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Influence of different pig genotype on aroma, colour and fatty acid composition of smoked dry-cured ham

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ABSTRACT

The aim of this study was to determine the influence of different genotypes of pigs ((Landrace x large Yorkshire) x Duroc (LYD) and Black Slavonian (BS) pig) on the colour, fat content and fatty acid composition of smoked dry-cured ham and identify volatile aroma-active compounds. The fat content was determined by applying the Smedes method and the composition of fatty acids by using the gas chromatography, while volatile aroma-active compounds were investigated by using the headspace-solid phase microextraction (HS-SPME) and the gas chromatography-mass spectrometry (GC-MS). Different genotypes of pigs did not show a statistically significant difference ($p>0.05$) in total fat content, but there was a difference in the proportion of individual fatty acids. We identified a total of 103 volatile compounds belonging to the following groups of chemical compounds: 19 aromatic hydrocarbons, 17 aliphatic hydrocarbons, 17 ketones, 15 phenols, 14 aldehydes, 11 alcohols, 5 acids, 2 terpenes and 1 sulphur compound. The most abundant chemical groups of compounds in samples of smoked dry-cured ham from LYD pigs were aldehydes, phenols and aromatic hydrocarbons, while the most abundant chemical groups of compounds in samples of smoked dry-cured ham of BS genotype were phenols, aldehydes and alcohols.

Key words: smoked dry-cured ham, pig genotype, aroma, fat content, fatty acids

INTRODUCTION

Pig genotype is one of the most prominent factors affecting the final quality of the dry-cured ham, alongside with the other factors such as raw material (sex, age, rearing system or feed) and manufacturing process (Senčić et al., 2015; Senčić and Samac, 2017). Previous studies have shown that aroma, intramuscular fat content (IMF) and colour of the final product are highly under the influence of the pig genotype (Pugliese et al., 2012; Lebret et al., 2011; Čandek-Potokar and Škrlep, 2012). Industrial pig farming is nowadays mainly focused on pig crossbreeds rearing, to improve meat quality (Choi et al., 2016). Three-way crossbreed pigs (Landrace×Yorkshire×Duroc (LYD)) are nowadays the most common commercial breed used for production of dry-cured hams, owing to their desirable production traits, such as enhanced growth rate, higher litter size and increased meat yield of the carcass, in comparison with the other crossbreeds (Yim et al., 2019; Choi et al., 2016; Senčić and Samac, 2017). LYD pigs are offspring of two-way crossbreed of Swedish Landrace sow

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and large Yorkshire bow, crossed with Duroc bows. In this way, the best characteristics from all three breeds are achieved; excellent growth rate and high level of IMF from Duroc, thin subcutaneous fat layer and large hams from Landrace and good stress resistance and better quality of muscle tissue from Yorkshire (Yim et al., 2019; Senčić and Samac, 2017). LYD pigs are reared under the intensive system, generally associated with large-scale breeding and higher productivity (Antunović et al., 2010). Senčić and Samac (2017) highlighted better sensory characteristics of dry-cured hams produced from LYD pigs in comparison with the ones produced from other genotypes. This breed is commonly used for the production of traditional Croatian dry-cured hams, and also for some types of European dry-cured hams, such as Serrano and Bayonne (Krvavica and Đugum, 2006).

Black Slavonian pig (BS) (also known as "Fajferica") is the typical pig breed in the Slavonian region, commonly used for the production of dry-cured ham, kulen, bacon, sausage and fat. Traditionally, the BS pig is breed under semi-intensive conditions in which pigs are allowed to move out to feed on natural vegetation (Margeta et al., 2019). While the breed was at the risk of extinction in the mid-90, in recent years' population of BS pigs increased, due to the preventive measures that Croatia undertook to prevent breed decline (Karolyi et al, 2010). Compared with meat from modern pig breeds, BS pig meat possesses higher proportion of fatty tissue, higher content of intramuscular fat (IMF), lower SFA and MUFA and higher PUFA and ALA share, darker and redder meat colour and possibly, superior stress resistance during pre-slaughter handling (Karolyi et al, 2010; Margeta et al., 2019). These characteristics are the result of keeping conditions and the feedstuffs in the traditional production system (such as acorns, natural pastures, and stubble) (Margeta et al., 2019; Karolyi et al., 2010).

Consumers today often seek for diverse, high quality and nutritious meat products that are associated with a certain local area or related to a gastronomic heritage of the particular geographic region. This growing demand has created a market for value-added products that are positively perceived by consumers (Díaz-Caro et al., 2019, Cerjak et al., 2014). According to the trends, the novelty on the market is the dry-cured ham produced from the BS pigs.

Since LYD pigs and are mainly used for commercial pork production, and no previous study characterized differences in quality traits between smoked dry-cured ham produced from BS pigs and LYD pigs, the aim of this research was to determine differences in colour, fat content, fatty acid composition and aroma profile in smoked dry-cured ham produced from two different pig genotypes.

MATERIALS AND METHODS

Samples

The research was conducted on two groups of dry-cured ham samples. The first group of samples was comprised of 10 dry-cured hams produced from three-way crossbreed pigs (LYD), while the second one was comprised of 10 dry-cured hams produced from BS pigs. All samples were produced from the same manufacturer and under the same technological conditions, following the protocol for Dalmatian dry-cured ham production. The production process included the following steps: trimming and removal of pelvic bones, dry salting with sea salt, pressing, cold smoking (< 22 °C), drying and ripening. Dry-cured hams from both groups have ripened for 18 months. All analyses were carried out on muscle biceps femoris. Each sample was analysed for colour measurement, total fat content, fatty acid composition and volatile compounds.

Determination of total fat content

The fat content was determined by the method according to Smedes (1999) by extraction with cyclohexane and propan-2-ol. Each sample of dry-cured ham was analysed in four parallel analyses.

Preparation of methyl esters fatty acid

Extracted fat was used to determine fatty acid composition. The ester-bound fatty acids have been converted into methyl esters fatty acid suitable for analysis by gas chromatography (ISO 12966-2, 2011).

Determination of fatty acid composition

The fatty acid composition was determined by gas chromatography according to the method described in Petrović et al. (2010) using CP-3800 (Varian, Palo Alto, CA, USA). A TriPlus autosampler

(Thermo Scientific, Augustin, TX, USA) was used for injection. The temperature of the injector was set at 250 oC and the injection volume was 1 µL with a split ratio of 1:30. Samples were analyzed on a DB-23 capillary column (60 m x 0.25 mm x 0.25 µm) (Agilent, Walnut Creek, CA, USA). The carrier gas was helium at a flow rate of 1.5 mL/min. Fatty acid methyl ester peaks were identified by comparing their retention times with those of FAME standards (C8–C22). Each sample of dry-cured ham was analysed in five parallel analyses.

