

COLOUR AND MARBLING OF *M. semimembranosus* AND *M. longissimus thoracis et lumborum* FROM FIVE PUREBRED PIGS PRODUCED IN VOJVODINA

BOJA I MRAMORIRANOST *M. semimembranosus* I *M. longissimus thoracis et lumborum* PET ČISTIH RASA SVINJA ODGAJANIH U VOJVODINI

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ABSTRACT

Sensory evaluation of colour and marbling of *M. semimembranosus* (SM) and *M. longissimus thoracis et lumborum* (LTL) from five purebred pigs produced in Vojvodina (Large White, Landrace, Duroc, Hampshire and Pietrain) was performed. Colour was evaluated by the panellists with 6-point colour score cards (1–pale pinkish-gray to white; 6–dark purplish-red). Marbling was evaluated by the panellists with 7-point marbling score cards (1–devoid, 6–moderate/10–abundant). The differences in the colour and in the marbling of the SM muscles and of the LTL muscles among the five purebred pigs were not significant ($P>0.05$). A darker colour was obtained for SM muscles than for LTL muscles for all five purebred pigs, with a significant differences for Duroc ($P=0.018$) and Pietrain ($P=0.002$). The type of the muscles had no significant effect on marbling ($P>0.05$). The Vojvodian pork meat showed lighter colour than optimum for pork. According to average marbling scores fat content in pork produced in Vojvodina was less than 2 %.

Key words: pigs, colour, marbling, *M. semimembranosus*, *M. longissimus thoracis et lumborum*.

REZIME

Senzorski kvalitet mesa se smatra jednim od najvažnijih faktora kvaliteta jer utiče na odluku za ponovnu kupovinu od strane potrošača. *M. semimembranosus* (SM) i *M. longissimus thoracis et lumborum* (LTL) su dva ekonomski najznačajnija mišića na trupu svinja. Boja i mramoriranost su ispitivani na SM i LTL mišićima svinja rasa: Velika Bela ($n=118$), Landras ($n=116$), Durok ($n=112$), Hempšir ($n=112$) i Pietren ($n=121$), odgajanih u Vojvodini. Uzorci za određivanje boje i mramoriranosti uzeti su iz centralnog dela svakog mišića (tri odreska), upravno na dužu osu mišića; minimalna debljina uzoraka bila je 2,5 cm. Boja je ocenjena korišćenjem skale u boji (karti) od 1 do 6 (1–bledo-ružičasto-siva do bela; 6–tamno purpurno-crvena). Mramoriranost je ocenjena korišćenjem skale u boji (karti) od 1 do 6 (10) (1–bez mramoriranosti; 6–umerena/10–obilna). Razlike u boji i mramoriranosti mišića SM kao i mišića LTL između pet čistih rasa svinja nisu bile značajne ($P>0,05$). Tamnija boja mišića SM, u odnosu na mišiće LTL utvrđena je kod svih pet čistih rasa svinja, sa značajnom razlikom kod Duroka ($P=0,018$) i Pietrena ($P=0,002$). Ukupno, boja mišića SM i LTL je ocenjena prosečnim ocenama 2,48 i 2,19, redom, sa značajnom razlikom ($P<0,001$). Tip mišića nije imao značajan uticaj na mramoriranost ($P>0,05$). Ukupno, mramoriranost mišića SM i LTL je ocenjena prosečnim ocenama 1,78 i 1,6, redom. Svinjsko meso proizvedeno u Vojvodini ima svetliju boju od optimalne. Na osnovu prosečnih ocena za mramoriranost može se zaključiti da je sadržaj masti u svinjskom mesu proizvedenom u Vojvodini manji od 2%.

Ključne reči: svinje, boja, mramoriranost, *M. semimembranosus*, *M. longissimus thoracis et lumborum*.

INTRODUCTION

Meat quality can be defined as a combination of diverse properties of fresh and processed meat. These properties contain both sensory characteristics and technological aspects, such as colour, water-holding capacity, cooking losses, and texture. Many studies have been undertaken on meat quality, but it is only in the last decade that those with a specific objective of improving the sensory quality of pork are reported (Nam *et al.*, 2009; Ngapo *et al.*, 2012).

