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Boar taint and meat quality characteristics of entire male and castrated male pigs

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Abstract. *The aim of the present research was to study the chemical composition, technological traits and intensity of boar taint of meat in entire male (EM) and surgically castrated male (CM) pigs. The study included 46 male pigs, cross F_1 (Landrace x Danube White), fattened to average live weight 90 kg. In terms of chemical composition, the higher water and lipid content of the meat of entire male pigs, compared to the meat of surgically castrated male pigs was not statistically significant. A significant difference in the meat's technological traits - pH values, water-holding capacity, cooking losses and tenderness between the two groups of male animals ware not found. The influence of the factor "castration" was reported in trait marbling of meat ($p<0.001$). There were statistically significant differences in the values of L*, b* and Hue angle, defining the color characteristics of the meat.*

Keywords: water-holding capacity, chemical composition, technological traits, pH, color, tenderness

Abbreviations: EM - entire male pig; CM - (surgically) castrated male pig; LTL - *m. Longissimus thoracis et lumborum*; WHC - water holding capacity.

Introduction

In pig farms in Bulgaria entire male pigs (EM) are reared mainly for producing male animals included in the systems for production of purebred breeding pigs and for pork production. The main reason to avoid their fattening is the presence of boar taint, which is negatively perceived by the pork consumers (Squires and Bonneau, 2014). Their rearing also has its advantages - higher protein content in meat and more lean carcasses (Bañón et al., 2004); better feed-conversion ratio (Pauly et al., 2009); more intense growth than castrated, etc. The meat of EM is with better pH values, compared to castrated ones (Boler et al., 2014) and with a lower incidence of pale, soft and exudative meat (PSE) and dark, firm and dry meat (DFD) (Guárdia et al., 2005); higher water-holding capacity (WHC) of the meat (Miyahara et al., 2004), etc. All these positive aspects have been imposed in recent years in industrial pig farming to increasingly implement the system for fattening of EM and seek solutions to prevent the occurrence of unpleasant boar taint in the meat.

However, the issue of the main problems in the rearing of EM remains, namely the presence of an unpleasant boar taint in the meat (Patterson, 1968; Vold, 1970; Squires and Bonneau, 2014) and their aggressive behavior during rearing (Zamaratskaia and Rasmussen, 2015). This necessitates a more detailed study of the mechanism of formation of unpleasant boar taint, the factors influencing its manifestation, as well as the physico-chemical properties and technological traits of the meat in EM. Therefore, we aimed to compare the chemical composition, technological traits and incidence of boar taint between entire male and castrated male pigs and to report the results how castration influences these meat qualities.

Material and methods

The study was conducted between September 2016 and May 2017. The research included 46 male pigs – entire male (n=27) and surgically castrated male (n=19) pigs, cross F_1 (Landrace x Danube White). Animals were reared under the same nutrition and housing conditions up to a live weight of 90kg during 150-160 days. The *m. Longissimus thoracis et lumborum* (LTL) was sampled for proximate analysis, and evaluation of technological and organoleptic traits. In the slaughter of pigs, all requirements of Regulation No. 22 (2005) on reduction to minimum the suffering of animals during slaughter were observed.

The pH values at 45th min (pH1) and 24th h (pH_2) post mortem were determined with a pH-meter "Testo 205". Detection of boar taint was done by a trained evaluator who smelled heated fat tissue (on neck, back and chest) by the so-called hot iron method (Aluwé et al., 2012). The boar taint was evaluated at four-level scale: „0" - lack of boar taint (odourless); "1" - weak perceptible boar taint; "2" - perceptible (pronounced) boar taint and "3" - strong (offensive) boar taint.

Chemical composition, WHC, cooking losses during baking, marbling, tenderness and color of the meat were determined at the 24th hour post mortem in the Laboratory of the "Meat and Meat Products" at the Department of Morphology, Physiology and Animal nutrition, Faculty of Agriculture, Trakia University - Stara Zagora.

The content of water, protein, lipids, ash and dry matter were determined by chemical analysis (Bulgarian State Standard - BSS 5712: 1974, BSS 8549: 1992, BSS 9373: 1980, BSS 9374: 1982). The WHC muscle was determined by the method of Zahariev and Pinkas (1979). Thermal cooking losses were determined by roasting the meat samples at 150°C

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for 20 min. Meat marbling was evaluated on *m. Longissimus thoracis et lumborum* (LTL) according to the standard of the National Pork Producers Council, USA (NPPC, 1999). One point of the NPPC score corresponded to 1% intramuscular fat content.

The color of LTL was determined by the system CIE L*a*b*. For this purpose, a "Minolta CR-400" colorimetry by Konica Minolta (Osaka, Japan) was used, using a D_{65} illumination and a 2° observation angle. The angle of Hue (tinge of meat) was determined by the formula Hue°=tg-1(b*/a*), and the chroma (C*) of the meat was calculated by the formula $C^*=\sqrt{(a^{*2}+b^{*2})}$.

