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Influence of breed, season and gender on chemical composition and meat quality of pigs

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Abstract

The effect of breed, gender and the farrowing season on the variability of pork quality traits was examined in the present study. The observed properties were the pH value (pH_{45} and pH_{24}) of the *Longissimus dorsi muscle* (LD) and *Semimembranosus muscle* (SM), the chemical composition (water, fat, ash and protein content), the water binding capacity, the colour and thickness of the LD fibres. In the present study, the influence ($P<0.05$) of the farrowing season for both measured pH values in SM was established, as well as significant influence ($P<0.01$) on pH_{24} in LD, while the other factors did not influence the pH of the muscles tested. The established difference in the mean values of water content in LD between fatteners SW and LWxSL (0.69%) was statistically very significant ($P<0.001$) while the influence of genotype and sex of fatteners was not determined for fat, ash and protein content. The genotype of fatteners influenced the ability to bind water ($P<0.001$) and the meat colour ($P<0.05$) while the muscle thickness was not affected ($P>0.05$).

Keywords: breed, fatteners, offspring, pig, season, sex

Introduction

The pH of meat is one of the most important indicators of the quality of raw meat. Of all the indicators, the most important are pH values, since they affect the majority of meat properties, such as colour, water binding capacity, taste, firmness and sustainability (Kralik et al., 2007). The pH limit values for pale, soft and exudative meat (PSE) meat vary according to certain authors. Honikel (1999) states that the meat of "normal" quality has values of pH_{45} greater than 6, and pH_{24} from 5.4 to 5.85. One group of researchers find that the pH value of muscles varies under the influence of the genotype or sires (Josell et al., 2003; Latorre et al., 2003; Radović et al., 2009). Nutritional value, i.e. chemical composition of meat may vary depending on a number of factors: breed, sex, diet, age, methods of keeping animals, health

status, etc. According to the majority of authors (Grolichova et al., 2004; Ryu and Kim, 2005; Purslow, 2005; Kušec et al., 2006) pig meat has 60-75% water, 18-21% protein, 1.5 - 5.9% fat, and 0.8 - 1.2% of mineral matter. The colour and appearance of meat are crucial for making a decision when buying meat. The unusual and changed colour of meat and the release of liquid lead to rejection of such product by the customers. Fresh pork is reddish-pink, of compact structure and dry surface (RFN, Red, Firm, Non-exudative). Karolyi (2004) stated that the development of PSE meat is associated with the hereditary condition of the stress sensitivity of pigs (PSS-Porcine Stress Syndrome).

Material and methods

The trial was conducted at the experimental farm and slaughterhouse of the Institute for Animal Husbandry, Zemun-Belgrade. The offspring (both sexes) were following genotypes: Swedish Landrace (SL; n=174), and crosses: Large White × Swedish Landrace (LW×SL; n=170), 33 animals of genotype SL× (LW×SL) and genotype LW× (LW×SL) 33 animals. The pH value (pH_{45} and pH_{24}) of the *Longissimus* dorsi muscle (LD) and *Semimembranosus muscle (*SM*)* was measured in 410 offspring (207 male and 203 female offspring) born in the winter, summer and autumn. Samples of LD originate from 50 offspring were taken between the 13th and 14th rib (29 samples taken from the offspring of SL genotype and 21 samples of LWxSL genotype). The chemical composition (water, fat, ash and protein content), the water binding capacity, the colour and thickness of the LD fibres. The body weight at the end of the fattening it was average of 101.04 kg. Data was processed by applying the adequate software package "LSMLMW and MIXMDL, PC-2 VERSION" (Harvey, 1990), i.e. by using the procedure of the Least Square Method in order to determine the significance ($P<0.05$) of systematic influences on traits of meat quality. Models included breed, gender, farrowing season and carcass side mass (linear effect).

Results

By observing the influence of the factors included in the model (Table 1), can be see that the genotype and sex of the fatteners did not influence statistically significant variation of pH_{45} and pH_{24} of LD and SM ($P>0.05$).

The influence ($P<0.05$) of the farrowing season for both measured pH values in SM and the significant influence ($P<0.01$) on pH_{24} in LD were determined. Table 2 shows the values of nutritive quality, i.e. the chemical composition of LD. The results show that in LD there were on average 73.1% water, 24.08% protein, 1.65% fat, and 1.17% ash. The established difference in the mean values of water content in LD between fatteners of SL and LWxSL (0.69%) was statistically very significant ($P<0.001$).

Table 3 shows the average values of water binding capacity (WBC), muscle fibre colour and thickness (MFT) of LD. The two breed crosses had a higher mean WBC (+5.67%; $P<0.001$) and muscle colour (+0.05; $P<0.05$) but not MFT (-2.49 μm; $P>0.05$) compared to Swedish Landrace animals.

Table 1. Influence of genotype, sex and season on pH value of muscle (LS Mean ±S.E.)