Visual appearance characteristics (i.e., colour, fat content, marbling, drip loss) of meat has been regarded as the most critical trait at the point of purchase, also they influence repeat purchases, because these characteristics consumers used to assess food quality. Colour is one of the most critical characteristics that consumers consider when making decisions to purchase meat, probably because they use inadequate colour as an indicator of spoilage and wholesomeness. Consumers relate red–purple colour with freshness and brown colour with lack of freshness. Furthermore, consumers familiar with meat

consumption use colour to predict experienced sensory quality although not always eating satisfaction was related with colour (Carpenter *et al.*, 2001; Mancini and Hunt, 2005; Nam *et al.*, 2009; Knežević *et al.*, 2013; Font-i-Furnols and Guerrero, 2014). From technological point of view colour, beside texture (firmness) and exudation (drip loss), is one of the most important quality factor for classifying meat into several quality categories. Pork of ideal class has normal colour (reddish pink), texture, and water-holding capacity, while as the most important defect of pork is meat of pale colour. Measurements of pH or paleness are often being used as indicators of meat with potential PSE characteristics (Warriss *et al.*, 2006; Tomović *et al.*, 2013).

Marbling, as a visual appearance characteristic of the meat, presenting intermingling of fat with lean in the muscle, is considered less important than colour and fat content in pork, although some studies showed marbling to be the most important cue in consumers' perception of quality and in intention to buy. The degree of marbling is important for estimating the potential eating quality of pork. It is generally accepted that an increase in the amount of intramuscular fat has a positive influence on the sensory qualities of pork. Marbling in pork contributes to the

juiciness and flavor of meat and may also have a positive effect on its tenderness. In the pork meat industry, visual assessment of marbling scores is currently widely used (Jeremiah and Miller, 1998; Ngapo et al., 2007; Cannata et al., 2010; Liu et al., 2012; Papanagiotou et al., 2013). At the end, meat acceptability, by consumers, depend on cultural aspects, experience or consumption habits (Font-i-Furnols and Guerrero, 2014).

Sensory meat quality traits (colour, marbling, odour, flavour, juiciness, tenderness) may be influenced by multiple interacting factors before and after slaughter. These include breed, genotype, sex, feeding, production systems, pre-slaughter handling, stunning method, slaughter procedure, chilling and storage conditions (Nam et al., 2009; Tomović et al., 2010).

Five purebred pigs (Large White, Landrace, Duroc, Hampshire and Pietrain) and their crosses are used for commercial pork production in Vojvodina. In (cross) breeding programme Large White and Landrace are used as female lines and Duroc, Hampshire and Pietrain are used as male lines (Tomović et al., 2011; Jokanović et al., 2012).

The *M. semimembranosus* (SM) and *M. longissimusthoracis et lumborum* (LTL) are two economically most important muscles in the pork carcass.

This study evaluated the variation in sensory characteristics (colour and marbling) of meat within two muscles (*M. semimembranosus* and *M. longissimusthoracis et lumborum*), obtained from five purebred pigs (Large White, Landrace, Duroc, Hampshire and Pietrain) used nowadays in Vojvodina for pork production.

MATERIAL AND METHOD

Animals, diet, sampling and preparing. In this study five purebred pigs (castrates males and females) were used: Large White (n=118), Landrace (n=116), Duroc (n=112), Hampshire (n=112) and Pietrain (n=121). The pigs were fattened at the production farms in the northern part of the Republic of Serbia (Autonomous Province of Vojvodina). The pig fattening involved the following phases: starting period (from 15 to 25 kg), growing period (from 25 to 60 kg) and finishing period (from 60 to 110 kg). The diets were based on locally produced corn and soybean meals, and were formulated to meet the nutrient requirements for the different growth phases (NRC, 1998; Tomović et al., 2011). All pigs had ad libitum access to a diet and water. The pigs were randomly selected at an individual live weight between 95 and 110 kg, and were about 6 months old. The pigs were slaughtered in the two biggest Vojvodian slaughterhouses according to routine procedure. Carcasses were conventionally chilled for 24 h in a chiller at 2–4 °C. After chilling, *M. semimembranosus* (SM) and *M. longissimus thoracis et lumborum* (LTL) were removed from the each right half-carcases. SM and LTL muscles were taken from the same half-carcases. Samples for colour and marbling evaluation were taken from the central part of each muscle, perpendicularly to the long axis of muscle; the minimum thickness of samples was 2.5 cm.