Colour instrumental measurement

The color measurement was performed on the surface of biceps femoris muscle samples using a Konica Minolta Spectrophotometer (CM-700d, Minolta, Japan) equipped with illuminant D65 10° standard observer, 8 mm aperture, with open cone. L*, a* and b* values were determined (CIE, 1976). Each measurement was performed in 6 replicates.

Analysis of volatile compounds

Volatile compounds were extracted by solid phase microextraction (SPME) method and analysed with gas chromatography coupled with mass spectrometer (GC/MS) by the method as described by Marušić et al. (2011). The analyses of the volatile compounds were performed in a 6890N gas chromatograph coupled to a 5975i mass selective detector (Agilent Technologies, Santa Clara, CA, USA). After extraction, the SPME fiber was immediately injected to the injection port at 250 °C for 10 min in splitless mode. The GC/MS was equipped with capillary column DB-5ms 30m x 0.25mm x 0.25 µm (Agilent Technologies, Santa Clara, CA, USA), while helium was used as a carrier gas at 1.0 mL/min flow rate. Temperature program was at 40 °C, isothermal for 10 min, then rising to 200 °C at a rate of 5 °C/min and then raising to 250 °C at a rate of 20 °C/min. The final temperature was held for 5 min. The transfer line temperature was maintained at 280 °C. The mass spectra were obtained at 70 eV with a rate of 1 scan/s over the m/z range of 50–450. To calculate the retention indices (RI) of detected compounds, an in-house mixture of C8–C20 n-alkanes were run under the same chromatographic conditions. Compounds were identified using AMDIS 3.2 program version 2.62 with IST 2005 version 2.0 spectral library (NIST, Gaithersburg, MD, USA) and comparing obtained retention indices with literature values (Adams, 2001 and in-house library). Each sample of dry-cured ham was analysed in three parallel measurements.

Statistical analyses

One-way ANOVA was carried out for physical and chemical data as well as for the volatile compounds using the SPSS 17.0 computer program (StatSoft Inc, Tulsa, Oklahoma, USA). Statistical significance was predetermined at 0.05.

RESULTS AND DISCUSSION

Determination of fat content and fatty acids composition

Intramuscular fat (IMF) content is one of the most relevant factors affecting the final quality of the dry-cured ham, since it contributes to the desirable meat qualities, such as meat texture and juiciness. In addition, IMF triacylglycerols act as carriers of aromatic compounds, contributing to the development of desirable aroma (Hui et al., 2017). IMF content in dry-cured ham is highly variable since it depends on the rearing system and genetic characteristics of the pig breed (Senčić and Samac, 2017). For instance, pig genotypes such as Pietrein or Belgium Landrace are characterized by higher leanness of the meat, which makes them less suitable for dry-cured ham production (Čandek-Potokar and Škrlep, 2012). On the other hand, the most distinctive characteristic of BS pigs, in comparison with modern pig breeds, is a higher share of IMF (6-8 %). This is on account of genotype predisposition for fat accumulation, in combination with a specific diet, as reported by Karolyi et al. (2010).

Results of the determination of the total fat content in dry-cured ham samples from two different pig breeds are presented in Table 1. The fat content determined in samples of dry-cured ham from LYD and BS pigs was 9.15 ± 0.33 % and 9.02 ± 0.63 %, respectively, with no statistically significant difference ($p>0.05$) observed. Average levels of total fat are below those reported by other authors (Petričević et al, 2018; Marušić Radovčić et al., 2016; Pleadin et al., 2016), who investigated the total fat content in Dalmatian dry-cured ham. In their experiment on Slavonian ham from LYD and BS pigs, Senčić et al. (2018) reported higher total fat content (10.2.20 ± 2.20 %) in BS than in

LYD samples (7.25 ± 3.25 %). Previous researchers reported the total fat contents in various European traditional dry-cured hams, such as Serrano (5.90 %), Iberian (20.50 %), San Daniele (3.60 %), Bayonne (5.0 %) (Krvavica and Đugum, 2006) and Kraški dry-cured ham (23.20 %) (Pleadin et al., 2016). Iberian dry-cured hams are rich in fat, as a result of genetic background and traditionally extensive breeding, called "montanera" system (Díaz-Caro et al., 2019).

Table 1 Fat content (%) and instrumental colour (mean ± standard error) in smoked dry-cured ham samples from two different pig breeds.
Tablica 1. Udio masti i instrumentalno određivanja boje (%) (srednja vrijednost ± standardna pogreška) u uzorcima dimljenog pršuta proizvedenih od dvije različite pasmine svinja.

	(Landrace x large Yorkshire) x Duroc)	Black Slavonian pig	*p-value*
Fat (%)	9.15±0.33	9.02±0.63	*0.860*
L*	51.56±0.60^{b}	48.40±0.44^{a}	*0.002*
a*	6.38±0.41^{b}	4.76±0.36^{a}	*0.014*
b*	6.28±0.44^{b}	4.60±0.17^{a}	*0.005*

** Different superscripts (a.b) in the same row mean that results are statistically different (p<0.05)/ Različita slova (a, b) u istome redu označavaju statistički značajnu razliku (p<0.05)*

Generally, pork meat products contain higher saturated fatty acids (SFA) and lower monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) share (Pleadin et al., 2016). Lipids from white breed pig's meat are averagely composed of 35–40 % SFA, 45–50 % MUFA and 10–15 % PUFA. On the other hand, Iberian dry-cured hams have a higher MUFA (54-58 %), and lower SFA (30–35 %) and PUFA (8–12 %) share, due to the higher intake of oleic acid through acorn-based diet (Jiménez-Colmenero et al., 2010). In this study, fatty acid composition and differences in proportions of SFA, MUFA and PUFA of LYD and BS dry-cured hams were investigated. The obtained results are presented in Table 2.

Table 2 Average fatty acid composition (% of total fat content) of the smoked dry-cured ham samples from two different pig breeds (mean ± standard error).
Tablica 2. Prosječni sastav masnih kiselina (% od ukupne masti) u uzorcima dimljenog pršuta proizvedenih od dvije različite pasmine svinja (srednja vrijednost ± standardna pogreška).

Fatty acid	(Landrace x large Yorkshire) x Duroc)	Black Slavonian pig	*p-value*
C10:0	0.14±0.00^{b}	0.12±0.01^{a}	*0,035*
C12:0	0.09±0.00	0.08±0.00	*0,065*
C14:0	1.42±0.01	1.34±0.04	*0,109*
C15:0	0.00±0.00^{a}	0.06±0.01^{b}	*0,000*
C16:0	24.82±0.07^{b}	21.81±0.19^{a}	*0,000*
C16:1	3.42±0.03^{a}	4.82±0.10^{b}	*0,000*
C17:0	0.16±0.00^{a}	0.24±0.00^{b}	*0,000*
C17:1	0.19±0.00^{a}	0.32±0.01^{b}	*0,000*
C18:0	11.92±0.08^{b}	7.36±0.17^{a}	*0,000*
C18:1t	0.18±0.01	0.31±0.08	*0,148*
C18:1c	49.54±0.08^{a}	53.10±0.34^{b}	*0,000*
C18:2c	6.45±0.05^{a}	7.23±0.04^{b}	*0,000*
C18:3n6	0.00±0.00^{a}	0.06±0.01^{b}	*0,000*
C18:3n3	0.28±0.00^{a}	0.37±0.01^{b}	*0,000*
C20:0	0.19±0.01^{a}	0.22±0.01^{b}	*0,031*
C20:1	0.00±0.00^{a}	0.92±0.02^{b}	*0,000*

Table 2 Continued from previous page.
Tablica 2. Nastavak s prethodne stranice.