The method of penetration was used to measure meat tenderness (Ribarski et al., 2017). For this purpose, a penetrometer "PA" (VEB Feinmess Dresden, Germany) was used, equipped with a needle (12.5g) for penetration. The tenderness values were reported in penetrant degrees (°P).

All data were processed by IBM SPSS Statistics 20.0.

Results and discussion

Chemical composition of meat from EM and CM pigs

Table 1 presents the results obtained in the chemical analysis of LTL in EM and CM with an average live weight of 90kg.

From the data shown in the table it is evident that statistically significant differences in chemical composition between the two groups of male pigs were not detected. The higher water content (74.40%) and lipids (1.56%) in EM compared to CM (73.79% and 1.37%) was not statistically significant. With regard to protein, mineral and dry matter content in the examined muscle, CM outweighed the EM but not significantly, 23.74% versus 23.00% for proteins, 1.10% versus 1.04% for mineral substances and 26.21% versus 25.60% for dry matter, respectively.

The results obtained for the water content corresponded to the data of Andersson et al. (1997) and Stoykov and Dragoeva (2002), which found significantly higher content of water in TLT in EM. With regard to the protein and lipid content, the results obtained by us differ from those reported for a higher protein content (Andersson et al., 1997) and a lower lipid content (Zamaratskaia and Rasmussen, 2015) in EM compared to the castrated.

Technological traits of meat from EM and CM pigs

Table 2 shows the results for the mean pH_1 and pH_2 values of LTL in the two groups of male pigs from the crossbreed studied. The observed differences in the mean values of pH1 between the two groups were minimal and statistically not significant, respectively, 6.33 for EM and 6.48 for CM. The established values are close to the results of Stoykov and Dragoeva (2002) and Boler et al. (2014), which found that young EM had lower pH values at 45min compared to CM.

The pH values of the meat during the first postmortem minutes are an indicator characterizing the quality of pork meat and a sign for the incidence of PSE-meat. Within the total number of surveyed 27 EM and 19 CM, the percentage of PSE meat in both groups was equal - 12.50%. In our opinion, castration does not affect the appearance of this meat disadvantage (PSE-meat), which is close to the findings of Van der Wal et al. (1999), that under the same stress or lack of one, the difference between groups of male animals was not observed.

The main factors affecting the incidence of PSW-meat in both groups, in our view was due to short term stress to which they were subjected during transportation to the slaughterhouse, the short rest before slaughter (less than 4 hours) and the inhumane treatment of pigs by workers at the slaughterhouse (Warriss, 2000).

At the 24th hour post mortem, the mean pH values for both groups of male pigs were within the range of 5.4. Other authors have reported similar pH values in pork studies (Stoykov and Dragoeva, 2002; Nakev et al., 2015). The reported pH2 values give us reason to assume that in both groups of pigs there is no dark firm dry meat (DFD). According to a large number of authors, the cases of DFD-meat among the pigs are very rare (Adzitey and Nurul, 2011). Babol and Squires (1995) noted that the portion of DFD-meat in EM was higher compared to CM, due to the long-term stress of the animals and increased aggression during transporting them to the slaughterhouse, lack of feed when prolonging the time for their preparation to slaughter, etc.

Table 3 presents the technological traits of the meat in EM and CM. With regard to values of WHC of LTL, the difference between the two groups of male pigs was not statistically significant, 23.44% for EM and 19.96 for CM, respectively. The results for WHC of meat obtained by us in both groups were lower compared to these reported by Stoykov and Dragoeva (2002), Slanev et al. (2006), Petrov and Nakev (2009) in studying meat of different categories and groups of pigs. They found an average of over 30% of the water-holding capacity of the meat.

The results obtained do not correspond with the statements of Miyahara et al. (2004) that EM have a better WHC of meat than CM. On the other hand, Warriss and Brown (1985) and Lundström et al. (1987), in a study of the same muscle, did not find significant differences in this trait between the groups of male pigs.

The data in Table 3 shows that cooking losses of LTL were in the range of 36.20% for EM to 36.52% for CM. Compared to other authors (Stoykov and Dragoeva, 2002, Nakev et al., 2015), the cooking losses reported in our study were lower, which in our opinion was probably due to the different methods used in their determination.

A significantly higher content ($P<0.001$) of intramuscular lipids in the examined muscle in EM (1.61%) was found against CM (1.00%). Taking into account the limit of 2% intramuscular fat established by Bejerholm and Barton-Gode (1986), we can assume that meat from EM will be better accepted by consumers than CM. Our results for marbling of meat from EM differ from the published data of Gispert et al. (2010) and Elsbernd et al. (2016) for a lower degree of marbling in EM compared to CM.

Analyzing the data of meat's tenderness, there was a statistically not significant difference for more tender meat in EM (377.41°P) in comparison with the CM (363.64°P). The obtained data differs from the one reported by Squires and

Bonneau (2014) that the meat of CM has better tenderness than EM. In our opinion, the higher tenderness was due to the higher lipid content found by us and, therefore, higher marbling of the meat in EM.