Sensory analyses. The sensory analyses were performed by an 8-member panel (4 female and 4 male). All of them were previously trained according to ISO 8586-1 (1993) and had already served as members of meat products evaluation panels. The samples were individually labelled with three-digit random numbers and were served one at a time in random order. Prior to being presented to the panellists, the samples were exposed to air for 60 min at 4 °C to allow for complete bloom. The samples were presented in the laboratory for sensory analyses (ISO 8589, 2007), where the assessors were asked to evaluate colour and marbling using sets of colour and marbling standards (NPPC,

2000). Colour was evaluated, for each chop, by the panellists with 6-point colour score cards (1–pale pinkish-gray to white, 2–grayish-pink, 3–reddish-pink, 4–dark reddish-pink, 5–purplish-red, 6–dark purplish-red). Marbling was evaluated, for each chop, by the panellists with 7-point marbling score cards (1–devoid, 2–traces, 3–slight, 4–small, 5–modest, 6–moderate, 10–abundant).

Statistical analysis. All data are presented as mean, standard deviation (SD) and range. Independent t-test and analysis of variance (one-way ANOVA) were used to test the hypothesis about differences between two or more mean values. The software package STATISTICA 12.0 was used (StatSoft, 2012).

RESULTS AND DISCUSSION

Table 1 provides the means, standard deviations, and overall ranges for the sensory quality traits of both colour and marbling for SM and LTL muscles from five purebred pigs.

The differences in the colour of the SM muscles and of the LTL muscles among the five purebred pigs were not significant ($P>0.05$). Mean visual NPPC colour scores for SM muscles ranged from 2.25 for Landrace to 2.71 for Pietrain, while for LTL muscles scores ranged from 2.00 for Duroc to 2.28 for Large White. Results reported by Brewer et al. (2001a) indicated differences in meat colour (two-toning, lightness, pinkness) between Duroc, Pietrain and Large White pigs. Also, some reports suggested that Duroc had more favourable visual colour and increased redness than Pietrain pigs (Mancini and Hunt, 2005). According to results of Gil et al. (2008) the colour of *Longissimus thoracis* of Landrace was significantly lighter (paler) than of other lines (Large White, Duroc and Pietrain).

In the present investigation a darker colour was obtained for SM muscles than for LTL muscles for all five purebred pigs. The significant differences between colour of SM and LTL muscles were noted for Duroc ($P=0.018$) and Pietrain ($P=0.002$) breeds. Overall, colour of SM muscles was evaluated within range 1.5–4.0 score, with an average score of 2.48. Colour of LTL muscles was evaluated within range 1.5–3.5 with an average score of 2.19. Regarding overall colour scores for SM and LTL muscles a significant differences ($P<0.001$) was determined between muscles. Having in mind that the optimal or normal colour of pork is graded with 3.5 NPPC colour score, results obtained in this investigation are pointing to a bit lighter colour (from 1 to 1.3 lower scores for SM and LTL, respectively) of pork than optimal. Report of Nam et al. (2009) showed that overall acceptability of pork had the exact same correlations as those of colour and appearance acceptance with other meat quality traits (pH, CIE colour parameters, water holding capacity, drip loss, cooking loss, texture) indicating that colour and general appearance are limiting factors for customers selecting meat because they influence the attractiveness of pork. The differences in the marbling of the SM muscles and of the LTL muscles among the five purebred pigs were not significant ($P>0.05$). Study of Channon et al. (2004) shown that the Duroc breed produces pork with a higher intramuscular fat content relative to the white European breeds, including the Large White and Landrace. Duroc line presented higher marbling than Landrace, Large White and Pietrain lines in study of Gil et al. (2008). In the present study mean marbling scores for SM and LTL muscles of Duroc were only numerically the highest (2.13 and 1.92, respectively) comparing to other four purebreds. Even though the SM muscles had higher scores for marbling than LTL muscles (except for Hampshire) the differences were not significant, impaling that the type of the muscle had no significant effect ($P>0.05$) on marbling. Overall, marbling of SM muscles was evaluated within range 1.0–3.5 score, with an