Fatty acid	(Landrace x large Yorkshire) x Duroc)	Black Slavonian pig	*p-value*
C20:2	0.35±0.01[a]	0.40±0.01[b]	*0,000*
C20:3n6	0.07±0.00[a]	0.10±0.00[b]	*0,000*
C20:4n6	0.27±0.01[a]	0.46±0.01[b]	*0,000*
C20:3n3	0.00±0.00[a]	0.03±0.01[b]	*0,040*
C23:0	0.51±0.03	0.66±0.20	*0,478*
SFA	39.24±0.11[b]	31.89±0.23[a]	*0,000*
MUFA	53.32±0.10[a]	59.47±0.22[b]	*0,000*
PUFA	7.43±0.06[a]	8.25±0.06[b]	*0,000*
n6	6.80±0.06[a]	7.79±0.05[b]	*0,000*
n3	0.28±0.00[a]	0.40±0.02[b]	*0,001*
n6/n3	24.03±0.31[b]	19.55±1.08[a]	*0,004*
PUFA/SFA	0.19±0.00[b]	0.14±0.00[a]	*0,000*
MUFA/PUFA	7.18±0.07	7.21±0.05	*0,735*

** Different superscripts (a.b) in the same row mean that results are statistically different (p<0.05). SFA -Saturated Fatty Acid; MUFA-Monosaturated Fatty Acid; PUFA- Polyunsaturated Fatty Acid / Različita slova (a, b) u istome redu označavaju statistički značajnu razliku (p<0,05). SFA (engl. Saturated Fatty Acid) – zasićena masna kiselina; MUFA (engl. Monosaturated Fatty Acid) – jednostruko nezasićena masna kiselina; PUFA (engl. Polyunsaturated Fatty Acid) – višestruko nezasićena masna kiselina.*

Regarding SFA, MUFA and PUFA share, no statistically significant differences (p>0.05) were observed among studied samples. SFA, MUFA and PUFA share for LYD and BS samples were 39.24±0.11 % and 31.89±0.23 %, 53.32±0.10 % and 59.47±0.22 % and 7.43±0.06 % and 8.25±0.06 %, respectively. In a study investigating Dalmatian and Istrian dry-cured hams, Marušić et al. (2013) reported similar fatty acid composition. Jiménez-Colmenero et al. (2010) reported lower SFA and higher PUFA share in other European dry-cured hams. The most abundant fatty acids found in investigated dry-cured hams from LYD and BS pigs were oleic (C18:1c) (49.54±0.08 and 53.0±0.34 %), palmitic (C16:0) (24.82 ±0.07 and 21.81±0.19 %) and stearic (C18:0) (11.92±0.08 and 7.36±0.17 %). Statistical significant differences (p<0.05) among two groups of samples were observed for 16 fatty acids (of 21 detected) from each group (SFA, MUFA and PUFA), which indicates that fatty acid composition of dry-cured hams from LYD and BS pigs differ. BS samples contained more fatty acids than LYD samples: pentacyclic acid (C15:0), γ – linolenic acid (C18:3n6), cis – 11 – eicosenoic acid (C20:1) and eicosatrienoic acid (C20:2).

The ratios of PUFA/SFA and n6/n3 represent the main parameters in terms of the nutritive quality of lipids. According to the data from the literature, PUFA/SFA ratio should be above 0.4, while the ratio of n6/n3 should be less than 4 (Choi et al., 2016, Pleadin et al., 2015). The detected PUFA/SFA ratio was significantly lower (p<0.05) in BS (0.14) than in LYD pigs (0.19) samples. The n6/n3 ratio detected in BS pigs samples (19.55±1.08) statistically differ (p<0.05) from the one detected in LYD pigs (24.03±0.31). Considering the mentioned suggested values for PUFA/SFA and n6/n3 ratios, dry-cured hams investigated in this study are not within recommended limits. Our results could be comparable with the ones obtained from Pleadin et al. (2015) who observed PUFA/SFA ratio for Istrian (0.21) and Dalmatian (0.17) dry-cured ham. In comparison, Spanish dry-cured hams such as Serrano (0.30) and Iberian (0.19-0.38) show a higher PUFA/SFA ratio (Jiménez-Colmenero et al., 2010; Fernández, 2007). Results for n6/n3 ratio are in accordance with values reported by Marušić et al. (2013) and above those reported by other authors (Pleadin et al., 2015; Bermudez et al., 2012; Fernández et al., 2007).

Colour instrumental measurement

The colour of dry-cured ham represents one of the main factors affecting consumer's acceptability of the product, while they often estimate the quality of meat based on its colour. (Morales et al., 2013). Also, colour of the dry-cured ham may indicate chemical changes that occurre during production and storage. It is related to the water, fat and myoglobin content in meat and may vary depending

on pig genetic type, feed, rearing system, age and other factors (Senčić et al., 2015; Karamucki et al., 2013; Pugliese et al., 2012).

Evaluated colour parameters of investigated dry-cured hams are presented in Table 1. Regarding colour measurement, significant differences in L*, a* and b* values were observed ($p<0.05$) in dry-cured samples of LYD and BS pigs. These differences in colour parameters may be attributed to different oxidative status, muscle composition and physicochemical traits of different pig breeds (Yim et al., 2019). The ham from BS samples was significantly darker, with detected lower L* values (4.40 ± 0.44) than LYD samples (51.56 ± 0.60), which is consistent with results reported from other authors (Gvozdanović et al., 2017; Karolyi et al., 2010). Determined L* values are also in accordance with those reported by other authors (Petričević et al., 2018; Karolyi et al., 2010). BS pigs are generally specified as redder than the meat from modern crossbreeds (Karolyi et al., 2010). However, BS samples in this study showed a lower a* values (4.76±0.36 for BS samples in comparison to 6.38±0.41 for LYD samples), which is in contrary to previous studies which have suggested that hams from BS pigs have redder meat (Karolyi et al, 2010; Senčić et al., 2018; Senčić et al., 2015). Determined b* values for LYD samples were also higher (6.28±0.44) than the ones detected in BS samples (4.60±0.17), which is in accordance to results from similar experiments from other authors (Senčić et al., 2018; Senčić et al., 2015). European dry-cured hams, however, show a higher b* values, such as 7.6 for Iberian, 10.5 for Serrano, and 6.0 for Parma and San Daniele, as reported by Marušić et al. (2014). Likewise, higher b* values are recorded in traditional Croatian dry-cured hams (Petričević et al., 2018).