Variation source		pH$_{45}$-LD[3]	pH$_{45}$-SM	pH$_{24}$-LD	pH$_{24}$-SM
μ ± S.E.		6.55 ±0.03	6.54 ±0.02	5.7 ±0.01	5.78 ±0.01
Genotype	1[1]	6.5 ±0.03	6.54 ±0.03	5.69 ±0.01	5.77 ±0.02
	2	6.58 ±0.03	6.55 ±0.03	5.71 ±0.01	5.79 ±0.02
	3	6.56 ±0.06	6.59 ±0.05	5.71 ±0.03	5.79 ±0.03
	4	6.55 ±0.05	6.5 ±0.05	5.71±0.02	5.79 ±0.03
P-value		NS[4]	NS	NS	NS
Sex	M[2]	6.54 ±0.03	6.56 ±0.03	5.71 ±0.01	5.79 ±0.02
	F	6.56 ±0.03	6.53 ±0.03	5.7 ±0.01	5.78 ±0.02
P-value		NS	NS	NS	NS
Season	Winter	6.6 ±0.06	6.62 ±0.06	5.64 ±0.03	5.73 ±0.03
	Summer	6.52 ±0.03	6.48 ±0.03	5.74 ±0.01	5.82 ±0.02
	Fall	6.52 ±0.02	6.54 ±0.02	5.72 ±0.01	5.81±0.01
P-value		NS	*	**	*
WCSW (b)		-0.002^{NS}	0^{NS}	-0.003**	-0.001^{NS}

[1]1-SL, 2-LWxSL, 3-SLx(LWxSL), 4-LWx(LWxSL); [2]M-male castrates, F-females; WCSW (b)-linear effect of the warm carcass side weight; [3]LD-*Longissimus dorsi muscle,* SM-*Semimembranosus muscle*; [4]NS=P>0.05; *P<0.05; **P<0.01; ***P<0.001.

Table 2. Influence of the genotype, sex and season on the chemical composition of LD in the carcass side (LS Mean ±S.E.)

Variation source		Water (%)	Fat (%)	Ash (%)	Protein (%)
μ ± S.E.		73.1 ±0.1	1.65 ±0.08	1.17 ±0.01	24.08 ±0.12
Genotype	SL[1]	73.45 ±0.14	1.54 ±0.11	1.17 ±0.01	23.84 ±0.18
	LWxSL	72.76 ±0.14	1.75 ±0.11	1.17 ±0.01	24.32 ±0.18
P-value		***[3]	NS	NS	NS
Sex	M[2]	73.05 ±0.13	1.65 ±0.1	1.16 ±0.01	24.14 ±0.16
	F	73.15 ±0.15	1.64 ±0.12	1.18 ±0.01	24.02 ±0.19
P-value		NS	NS	NS	NS
WCSW (b)		-0.04*	0.005^{NS}	-0.001^{NS}	0.036^{NS}

[1]SL-Swedish Landrace, LWxSL-crosses Large White x Swedish Landrace; [2]M-male castrates, F-females; WCSW (b)-linear effect of the warm carcass side weight; [3]NS=P>0.05; *P<0.05; **P<0.01; ***P<0.001.

Table 3. The effect of genotype and sex on the water binding capacity, colour and muscle fibre thickness of *musculus longissimus* (LS Mean ±S.E.)

Variation source		WBC[3] (%)	Meat colour	MFT (µm)
Genotype	SL[1]	53.93 ±1.17	0.333 ±0.016	65.62 ±1.53
	LWxSL	59.6 ±1.16	0.383 ±0.015	63.13 ±1.39
P-value		***[4]	*	NS
Sex	M[2]	56.57 ±1.07	0.363 ±0.014	63.58 ±1.26
	F	56.96 ±1.26	0.352 ±0.017	65.18 ±1.67
P-value		NS	NS	NS
WCSW (b)		-0.16[NS]	0[NS]	0.338[NS]

[1]SL-Swedish Landrace, LWxSL-crosses Large White x Swedish Landrace; [2]M-male castrates, F-females; WCSW (b)-linear effect of the warm carcass side weight; [3]WBC-water binding capacity, MFT-muscle fibre thickness; [4]NS=P>0.05; *P<0.05; **P<0.01; ***P<0.001.

Discussion

In the present study, only the effect (P<0.05 and P<0.01) of the season was determined on the pH value of the muscles studied, while Latore et al. (2003) and Kušec et al. (2003) found a very high impact (P<0.001) of the genotype, i.e. of the sire breed mated with sows of Landrace x Large White and also the effect of sex of offspring on pH_{45} and pH_{24} values SM and LD. Research by Mason et al. (2005) of the chemical composition of LD shows high statistically significant differences (P<0.001) for water content (73.63: 72.68%), significant (P<0.05) for ash content (1.19: 1.26%), but not for the protein content (23.37: 23.3%; P>0.05) between the Landrace breed and the Durok, which is in line with this research in regard to the water content. In the research of Radović et al. (2009), genotype showed no influence (P>0.05) on the variation of the chemical composition, and contrary to the abovementioned research Jukna and Jukna (2005) have found significant differences between certain genotypes for the protein content (P<0.05) and fat content (P<0.05 and P<0.001). In the examination of the water binding capacity of the LD Radović et al. (2009) have found that the genotype has influenced (P<0.01) and sex has not influenced this trait (P>0.05), which is consistent with this research. Contrary to this research, Jukna et al. (2009) have found that differences in water binding capacity between offspring of different sires were not significant (P>0.05), but that the sex of the offspring has influenced (P<0.05) the ability to bind water. Radović et al. (2009) have found that sex has exhibited impact (P<0.01) on the colour of the meat, which is contrary to this result (P>0.05). Radović et al. (2009) have found that the thickness of muscle fibres has ranged from 62.1 to 66.3 µm. However, Migdał et al. (2005), by examining two parts of LD (m. *longissimus thoracis* and *m. longissimus lumborum*), have determined a muscle fibre diameter of 52.14 to 100.67 µm.

Conclusions

In the present study, the influence of the farrowing season both measured pH values in SM was established, as well as significant influence on pH_{24} in LD, while the other factors did not influence the pH of the muscles tested. The established difference in the mean values of water content in LD between fatteners SL and LWxSL (0.69%) was statistically significant. The fatteners' genotype influenced the water binding capacity and the meat colour while the muscle thickness was not affected.

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