Table 1. Sensory evaluated colour and marbling for *M. semimembranosus* (SM) and *M. longissimusthoracis et lumborum* (LTL) of five purebred pigs

Param.	Muscle		Pig purebred					P value ¹	All animals
			Large White	Landrace	Duroc	Hampshire	Pietrain		
NPPC colour score	SM	X±Sd	2.33±0.49	2.25±0.45	2.50±0.52	2.58±0.79	2.71±0.56	0.102	2.48±0.57
		Range	1.5–3.5	1.5–3.5	1.5–3.5	1.5–4.0	1.5–4.0		1.5–4.0
	LTL	X±Sd	2.28±0.46	2.19±0.40	2.00±0.43	2.17±0.72	2.24±0.34	0.578	2.19±0.46
		Range	1.5–3.5	1.5–3.5	1.5–3.5	1.5–3.5	1.5–3.5		1.5–3.5
		P value ²	0.727	0.681	0.018	0.191	0.002	<0.001	
NPPC marbling score	SM	X±Sd	1.71±0.55	1.83±0.67	2.13±0.72	1.48±0.51	1.80±0.63	0.143	1.78±0.63
		Range	1.0–2.5	1.0–3.5	1.0–3.5	1.0–2.5	1.0–3.5		1.0–3.5
	LTL	X±Sd	1.44±0.70	1.50±0.63	1.92±1.00	1.50±0.80	1.71±0.85	0.487	1.61±0.79
		Range	1.0–3.0	1.0–3.0	1.0–4.0	1.0–3.0	1.0–3.0		1.0–4.0
		P value ²	0.214	0.169	0.547	0.928	0.727	0.122	

¹indicates significant difference between purebred within row

²indicates significant difference between SM and LTL muscles within column

average score of 1.78, while marbling of LTL muscles was evaluated within range 1.0–4.0 with an average score of 1.61. Obtained results are in accordance with results reported by Gil et al. (2008). According to correlation between NPPC marbling score and percent of intramuscular fat (IMF) (NPPC, 2000) results obtained in this investigation showed less than 2 % content of IMF in analysed muscles.

Results of Cannata et al. (2010) indicate that visual marbling score does influence the sensory quality of pork. Literature reports suggested that the intramuscular fat content of pork had to be greater than 2 % before any noticeable effects on sensory attributes of pork could be detected (Channon et al., 2004).

Others concluded that a level of 2.5–3.0 % of intramuscular fat was necessary to attain an acceptable level of tenderness in roasted pork chops (Channon et al., 2004). On the other hand there is a growing number of consumers seeking leaner meat as part of a lower calorie diet (Cannata et al., 2010), and authors reported problems in tenderness when intramuscular fat content was averagedly 1.2–1.3 % (Channon et al., 2004). Finally, consumers expressed a higher degree of purchase intent for leaner pork but found that more sensory acceptable (regarding tender, juicy and flavour) is pork with higher marbling percent (Brewer et al., 2001b).

CONCLUSION

The results of the present study obtained for sensory evaluated colour and marbling of two economically most important pork muscles (*M. semimembranosus* and *M. longissimusthoracis et lumborum*) from five purebred pigs (Large White, Landrace, Duroc, Hampshire and Pietrain) used nowadays in Vojvodina for pork production showed that purebred didn't affect the pork colour or marbling (P>0.05). Overall, colour of SM muscles was evaluated with significantly (P<0.001) higher scores than LTL muscles. The Vojvodian pork meat showed lighter colour than optimum for pork (reddish-pink). The type of the muscle had no significant effect (P>0.05) on marbling (P>0.05). According to average marbling scores it can be concluded that fat content in pork produced in Vojvodina was less than 2 %.

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