Analysis of volatile compounds

A total of 103 volatile compounds were detected by the SPME-GC-MS method in investigated samples of smoked dry-cured ham. The results of the analysis of volatile compounds are presented in Table 3. Detected compounds belonged to several classes of chemicals: aromatic hydrocarbons (19), aliphatic hydrocarbons (17) and ketones (17), phenols (15), aldehydes (14), alcohols (11), acids (5), esters (2), terpenes (2) and sulphuric compound (1). As presented in Table 3., the most abundant compounds found in BS samples were phenols (38.19 %), while in samples of LYD pigs, aldehydes were found in highest proportion (31.14 %), followed by phenols (19.67 %), aromatic hydrocarbons (14.74 %), aliphatic hydrocarbons (8.84 %), alcohols (8.81 %), ketones (7.06 %), terpenes (5.39 %), acids (2.61 %), esters (1.58 %) and sulphuric compounds (0.15 %). As shown in Table 3., significant differences ($p< 0.05$) were observed by means of 67 volatile compounds, of 103 total detected. Different genotypes of pigs did not show statistical differences ($p>0.05$) by means of ketones, esters, acids and sulphur compounds content.

Table 3 Contents (mean ± standard error) of volatile compounds extracted from samples of smoked dry-cured ham produced from two different pig breeds (percentage of the total area).
Tablica 3. Udio hlapivih spojeva (srednja vrijednost ± standardna pogreška) u uzorcima dimljenog pršuta proizvedenih od dvije različite pasmine svinja (udio od ukupne površine).

Volatile compound	RI	(Landrace x large Yorkshire) x Duroc)	Black Slavonian pig	*p-value*	Identification
Aldehydes					
3-Methylbutanal	688	1.20±0.10^{b}	0.77±0.11^{a}	*0.041*	MS, RI
2-Methylbutanal	692	2.26±0.26^{b}	1.02±0.17^{a}	*0.016*	MS, RI
Pentanal	714	1.07±0.05	1.49±0.25	*0.174*	MS, RI
Hexanal	800	9.21±1.11	7.90±0.54	*0.348*	MS, RI
Heptanal	902	1.35±0.15	1.13±0.04	*0.227*	MS, RI
Methional	907	0.55±0.05^{b}	0.00±0.00^{a}	*0.000*	MS, RI
Benzaldehyde	965	3.26±0.29	2.44±0.53	*0.246*	MS, RI
Octanal	1004	2.79±0.18	2.39±0.39	*0.398*	MS, RI
Benzeneacetaldehyde	1046	2.26±0.07^{b}	0.99±0.10^{a}	*0.000*	MS, RI
2,4-Hexadienal	1087	0.79±0.05^{b}	0.33±0.05^{a}	*0.002*	MS, RI
Nonanal	1105	4.40±0.18	4.48±0.87	*0.994*	MS, RI
2-Hexenal	1190	0.29±0.04	0.19±0.03	*0.132*	MS, RI

Table 3 Continued from previous page.
Tablica 3. Nastavak s prethodne stranice.

Volatile compound	RI	(Landrace x large Yorkshire) x Duroc)	Black Slavonian pig	*p-value*	Identification
Decanal	1206	0.86±0.11	0.51±0.08	*0.065*	MS, RI
2-Decenal	1264	0.84±0.06[b]	0.49±0.09[a]	*0.032*	MS, RI
	Total	31.14±1.54[b]	24.14±0.87[a]	*0.017*	
Phenols					
Phenol	990	0.00±0.00[a]	8.22±1.43[b]	*0.005*	MS, RI
2-Methylphenol	1061	2.74±0.14[a]	4.62±0.24[b]	*0.003*	MS, RI
4-Methylphenol	1081	4.06±0.15[a]	6.61±0.08[b]	*0.000*	MS, RI
2-Methoxyphenol	1089	4.97±0.26[a]	9.70±0.72[b]	*0.004*	MS, RI
4-Methoxyphenol	1098	0.33±0.04	0.51±0.05	*0.061*	MS, RI
2-Ethylphenol	1142	0.42±0.07	0.27±0.09	*0.270*	MS, RI
3,5-Dimethylphenol	1153	0.73±0.04	0.83±0.27	*0.727*	MS, RI
3-Ethylphenol	1170	0.00±0.00[a]	0.34±0.03[b]	*0.000*	MS, RI
2-Ethylphenol	1171	0.89±0.04	0.71±0.21	*0.473*	MS, RI
4-Methoxy-3-methylphenol	1179	0.49±0.01	0.61±0.13	*0.400*	MS, RI
2-Methoxy-4-methylphenol	1193	2.24±0.16[a]	3.47±0.24[b]	*0.013*	MS, RI
2-Ethylphenol	1200	0.46±0.03[b]	0.00±0.00[a]	*0.000*	MS, RI
2,6-Dimethoxyphenol	1250	0.25±0.03[b]	0.12±0.01[a]	*0.035*	MS, RI
4-Ethyl-2-methoxyphenol (4-Ethylguaiacol)	1280	1.43±0.09	1.53±0.31	*0.784*	MS, RI
2,6-Dimethoxyphenol	1353	0.65±0.06	0.65±0.07	*0.948*	MS, RI
	Total	19.67±0.84[a]	38.19±2.04[b]	*0.001*	
Alcohols					
1-Penten-3-ol	704	0.31±0.02	0.33±0.07	*0.753*	MS, RI
3-Methylbutanol	748	0.17±0.01[a]	0.31±0.02[b]	*0.004*	MS, RI
Pentanol	771	1.62±0.14	1.66±0.25	*0.884*	MS, RI
2-Furanmethanol	863	0.00±0.00[a]	3.22±0.86[b]	*0.020*	MS, RI
Hexanol	873	0.55±0.07a	2.58±0.10[b]	*0.000*	MS, RI
1-Heptanol	979	0.71±0.09[b]	0.31±0.03[a]	*0.014*	MS, RI
1-Octen-3-ol	986	2.14±0.22	1.74±0.13	*0.192*	MS, RI
2-Ethyl-1-hexanol	1035	0.41±0.02[a]	0.60±0.03[b]	*0.012*	MS, RI
2-Nonen-1-ol	1073	0.52±0.03[b]	0.33±0.03[a]	*0.006*	MS, RI
Octanol	1076	1.60±0.06	1.46±0.09	*0.248*	MS, RI
Phenylethyl alcohol	1112	0.77±0.07[b]	0.34±0.12[a]	*0.032*	MS, RI
	Total	8.81±0.39[a]	12.88±0.74[b]	*0.008*	
Terpenes					
Myrcene	994	0.83±0.22[a]	2.25±0.21[b]	*0.009*	MS, RI
Limonene	1029	4.57±0.21[b]	1.31±0.11[a]	*0.000*	MS, RI
	Total	5.39±0.34[b]	3.56±0.14[a]	*0.008*	
Aromatic hydrocarbons					
2,6-Dimethylpyrazine	913	1.40±0.11	1.12±0.10	*0.116*	MS, RI
Methoxy-phenyl oxime	921	3.08±0.59[b]	0.00±0.00[a]	*0.006*	MS, RI
2,5-Dimethylfuran	970	0.81±0.05[b]	0.00±0.00[a]	*0.000*	MS, RI
3-Methoxy pyridin	999	0.00±0.00[a]	0.36±0.08[b]	*0.012*	MS, RI
Trimethylpyrazine	999	2.00±0.07[b]	0.40±0.04[a]	*0.000*	MS, RI
2,4-Dimethylfuran	1054	0.60±0.04[b]	0.11±0.02[a]	*0.000*	MS, RI
2-Methoxy-3-methyl pyrazine	1133	0.32±0.03[a]	0.60±0.05[b]	*0.008*	MS, RI
Propylcyclohexane	1145	0.00±0.00[a]	0.23±0.01[b]	*0.000*	MS, RI
1,2-Dimethoxy-benzene	1151	1.40±0.07[b]	0.00±0.00[a]	*0.000*	MS, RI
1,4-Dimethoxy-benzene	1187	0.59±0.07[b]	0.00±0.00[a]	*0.001*	MS, RI
1,2,3-Trimethylcyclohexane	1222	0.16±0.02[b]	0.00±0.00[a]	*0.001*	MS, RI
3,4-Dimetoxytoluene	1242	1.60±0.15[b]	0.48±0.23[a]	*0.016*	MS, RI
Cyclooctane	1274	0.56±0.19	0.72±0.30	*0.668*	MS, RI
1,2,3-Trimethylcyclohexane	1284	0.22±0.04	0.14±0.05	*0.274*	MS, RI
3-Ethylbenzofurane	1305	0.39±0.05[b]	0.00±0.00[a]	*0.002*	MS, RI
1,2,3-Trimethoxybenzene	1315	0.97±0.02[b]	0.41±0.15[a]	*0.021*	MS, RI
Eugenol	1360	0.13±0.02[b]	0.05±0.00[a]	*0.034*	MS, RI

