9 kg in barrows, 76.3, 86.9 and 98.9 kg in gilts. Barrows compared to gilts showed a 2.8 kg lower carcass weight in the W1 group, a 0.8 kg higher weight in the W2 group and a 0.9 kg higher weight in the group W3. As shown in Table 1, the differences between the barrows and gilts were not statistically significant.

Regarding the lean meat share in the carcass, this parameter decreases with increasing carcass weight (descending from group W1 to group W3). In barrows the observed decrease was uniform throughout the whole weight range. The decrease in the W2 group as compared to the W1 group was smaller by 0.7%, while in the group W3 the decrease was 2.0% smaller when compared to the W1 group. The highest proportion of muscle (58.1%) was demonstrated in the class W2 in gilts, where the decrease of 1.2% was demonstrated only between the groups W3 and W2.

The subject of the carcass value parameters changing with increasing body weight was also studied by HOVORKA (1987). His work confirmed improved carcass body composition in gilts as opposed to barrows. The change in body composition, depending on the age, is described by STUPKA et al. (2009). They confirmed that the changes characteristic for different life periods are of unequal intensity. Regarding the muscle fibers characteristics, the monitored parameters (area, diameter, perimeter, circularity) increased with increasing carcass weight in both barrows and gilts. However the observed increase was not the same for all of the monitored parameters.

The highest increase in muscle fiber area was found in the group W1 (4486 μm²) and W3 (5158 μm²) barrows. In gilts these areas were 4419 μm² in the group W1 and 5630 μm² in the group W3. The increase in fiber area was higher than 15% in barrows, while in gilts the number reached up to 27%. Less significant increase was observed in the fiber diameter parameter, where in barrows the diameter increased by 6% and in gilts by 14%. The muscle fiber perimeter increased by 11% in both sexes. The smallest changes were observed in the circularity parameter, which increased 5% in barrows and 3% in gilts.

When comparing the muscle fibers characteristics in barrows and gilts of the same slaughter weight, there are obvious significant differences. At the lowest carcass weight the muscle area in gilts is insignificantly lower than in barrows (4419 μm² vs. 4486 μm²). This trend however changes with increased slaughter weight. The muscle fiber area in gilts of the W2 group is higher by about 250 μm² (5%) while in gilts of the W3 group the area increases by 472 μm² (9%). This finding may be connected to the carcass lean meat share. While the gilts in the W1 group show insignificantly higher lean meat share (by 0.16%), the gilts in W2 and W3 groups, respectively, show an increase of 1.7 and 1.79%. This corresponds with the fact that higher muscle fiber area has been observed in animals with higher lean meat share.

Table 1. Characteristics of the carcass and muscle fibers

	Barrows (B)			Gilts (G)			SEM
	W1	W2	W3	W1	W2	W3	
	LSM	LSM	LSM	LSM	LSM	LSM	
Carcass weight (kg)	73.58	87.80	99.90	76.34	86.95	98.95	0.52
Lean meat (%)	57.09	56.41	55.08	57.25	58.09	56.86	0.33
Area	4486	4834	5158	4419	5083	5630	76
EqDiameter	73.15	75.51	77.66	71.82	77.10	81.74	0.62
Perimeter	252.47	272.64	280.76	266.88	280.33	295.22	3.22
Circularity	0.74	0.77	0.78	0.75	0.76	0.77	0.004

OZAWA et al. (2000) demonstrated that with regards to the muscle fiber characteristics there are certain differences between the sexes. CANDEK - POTOKAR et al. (1998) found similar trends while describing the effects of age, where with increasing age of the animal the muscle fiber areas increased as well. Significant intersexual differences in adult animals were also demonstrated by BOTTINELLI REGGIANO (2000). The works of MILLER et al. (1993) showed that the muscle fiber diameter in castrated males is demonstrably smaller than in non castrated animals, where there was also a higher lean meat share demonstrated. The above mentioned conclusions, together with our own results, could be summarized to state that the higher the lean meat share, the higher the expected muscle fiber area and diameter. Insignificant differences between the sexes were observed in the following parameters: fiber circularity (-0.01 to +0.01μm) and diameter (-1.3 to +4.1 μm).

Conclusion

The results confirmed that the carcass composition of barrows and gilts differs depending on the carcass weight. Regarding lean meat share, better quality of carcass composition was demonstrated in gilts. This difference between sexes increased with increasing carcass weight.

Concerning the muscle fiber characteristics, we managed to confirm increased parameter values (area, diameter, perimeter, circularity) with increasing carcass weight of both the barrows and gilts. This trend however was not linear. In lower slaughter weight cathegories the muscle fiber area as well as the diameter were greater in barrows than in gilts. With increasing carcass weight there was a significant increase in the differences between barrows and gilts, with gilts reaching higher parameter (fiber area and perimeter) values. This trend could be explained by a different carcass composition, where the gilts show lesser decrease in lean meat share with increasing weight and therefore when compared with barrows of the same weight, the lean meat share demonstrated in gilts is higher. Animals with higher lean meat share also display higher muscle fiber areas.

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