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Quality of meat in purebred pigs involved in crossbreeding schemes. I. Chemical composition and quality characteristics of *m. Longissimus thoracis*

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Abstract

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The aim of the work was comparison of the chemical composition and some quality characteristics (pH, color and water-holding capacity) of *m. Longissimus thoracis* (*m. LT*) in pigs of Landrace, Pietrain, Large White and Duroc breeds. The differences between the four breeds concerning the studied traits were assessed through one-way ANOVA. The results showed that Durocs had the highest content of intramuscular fat in *m. LT*, while the meat of Pietrain and Large White was the leanest. Furthermore, the content of moisture was higher in Pietrain and Landrace, in comparison to Duroc and Large White. The quantity of ash was the highest in Duroc. The quality characteristics of *m. LT* – pH 45 min, pH 24 h, water-holding capacity (WHC) and color were within the optimal limits and did not show deviations from the parameters, characterizing the "normal" meat.

Keywords: pork; breeds; physicochemical composition

Introduction

The term "meat" includes all the parts of the animal carcass, fresh or processed that are suitable to be consumed. In a narrow sense, this term refers to the muscles of the slaughter animals, including connective tissue components, intra- and intermuscular fat, blood vessels, lymph nodes, nerves and bones (Pipek, 1995; Bartoň et al., 2012).

Pork consumption is related to the consumer's satisfaction and hence it is stimulated by the high quality of the meat (Bryhni et al., 2003). According to Lee et al. (2012), the consumer's perception is a complex combination of visual atraction and the satisfaction of eating. No uniform definition about the high quality of meat exists in the available literature. The meat quality is a combination of subjective and objective measurements that differ mong the various markets. The colour, pH, WHC, firmness and marbling are the most often used traits related to pork quality (PIC, 2003). According to Hambrecht (2004), the healthy and ethic qualities could as well be so important as the technological and sensory characteristics of the meat. All of them form a certain part of the "meat quality" involving hygiene, toxicology, nutrition and sensory parameters (Hullberg, 2004).

The growth of the pigs, the carcass composition, meat quality and the quality of the processed meat products depend on a wide range of factors and their interactions – genotype (genetic background, unfavourable alleles of HAL and RN2), rearing conditions (level of nutrition, pens, microclimate, production system), pre-slaughter treatment and carcass processing (Geverink et al., 1999; De Jong et al., 2000; Klont et al., 2001; Monin, 2003; Terlouw, 2005). According to Klimas and Klimienė (2001) and Jukna et al. (2003), sig-

nificant influence on the meat quality can be attributed to the breed, individual characteristics of the animals, rearing and nutrition, the ability to use their genetic potential at maximum level for production of competitive products. Hence the aim of the present work was to study the quality traits of meat in four pig breeds participating in the crossbreeding schemes for production of high quality meat.

Material and Methods

The study was carried out in the pig farm Golyamo Vranovo Invest AD with a total of 24 gilts divided into four groups according the breed: Landrace (n = 6), Pietrain (n = 6), Duroc (n = 6) and Large White (n = 6). During the finishing period the animals were reared according to the instructions described in the Regulation 21/14.12.2005 concerning the minimum requirements for protection and welfare for pig breeding. The animals were provided feed and water *ad libitum*. Two phase feeding was applied, as the first phase was in the period 40-80 kg, while the second phase was from 80 kg until slaughter. The diet composition is presented in Table 1. After slaughtering of the pigs, their carcasses were skinned. The carcass weight was as follows: Landrace – 83.39 kg (SEM 0.55), Pietrain 84.06 (SEM 0.89), Duroc 84.06 (SEM 0.89) and Large White 84.84 (SEM 0.76). Samples for analysis of the physico-chemical composition were taken from *m. LT* at the last rib of the left side of each carcass. The parameters analyzed included: pH1 45min *post mortem*, pH2 24h *post mortem* (measured by Hanna HI 8814), fat content (Soxhlet), protein (Kjieldal), moisture and ash. The water-holding capacity (WHC) of the meat was determined according to the method of Grau and Hamm (1952), the meat colour was measured by spectrocolorimeter "Spekol" at λ = 525 nm (Pinkas, 1981). For detection of eventual deviations in the pH, caused by stress we used the method of Warriss (2000) as presented in Table 2.

Table 1. Diet composition

Components	Finisher I phase	Finisher II phase
Corn, %	21.00	18.00
Barley, %	23.30	23.40
Wheat , %	19.00	23.00
Soy meal , %	15.00	16.00
Sunflower expeller, %	18.00	16.00
Soy oil, %	2.40	2.40
Limestone, %	0.50	0.50
Panto Mix 3148 finisher, %	0.20	0.20
Hostazim + Optiphos, %	0.10	0.10
Lysine, %	0.20	0.20
Salt, %	0.30	0.20
Total	100.00	100.00
ME, kcal	3424	3432
Crude protein, %	19.052	18.89
Crude fibers, **%**	5.37	5.14
Fat, **%**	5.93	5.77
Lysine, %	1.07	1.08
Methyonine, %	0.34	0.33
Methyonine + Cysteine, %	0.65	0.64
Trpiptophane, g	0.31	0.30
Ca, **%**	0.48	0.48
P, **%**	0.60	0.59

Table 2. PH values of *m. Longissimus thoracis* for PSE, normal and DFD meat (Warriss, 2000)

Category	pH 45 min	pH 24 h
PSE	<5.8	<5.3
Normal	5.8-6.4	5.3-6.0
DFD	>6.4	>6.0

The data were statistically evaluated by one way ANOVA. In case of significance, Tukey post hoc comparisons were applied. The statistical procedures were performed using the JMP v. 7 software package.