Table 3 Continued from previous page.
Tablica 3. Nastavak s prethodne stranice.

Volatile compound	RI	(Landrace x large Yorkshire) x Duroc)	Black Slavonian pig	*p-value*	Identification
1,2,3-Trimethoxy-5-methyl-benzene	1406	0.51±0.06[b]	0.00±0.00[a]	*0.001*	MS, RI
1,2,4-Trimethoxybenzene	1449	0.00±0.00	0.09±0.04	*0.088*	MS, RI
	Total	14.74±0.52[b]	4.70±0.55[a]	*0.000*	
Aliphatic hydrocarbons					
2-Hexene	790	0.40±0.08	0.53±0.15	*0.515*	MS, RI
Tetradecane	1148	0.65±0.07[b]	0.00±0.00[a]	*0.001*	MS, RI
2.5-Dimethyl-2.4-hexadiene	946	0.00±0.00[a]	0.38±0.07[b]	*0.006*	MS, RI
3-Methyl-nonane	978	0.24±0.03[b]	0.00±0.00[a]	*0.001*	MS, RI
2,5-Dimethyl-2,4-hexadiene	1021	0.24±0.05[a]	0.43±0.03[b]	*0.042*	MS, RI
3-Ethyl-2-methyl-1,3-hexadiene	1033	0.33±0.04[b]	0.19±0.03[a]	*0.044*	MS, RI
4,5-Dimethyl-nonane	1038	1.75±0.08[b]	0.50±0.06[a]	*0.000*	MS, RI
3-Ethyl-2-pentene	1049	0.00±0.00[a]	0.22±0.04[b]	*0.007*	MS, RI
5-Undecene	1059	0.36±0.02[b]	0.00±0.00[a]	*0.000*	MS, RI
Undecane	1100	0.56±0.02	0.65±0.09	*0.388*	MS, RI
9-Methyl-5-undecene	1119	1.93±0.16[b]	0.00±0.00[a]	*0.000*	MS, RI
2,5-Dimethyl-2-undecene	1202	0.20±0.03[b]	0.00±0.00[a]	*0.001*	MS, RI
3,3-Dimethyle-hexane	1213	0.91±0.10[b]	0.00±0.00[a]	*0.001*	MS, RI
3-Tridecene	1229	0.45±0.05[b]	0.00±0.00[a]	*0.001*	MS, RI
Tridecane	1300	0.22±0.02[b]	0.00±0.00[a]	*0.001*	MS, RI
Nonadecane	1372	0.40±0.08[b]	0.00±0.00[a]	*0.007*	MS, RI
Tetradecane	1400	0.20±0.02[b]	0.00±0.00[a]	*0.001*	MS, RI
	Total	8.84±0.64[b]	2.91±0.40[a]	*0.001*	
Ketones					
2-Butanone	659	0.40±0.11	0.61±0.13	*0.297*	MS, RI
2-Pentanone	708	0.19±0.02	0.34±0.06	*0.081*	MS, RI
2-Methyl cyclopentanone	839	0.00±0.00[a]	0.23±0.05[b]	*0.011*	MS, RI
3-Methyl cyclolopentanone	846	0.00±0.00[a]	0.21±0.06[b]	*0.020*	MS, RI
2-Heptanone	893	0.44±0.05	0.27±0.04	*0.053*	MS, RI
2-Methyl-2-cyclopenten-1-one	906	0.33±0.02[a]	1.21±0.34[b]	*0.002*	MS, RI
2.5-Dimethyl-2-cyclopenten-1-one	952	0.69±0.01[b]	0.20±0.05[a]	*0.001*	MS, RI
4-Methyl-cyclohexanone	963	0.00±0.00[a]	0.15±0.05[b]	*0.042*	MS, RI
1-Octen-3-one	984	0.32±0.03	0.44±0.11	*0.364*	MS, RI
2,3-Dimethyl-2-cyclopenten-1-one	997	0.45±0.07	0.71±0.11	*0.113*	MS, RI
2,3-Dimethyl-2-cyclopenten-1-one	1040	1.90±0.03	2.61±0.31	*0.086*	MS, RI
3-Methyl-2-cyclohexene-1-one	1057	0.48±0.05	0.29±0.15	*0.274*	MS, RI
2,3,4-Trimethyl-2-cyclopeneten-1-one	1066	0.72±0.04[a]	1.14±0.13[b]	*0.034*	MS, RI
1-Phenyl-ethanone	1068	0.24±0.02[a]	0.56±0.04[b]	*0.002*	MS, RI
2-Nonanone	1094	0.51±0.03[a]	0.87±0.08[b]	*0.014*	MS, RI
4-Ethyl-cyclohexanone	1182	0.24±0.03	0.00±0.00	*0.002*	MS, RI
3-Methyl-2-cyclopenten-1-one	1185	0.14±0.01	0.08±.0.02	*0.076*	MS, RI
	Total	7.06±0.28	9.93±1.48	*0.130*	
Esters					
3-methyl-butanoic acid	856	0.73±0.23[a]	1.39±0.06[b]	*0.049*	MS, RI
Ethyl octanoate	1198	0.85±0.08[b]	0.07±0.00[a]	*0.001*	MS, RI
	Total	1.58±0.21	1.45±0.06	*0.595*	
Acids					
3-Methyl-butanoic acid	853	0.55±0.05[a]	0.90±0.12[b]	*0.046*	MS, RI
2-Methyl-butanoic acid	875	0.00±0.00	0.61±0.28	*0.096*	MS, RI
Octanoic acid	1177	0.46±0.06	0.63±0.07	*0.156*	MS, RI
Decanoic acid	1367	0.74±0.12[b]	0.00±0.00[a]	*0.004*	MS, RI
Decanoic acid	1397	0.85±0.09[b]	0.00±0.00[a]	*0.001*	MS, RI
	Total	2.61±0.25	2.14±0.13	*0.180*	
Sulphur compounds					
Dimethyl-disulfide	751	0.15±0.02	0.08±0.02	*0.083*	MS, RI
	Total	0.15±0.02	0.08±0.02	*0.830*	