With regard to color characteristics of the meat (Table 3) a significant difference in the brightness of the meat (L*) between the two groups was observed, 51.68 in EM and 54.00 in CM, respectively. In the a* values statistically significant differences were not found. Differences between the b* values of CM (7.19) and EM (4.88) were reported. A significant difference was also found at the Hue angle, which in the EM was lower (0.68) than the CM (0.82). In meat saturation (C*), significant differences were not established.

From the results obtained for the color of the meat of the EM and CM studied by us, we can conclude, that statistically significant differences for L* and b* reported by us were approaching the data of Gispert et al. (2010) and Boler et al. (2014), which found influence of the castration on these two traits characterizing the color of meat. On the other hand, the values obtained for a* differ from the findings of Miyahara et al. (2004) that the meat of EM had higher a* values and, therefore, more red color of the meat. Jeong et al. (2008) also reported significant differences in the values of a* between the two groups of male pigs.

Incidence and intensity of boar taint

Table 4 presents the results of manifestation of unpleasant boar taint of meat in both studied groups of male pigs, evaluated by a four-point system. From the results obtained, it is obvious, that 51.85% of EM showed boar taint in different degree, which we believe is a quite serious percentage of manifestation. Stoykov and Dragoeva (2002) reported the presence of boar taint an average from 8 to 16% in EM, and Zamaratskaia (2004) and Squires and Bonneau (2014) an average of 10-15%. This should be taken into account if pork producers have intention to fatten EM from the crosses F1 Landras x Danube White.

Expressed in scores, the unpleasant boar taint in EM had the following characteristics: 50% of pigs with boar taint had score 1, 35.71% had score 2, and 14.29% with the strongest and most compulsive boar taint had score 3. Only 31.58% of CM had an unpleasant boar taint and 100% of them had score 1. This confirms the finding by Aluwe et al. (2012) that even in CM a small degree of unpleasant boar taint was reported. It should be noted that very often the establishment of an unpleasant odor in this group of male pigs is not always associated with the boar taint but is due to poor rearing hygiene, carcass contamination, etc. The "degree of qualification" of the evaluators of this unpleasant boar taint also influences, which gives grounds to introduce training of specialists evaluating this particular quality of meat.

Conclusion

Summarizing the results obtained for the chemical composition of the meat of EM and CM, it can be underlined, that the castration of male pigs has no significant effect on it. The lower content of water and lipids in the meat of EM in com-

Table 1. Chemical composition of *m. Longissimus thoracis et lumborum* from entire (EM) and castrated (CM) male pigs, 24 hours post mortem

Rates	Group male pigs	
	EM (n=11)	CM (n=9)
Water, %	74.40±0.27	73.79±0.32
Protein, %	23.00±0.37	23.74±0.33
Lipids, %	1.56±0.23	1.37±0.16
Ash, %	1.04±0.08	1.10±0.11
Dry matter, %	25.60±0.27	26.21±0.32

Table 2. pH values of *m. Longissimus thoracis et lumborum* from entire (EM) and castrated (CM) male pigs

pH values	Parameters	Group male pigs	
		EM	CM
pH_1	n	27	19
	mean±SE	6.33±0.09	6.48±0.08
	PSE meat, %	12.50	12.50
pH_2	n	19	9
	mean±SE	5.47±0.04	5.46±0.05
	DFD meat, %	0.00	0.00

Table 3. Technological traits of *m. Longissimus thoracis et lumborum* from entire (EM) and castrated (CM) male pigs, 24 hours post mortem

Technological quality trait	Group male pigs	
	EM (n=18)	CM (n=10)
WHC, %	23.44±1.22	19.96±1.15
Cooking loss, %	36.20±1.03	36.52±1.84
Marbling, %	1.61±0.12***	1.00±0.01***
Tenderness, °P	377.41±10.48	363.64±13.65
Colour:	(n=8)	(n=8)
L*	51.68±0.71*	54.00±0.65*
a*	5.99±0.62	6.76±0.56
b*	4.88±0.61**	7.19±0.51**
Hue°	0.68±0.02***	0.82±0.01***
C*	7.73±0.87	9.88±0.75

Significance: * - p<0,05; ** - p<0,01; *** - p<0,001

Table 4. Incidence of boar taint in entire (EM) and castrated (CM) male pig carcasses, 45 min post mortem

Groups	Group male pigs	
	EM (n=27)	CM (n=19)
Score 0, number (%)	13 (48.15%)	13 (68.42%)
Boar taint, number (%)	14 (51.85%)	6 (31.58%)
Score 1	7 (50.00%)	6 (100.00%)
Score 2	5 (35.71%)	0
Score 3	2 (14.29%)	0

parison with the CM was not statistically significant. Statistically not significant differences between EM and CM were also observed in some technological traits like pH values, PSE-meat, WHC and cooking losses. This can be taken into account by the specialist technologists, both in the sorting of pork by quality and in the preparation of individual recipes in the production of cooked and raw meat products. From the data on the presence of a specific boar taint it can be concluded that fattening of some breeds and crossed entire male pigs to a live weight of 90 kg set a problem for the modern swine industry.

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