Results and Discussion

The initial and ultimate pH is an index for the degree of protein denaturation in the fresh pork. The values of pH 45 and pH 24 (Table 3) did not show deviations from the "normal" meat according to Warriss (2000). The ultimate pH is the main factor affecting the pork quality in the early post-slaughter period (Offer et al., 1991). Li et al. (2013) found significantly higher ultimate pH in Durocs (5.71) when compared to Landrace (5.61) and Yorkshire (5.62). On the other hand, when studying Landrace gilts, Ryu et al. (2008) reported lower that ours values of pH 45min – 5.8 and pH 24h – 5.49. In line with our results concerning Duroc breed, Choi et al. (2014) reported pH 24h – 5.73. Some scientists determine considerably higher pH 45 min (Jeleniková et al., 2008) and pH 24h (Gjerlaug-Enger et al., 2010; Li et al., 2013) in the muscles of pure Durocs when compared to nonpigmented breeds. Permentier et al. (2013) concluded that the use of Pietrain as a sire breed in the crossbreeding schemes improved the carcass quality, however the quality o the meat could be deteriorated, especially in the European countries where the market value of the pig carcasses is based on the weight and the lean meat content.

Table 3. Physico-chemical composition and quality characteristics of *m. Longissimus thoracis*

Item	Landrace	Pietrain	Duroc	Large White	SEM	Sig.
pH 45 min	6.18	6.24	6.24	6.17	0.02	NS
pH 24 h	5.85	5.84	5.87	5.87	0.01	NS
WHC	30.61	30.93	29.83	30.82	0.78	NS
Colour/525nm	22.98	23.09	22.37	20.08	0.47	0.07
Fat, %	2.23ab	2.22ab	2.81b	1.70a	0.12	**
Protein,%	22.23	21.68	23.20	23.80	0.38	NS
Moisture,%	74.49	75.09	72.83	73.83	0.40	NS
Ash,%	1.04	1.01	1.16	1.12	0.02	NS

** $P < 0.01$; Means connected with different letters are significantly different ($P < 0.05$)

Pork can be classified as normal or abnormal (pale, soft, exudative or dark, firm, dry) according to the pH. This parameter is related to the rest of the quality traits such as colour and WHC (Brewer et al., 2001). In the Large White gilts, the reflectance was 3.01% lower in comparison to the Pietrains, however no significance was detected. No significant differences in regard to the meat colour existed between the other two breeds of the study. Close and within the normal range are the WHC values as well.

In chemical aspect, meat consists of four main components – water, proteins, lipids and minerals. Furthermore, it contains vitamins, enzymes, pigments and aromatic compounds (Jukna et al., 2013).

The intramuscular fat and protein contribute the most to the energy value of the meat. Many authors report that the energy in meat increases with the increase of the fat content (Fernandez et al., 2000; Fortin et al., 2005; Purslow, 2005; Jukna et al., 2007). Fats also affect directly the flavour of the meat (Shi-Zheng & Su-Mei, 2009). According to Wood et al. (2008), in modern breeds as a result of the selection towards higher lean meat percentage, the fact content decreases drastically to <1%. The increase of the lean meat percent leads to pathological changes in the microstructure of *m. Longissimus lumborum*, which can deteriorate the pork quality (Wojtysiak, 2012). For acceptable flavour of pork, it is recommended the fat content to vary within the range of 2-4% (Verbeke et al., 1999). Fernandez et al. (2000) recommend 2.5-3.5% fats in pork. According to Obadálek (1999) the total content of intramuscular fat should be between 1.6 and 2%, as below this limit, the culinary value of the meat worsens considerably. Ingr (2005) stated, that fat content below 2% diminish the juiciness of the pork which is unfavourable both visually and from a culinary point of view. The high levels of intramuscular fat lead to increased cooking loss (Cannata et al., 2010).

The breed significant effect on the intramuscular fat content of *m. LT* ($P < 0.01$), as Duroc gilts was higher than the other breeds. This indicates that the participation of Duroc in the crossbreeding schemes should be favorable for the phenotypic display of this trait. This was also concluded by Põldvere et al. (2015). According to Wood et al. (2008) the easiest way for optimizing the level of the intramuscular fat is to use Duroc into the crossbreeding schemes. The high content of intramuscular fat in *m. LT* in Duroc breed was reported by Franco et al. (2014) and Choi et al. (2014). When compared to Large White, the intramuscular fats in Landrace and Pietrain are higher, respectively by 0.53 and 0.52%. The moisture content is higher in the Pietrain and Landrace, in comparison to Duroc and Large White, the differences were not significant. The protein content is the highest in the Large White and Duroc.

The results of the work so far show that breed is one of the major factors affecting the variation in the quality characteristics of the pork. The results of Lee et al. (2012) and Ryu et al. (2008) show that the carcass and meat quality in pigs have been considerably determined by the breed of the animals.

Conclusions

The quality characteristics of the meat in the examined breeds did not deviate from the parameters of the "normal" meat.

The fattened Duroc pigs exhibited higher levels of intramuscular fat in *m. Longissimus thoracis* when compared to the Landrace, Pietrain and Large White.

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