Proteolytic and lipolytic reactions occurring during the ripening process represent the key factors affecting the generation of the volatile compounds in dry-cured ham. An essential contribution to the generation of volatiles also has the length of the ripening process, smoking process, spices added during the manufacturing process, pig breeding and feeding and other factors (Petričević et al., 2018; Pugliese et al., 2015, Garcia-Gonzales et al., 2013). The main secondary products of lipid oxidation are aldehydes, and due to low threshold value, they play an important role in determining the overall aroma of dry-cured ham (Pugliese et al., 2015). Aldehydes content detected in LYD pigs (31.14 %) statistically differs ($p < 0.05$) from the ones found in BS samples (24.14 %). The results from LYD samples regarding aldehydes content are in accordance with findings of other authors on other types of dry-cured ham (Pugliese et al., 2015; Petričević et al., 2018; Marušić Radovčić et al., 2016; Marušić et al., 2014). Of all total identified aldehydes, hexanal was found in the greatest proportion (7.90 ± 0.54 in LYD and 9.21 ± 1.11 % in BS) in both samples. Hexanal is a product of oxidation of n-6 fatty acids (such as linoleic and arachidonic acids) and it is considered as a marker of lipid oxidation (Marušić et al., 2015; Petričević et al, 2018). After hexanal, the most abundant aldehydes found in LYD and BS were nonanal (4.40± 0.18 and 4.48±0.87 %), benzaldehyde (3.26 ± 0.29 and 2.44 ± 0.43 %) and octanal (2.79 ± 0.18 and 2.39 ± 0.39 %). Statistically higher ($p<0.05$) amounts of 3-methylbutanal, 2-methylbuthanal, methional, benzenacetaldehyde, 2,4-hexedienal and 2-decenal were found in LYD samples. Saturated aldehydes such as hexanal, octanal and nonanal are significant contributors to the overall aroma, however, when present in higher concentrations, it may lead to rancidity (Laureati et al., 2014; Marušić et al., 2011). 2- and 3-methylbutanal are compounds derived from Strecker degradation reactions from amino acids (such as valine, isoleucine and leucine), on contrary to saturated and unsaturated aldehydes which are derived from lipid oxidation (Garcia-Gonzales et al., 2013). Benzaldehyde and benzenacetaldehyde are related to the length of the ripening, since their concentration increases during ripening process (Garcia-Gonzales et al., 2013; Pugliese et al., 2015). Petričević et al (2018) studied the volatile compounds in four types of traditional Croatian dry-cured hams. In their study, the content of aldehydes found in Dalmatian dry-cured ham was 49.78 %, while the benzaldehyde was aldehyde found in the highest proportion (8.94 %). In other types of dry-cured hams, aldehydes found in highest proportions were hexanal and 3-methylbutanal in Iberian and Jinhua (García-González et al., 2013, Song et al., 2008), and hexanal in Bayonne dry-cured ham (Théron et al., 2010).

Phenols are formed during the smoking process, as a result of pyrolysis and oxidation of lignin. Besides contributing to the specific aroma of smoked meat products, they have an antimicrobial and antioxidative effect (Petričević et al., 2018; Marušić Radovčić et al., 2016). Phenols were the most abundant volatiles in BS samples (38.19±2.04 %), while their content in LYD samples was significantly lower ($p < 0.05$) (19.67±0.84 %). Methoxyphenols are considered as compounds of significant influence on aroma (Marušić Radovčić et al., 2016). In BS samples, 2-methoxyphenol was found in the highest proportion (9.70±0.72 %), while lower amount was found in LYD samples ($p <0.05$) (4.97±0.26 %). In their investigation on smoked Dalmatian dry-cured ham, Marušić Radovčić et al. (2016) detected phenols as the second most abundant group of volatiles (34.3 %). Phenols were present due to the cold smoking process (15-25 °C), characteristic for Dalmatian and Drniš dry-cured ham production process, which distinguishes them from other types of European dry-cured hams

Lipid oxidation can also result in rising of linear and branched alcohol formation (Garcia-Gonzales et al., 2013; Petričević et al., 2018). Branched alcohols may also originate from microbiological degradation of specific aldehydes, which may lead to their higher concentrations in hams with lower NaCl concentration (Garcia-Gonzales et al., 2013). A total of 11 alcohols were detected in investigated samples, while their proportion was significantly ($p < 0.05$) higher in BS samples. 2-furan methanol (3.22±0.86 %) and hexanol (2.58±0.10 %) were the most abundant in BS samples. 1-octen-3-ol was found in LYD samples in the highest proportion (2.14 ± 0.22 %), which is lower than concentrations detected by other authors (Petričević et al., 2018; Marušić Radovčić et al., 2016).

Presence of terpenes in dry-cured hams is generally a result of the addition of spices during the salting phase, although they may also be present due to the animal feedstuffs, such as limonene (Petričević et al., 2018; Marušić et al., 2011). Since

spices haven't been added during the production, low terpenes content in studied samples was found. Statistically significant differences were observed ($p<0.05$) in terpenes content among two groups of samples, with higher terpenes content in LYD samples (5.39±0.34 %) in comparison to BS samples (3.56±0.14 %). Detected terpenes were limonene (1.31-4.57 %) and myrcene (0.83-2.25 %). High terpenes content is characteristic for Istrian dry-cured ham, due to the addition of rosemary, laurel and black pepper (Petričević et al., 2018; Marušić et al., 2011).

The majority of volatiles detected in investigated samples belonged to the group of aromatic hydrocarbons. Their presence in dry-cured hams is mostly attributed to the smoking process (Petričević et al., 2018). BS samples had a significantly lower ($p < 0.05$) aromatic hydrocarbons content (4.70 ± 0.55 %) than LYD samples (14.74 ± 0.52 %). The most abundant volatiles from this chemical group were methoxyphenyloxime (3.08 ± 0.59 %), trimethylpyrazine (2.00 ± 0.07 %) and 3,4-dimetoxytoluene (1.60 ± 0.15 %), for LYD samples and 2,6-dimethylpirazine (1.12 ± 0.10 %), cyclooctane (0.72 ± 0.30 %) and 2-methoxy-3-methyl pyrazine (0.60 ± 0.05 5) for BS samples. Marušić Radovčić et al. (2016) detected 6 aromatic hydrocarbons in samples of Dalmatian dry-cured ham, with 1,2-dimethoxybenzene (1.5 %) as the most abundant one. Aliphatic hydrocarbons originate from fatty acids autooxidation, with no significant influence on aroma due to the high odour threshold (Lorenzo et al., 2013). LYD samples (8.84 ± 0.64 %) had significantly ($p<0.05$) higher share than BS ones (2.91 ± 0.40 %). Data from other studies on smoked dry-cured ham show lower content (1.90 % and 2.2 %) in Dalmatian dry-cured ham (Marušić Radovčić et al., 2016; Petričević et al., 2018) and 3.59 % in Drniš dry-cured ham (Petričević et al., 2018). 9-methyl-5-undecene was the most abundant aliphatic hydrocarbon detected in LYD samples (1.93 ± 0.10 %) and undecane in BS samples (0.65 ± 0.09 %). Other aliphatic hydrocarbons present in higher share were 4,5-dimethylnonan in LYD (1.75 ± 0.08 %) and BS samples (0.5 ± 0.06 %), and 3,3-dimethylhexane (0.91±0.10 %) and tetradecane (0.65 ± 0.07 %) in LYD samples.

Ketones originate from decarboxilation of β-keto acids or β-oxidation of fatty acids or microbiological activity (Pugliese et al., 2015; Petričević et al., 2018). Consequently, smoked dry-cured hams show higher ketone content than the non-smoked ones, owing to the antimicrobial and antioxidant effect of smoke (Petričević et al., 2018). Ketones also determine the final aroma to a great extent, since they are often present in dry-cured ham in high amounts (García-González et al., 2013). Ketones content in LYD and BS samples was 7.06 ± 0.28 % and 9.93 ± 1.48, respectively, with no significant difference observed ($p > 0.05$). Detected values are above those detected in Dalmatian dry-cured ham (Petričević et al., 2018; Marušić Radovčić et al., 2016). The most abundant ketone in both groups of samples was 2,3-dimethyl-2-cyclopenten-1-one with 1.90 ± 0.03 % and 2.61 ± 0.31 % share for LYD and BS samples, respectively. Other authors found 1-hexene-3-on in Jinhua ham (Song et al., 2008), and 1-octen-3-one in samples of biceps femoris of investigated Iberian and non-Iberian dry-cured hams (García-González et al., 2013) as most abundant ketones in dry-cured ham samples.

Esters are generated in intramuscular tissue as a result of the interaction of carboxylic acids and alcohols. The esters formed from short-chain acids (C1-C10) are generally associated with a pleasant aroma, whereas the ones formed from long-chain acids display odours characterized by "fatty" or "greasy" (Toldra et al., 2009). Previous studies reported their increasing concentration with longer ripening processes, while the antioxidant effect of curing salts (primarily nitrates and nitrites) may reduce their content in the final product (Pugliese et al., 2015; Toldra et al., 2009). Our results showed low content of esters in LYD and BS samples, which were 1.58 ± 0.21 % and 1.45 ± 0.06 %, respectively, with no significant differences observed ($p > 0.05$). Our results are consistent with Petričević et al. (2018) who detected 1.42 % of esters in Dalmatian dry-cured ham. In this study, two esters were identified, 3-methylbutanoate and ethyl octanoate. Other authors detected hexyl hexanoate, isohexyl hexanoate, dodecenyl acetate in Dalmatian (Marušić Radovčić et al., 2016), 2- and 3-methylethylester and ethyl ester in Bayonne (Théron et al., 2010) and ethyl-2-methyl butanate and ethyl-3-methylbutanate in Jinhua ham (Song et al., 2008).

5 acids were detected, with content of 2.61 ± 0.25 % and 2.14 ± 0.13 % in LYD and BS samples, respectively. Detected contents are higher than those reported by other authors (Marušić Radovčić et al., 2016; Petričević et al., 2018). The most

abundant acid was 3-methyl butanoic acid, with statistically higher content ($p<0.05$) in LYD (0.55 ± 0.05 %) than in BS (0.90 ± 0.12 %) samples.

Thiols are derived from the sulfur-containing amino acids (methionine, cysteine and cystine) via Strecker degradations (Toldra et al., 2009). In this study, only dimethyl-disulfide was detected, with no significant differences ($p > 0.05$) observed between the studied LYD and BS samples.

CONCLUSION

Different pig genotype showed a statistically significant difference ($p<0.05$) by means of the proportion of individual fatty acids, PUFA/SFA and n6/n3 ratios, colour parameters and content of certain volatile compounds. It can be concluded that besides genetic features of a certain breed, the effect on the quality of smoked dry-cured hams also had a specific diet and rearing system typical for certain breed.

Although pig crossbreeding led to improvements in meat quality traits, results of this study showed that dry-cured ham produced from pure BS pig also possesses good quality traits that could be on par with the ones produced from modern crossbreeds. Following the example of branding traditional meat products from other European Mediterranean pig breeds, dry-cured ham produced from BS pigs could become a recognizable brand on the market, especially in the sphere of tourism and gastronomy.

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Utjecaj različitih genotipa svinja na aromu, boju i sastav masnih kiselina dimljenog pršuta

Sažetak

Cilj ovog rada bio je odrediti utjecaj različite pasmine svinja (tropasminski križanac (landras x veliki jorkšir) x durok (LYD) i crna slavonska (CS) svinja) na boju, udio masti i sastav masnih kiselina u dimljenom pršutu te odrediti hlapive spojeve arome. Udio masti određen je metodom po Smedesu, sastav masnih kiselina određen je metodom plinske kromatografije, dok su hlapivi spojevi arome određeni mikroekstrakcijom na čvrstoj fazi (SPME) i plinsko kromatografsko-masenom spektrometrijom (GC-MS). Iako različita pasmina svinja nije pokazala statistički značajnu razliku ($p>0,05$) u ukupnom udjelu masti, zabilježena je statistički značajna razlika u udjelima pojedinih masnih kiselina. Identificirano je ukupno 103 hlapiva spoja arome, a pripadaju sljedećim grupama kemijskih spojeva: 19 aromatskih ugljikovodika, 17 alifatskih ugljikovodika, 17 ketona, 15 fenola, 14 aldehida, 11 alkohola, 5 kiselina, 2 terpena, 2 estera i 1 spoj sa sumporom. U uzorcima dimljenog pršuta LYD genotipa, najzastupljenije grupe spojeva bile su: aldehidi, fenoli i aromatski ugljikovodici dok su u uzorcima dimljenog pršuta CS najzastupljenije grupe spojeva bile: fenoli, aldehidi i alkoholi.

Ključne riječi: dimljeni pršut, pasmina svinja, aroma, udio masti, masne kiseline

Einfluss unterschiedlicher Schweinegenotypen auf das Aroma, die Farbe und die Fettsäurezusammensetzung von geräuchertem Rohschinken

Zusammenfassung

Das Ziel dieser Studie war es, die Wirkung von verschiedenen Schweinegenotypen ((Landrasse- x Yorkshire) x Duroc (LYD) und schwarzes slawonisches (CS) Schwein)) auf die Farbe, den Fettanteil und die Fettsäurezusammensetzung von geräucherten Rohschinken zu bestimmten und die flüchtigen Aromainhaltsstoffe zu identifizieren. Der Fettanteil wurde durch die Anwendung der Smedes-Methode bestimmt, die Zusammensetzung der Fettsäuren anhand der Gaschromatographie-Massenspektrometrie, während die flüchtigen Aromainhaltsstoffe unter Verwendung der Headspace-Festphasenmikroextraktion (HS-SPME) und der Gaschromatographie mit Massenspektrometrie untersucht wurden (GC-MS). Obwohl unterschiedliche Schweinegenotypen keinen statistisch signifikanten Unterschied (p> 0,05) im Gesamtfettanteil gezeigt haben, gab es jedoch einen Unterschied im Anteil der einzelnen Fettsäuren. Es wurden insgesamt 103 flüchtige Aromainhaltsstoffe identifiziert, die den folgenden Gruppen von chemischen Verbindungen zugeordnet werden können: 19 aromatische Kohlenwasserstoffe, 17 aliphatische Kohlenwasserstoffe, 17 Ketone, 15 Phenole, 14 Aldehyde, 11 Alkohole, 5 Säuren, 2 Ester und 1 Schwefelverbindung. Die am häufigsten vorkommenden Gruppen von chemischen Verbindungen im geräucherten Rohschinken von LYD-Schweinen waren Aldehyde, Phenole und aromatische Kohlenwasserstoffe, während die am häufigsten vorkommenden Gruppen von Verbindungen in geräuchertem Rohschinken des Genotyps CS Phenole, Aldehyde und Alkohole waren.

Schlüsselwörter: geräucherter Rohschinken, Schweinegenotyp, Aroma, Fettgehalt, Fettsäuren

El impacto de diferentes genotipos de los cerdos sobre el aroma, el color y la composición de los ácidos grasos del jamón curado ahumado

Resumen

El fin de este trabajo fue determinar el impacto de diferentes razas de cerdos (el híbrido de tres razas (el Landrace x la raza de cerdo yorkshire grande) x el Duroc (LYD) y el Cerdo Negro de Eslavonia (CS)) sobre el color, el contenido de grasas y la composición de los ácidos grasos en el jamón curado ahumado y determinar los compuestos aromáticos volátiles. El contenido de grasas fue determinado por el método Smedes, la composición de los ácidos grasos fue determinada por la cromatografía de gases y los compuestos aromáticos volátiles fueron determinados por la microextracción en fase sólida (SPME) y por la cromatografía de gases-espectrometría de masas, GC-MS. Aunque las razas de cerdos diferentes no mostraron las diferencias estadísticamente significativas (p>0,05) en el contenido total de grasas, fue determinada la diferencia estadísticamente significativa en el contenido de varios ácidos grasos. Fueron identificados 103 compuestos aromáticos volátiles en total, pertenecientes a siguientes grupos de compuestos químicos: 19 hidrocarburos aromáticos, 17 hidrocarburos alifáticos, 17 cetonas, 15 fenoles, 14 aldehídos, 11 alcoholes, 5 ácidos, 2 terpenos, 2 ésteres y 1 compuesto de azufre. En las muestras del jamón ahumado del genotipo LYD, los grupos de compuestos más representados fueron: aldehídos, fenoles e hidrocarburos aromáticos, mientras en las muestras del jamón ahumado CS los compuestos más representados fueron: fenoles, aldehídos y alcoholes.

Palabras claves: jamón ahumado, raza de cerdos, aroma, contenido de grasa, ácidos grasos

Impatto dei diversi genotipi di maiale sull'aroma, sul colore e sulla composizione degli acidi grassi del prosciutto crudo affumicato

Riassunto

Questa ricerca ha voluto stabilire l'impatto di diverse razze suine - incrocio di tre razze: landrace x grande bianco o Yorkshire x duroc (LYD) e maiale nero di Slavonia (CS), sul colore, sulla percentuale di grassi e sulla composizione degli acidi grassi nel prosciutto crudo affumicato, oltre ad individuare i composti volatili dell'aroma. La percentuale di grassi è stata stabilita mediante il metodo d'analisi secondo Smedes, la composizione degli acidi grassi è stata accertata mediante la gascromatografia, mentre i composti volatili dell'aroma sono stati accertati mediante la tecnica della microestrazione in fase solida (SPME) e la gascromatografia accoppiata alla spettrometria di massa (GC-MS). Sebbene le differenti razze suine non abbiano mostrato una differenza statisticamente rilevante ($p>0,05$) riguardo alla percentuale totale di grassi, è stata registrata, invece, una differenza statisticamente rilevante riguardo alle percentuali di singoli acidi grassi. Circa i composti volatili dell'aroma, ne sono stati identificati 103 in totale, appartenenti ai seguenti gruppi di composti chimici: 19 idrocarburi aromatici, 17 idrocarburi alifatici, 17 chetoni, 15 fenoli, 14 aldeidi, 11 alcoli, 5 acidi, 2 terpeni, 2 esteri e 1 composto con lo zolfo. Nei campioni di prosciutto crudo affumicato del genotipo LYD è stata accertata una maggior presenza dei seguenti gruppi di composti: aldeidi, fenoli e idrocarburi aromatici. Nei campioni di prosciutto crudo affumicato del genotipo CS, invece, è stata accertata una maggior presenza dei seguenti gruppi di composti: fenoli, aldeidi e alcoli.

Parole chiave: prosciutto crudo affumicato, razza suina, aroma, percentuale di grassi, acidi grassi.