Quality of Slavonian ham of Black Slavonian pigfrom semi - outdoor and outdoor system

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short communication

Summary

The research included per 10 hams of Black Slavonian pigs from semi - outdoor and outdoor system. Pigs in both groups were fattened up to 130 kg of body weight. Production systems of keeping pigs (semi - outdoor and outdoor) had a significant effect on some of the analyzed characteristics of Slavonian hams of Black Slavonian pigs. In comparison to hams of pigs from the semi - outdoor system, hams of pigs from the outdoor system had a significantly higher "L" value (39.50 : 35.30) and "a" value (20.00 : 17.50) for color, a higher content of crude fat (12.00 : 10.00), a higher grade for cross- section appearance (6.50 : 5.00), odor (9.00 : 8.50) and taste (14.50 : 14.00). Significant differences between hams of pigs from the outdoor and the semi - outdoor system were not determined considering pH value (5.70 : 5.65), "b" value for color (6.50 : 6.45), aw (0.86 : 0.85), NaCl content (6.00% : 5.95%), water (52.30% : 54.00%), crude protein (27.70% : 27.50%) and ash (8.00% : 8.50%), then a grade for appearance (6.65 : 6.50) and firmness (8.00 : 8.50). The effect of production systems on quality of hams is a result of interaction of keeping conditions, food content and pig genotype to quality of hams, i.e., raw material for the production of hams.

Keywords: *Slavonian ham, Black Slavonian pig, semi - outdoor system, outdoor system*

Introduction

Ham quality is determined by a few indicators: appearance, cross- section appearance, odor and taste. These are the so- called organoleptic (sensory) characteristics of hams that are crucial in perception of consumers (buyers) and their choice of product. Still, some objectively measurable characteristics also indicate to quality of hams: pH value of ham meat, meat color determined by instrumental methods and especially, chemical composition of hams. These characteristics are, more or less, connected to sensory characteristics.

Quality of ham depends on many factors, which can be separated to two groups: factors of ham (raw material) quality and factors of ham processing technology. Factors of ham quality are pig genotype, sex and technology of pig fattening (body weight and age of pigs, breeding systems, housing conditions and pre- slaughter handling of animals). Housing conditions affect the quality of carcasses, therefore of hams too.

In comparison to pigs kept in closed systems, pigs kept in an outdoor system, i.e. on pastures, have more developed hams, with more muscle tissue and intramuscular fat (better marbling), less subcutaneous adipose tissue, more intensive color of muscle tissue and more favorable pH value (Pugliese et al., 2004; Butko et al., 2007; Senčić et al., 2008).

Pigs are combined in a semi- outdoor system: in strongly built stables and in limited space. There are detailed reports on the effect of the semi- outdoor system on slaughterhouse quality of Black Slavonian pigs (Senčić et al., 2008; Senčić et al., 2010a; Senčić et al., 2011). Semi-outdoor (combined) housing system can have a positive influence on consumers' perception of pork and its products, because it ensures conditions for improvement of pork, similar to standards for organic farming. In research by Lebret et al., (2008), a combined semi- outdoor system improved the juiciness of hams with pigs, which is a consequence of a higher content of intramuscular fat.

It is known that the meat of the Black Slavonian breed is characterized by a good quality with a high content of intramuscular and intermuscular fat, favorable pH value, a good water-binding capacity (no shrinkage), which makes it good for technological processing, especially for the production of Slavonian hams and Kulen (Senčić et al., 2010a; Senčić et al., 2011). There are no data in domestic professional literature on the effect of genotype and system of keeping pigs to quality of Slavonian ham. The aim of this paper is to indicate to quality of Slavonian hams of Black Slavonian pigs from semi- outdoor and outdoor system.

Material and methods

The research included per 10 hams of Black Slavonian pigs from semi-outdoor and outdoor system. Pigs in both groups were fattened up to 130 kg of body weight. Pigs from the semi-outdoor system were fed forage containing 14.00% crude protein and 13.37 MJME/kg in the period of 30-60 kg of body weight, and forage containing 11.88% of crude protein and 13.34 MJME/kg in the period of 60-130 kg of body weight, as well as mown green mass (alfalfa) which was eaten ad libitum, the same as forage. Pigs from the outdoor system were kept on pasture during daytime. During night and bad weather conditions pigs were under shelter. Except for the pasture, pigs were consuming food found on stubble fields after cereal harvest (wheat, barley), in wintertime on corn stubble fields, and they had reinforced nutrition by corn, mostly during wintertime (about 150 g/day). Fresh hams were technologically processed as described by Senčić (2009). After 24 hours of cooling, hams were primarily processed, i.e. shaped. Sacrum and pelvic bones (ilium, ischium and pubis) were taken out from the hams. After taking out pelvic bones, ham's muscles were rounded in a semicircle manner, so that its bottom is 3-4 fingers (6 cm) away from the femur head. Salting (dry brining) of the hams was performed in a cold, airy room, with the temperature of 8 -10°C and relative humidity of 85%. Hams were salted separately, rubbing the salt from the inside, then from the outside, by hand. One part of salt was put in a cut of the ankle joint. Salt quantity amounted 6-8% of ham weight. Salting of the hams lasted for 30 days at 6°C. Dry curing of the hams was performed in a classical manner, in a firmly built and airy room (smokehouse). Beech and elm wood were used for smoking. A cold manner of smoking (16-22°C) during 60 days was used. There was maturing of hams after the smoking in a separate, cold and airy room (temperature 15°C, humidity 75%) during the period of 150 days.

Out of sensory characteristics of meat, there were evaluated: appearance (1-7 points), cross-section appearance (1-8 points), odor (1-10 points), firmness (1-10 points) and taste (1 to 15 points). The evaluation of sensory characteristics was performed by a panel of five members.

Out of physicochemical characteristics there was determined a pH value of the hams (m. semimembranaceus) by the pH meter Mettler Toledo, meat color parameters ("L", "a" and "b" values) by the Minolta CR-410 chromometer, content of NaCl, water, crude protein, raw fat and ash, as well as the a_w value. The thickness of subcutaneous adipose tissue was measured at cross-section of the ham, where it is the thickest. Chemical analyses were performed on samples of m. semimembranaceus. Water content was determined by drying of a homogenized sample (200 g) at 105°C till it reached a constant mass. The loss of mass was expressed as the percentage of water in the sample. The content of crude fat was determined by the Soxhlet method and the content of raw protein was researched by the Kjeldahl method. Ash quantity was determined by the burning of organic matter at 550°C till it reached a constant mass. Ash content was expressed as percentage of sample mass. The a_w value of ham meat was determined by Hygrolab 3 (Rotronic). Statistical data processing of the research was performed through a t- test in statistical program (Stat. Soft. Inc.,2008).

Table 1 **Physicochemical properties of Slavonian ham**

Indicators	Semi- outdoor system (n=10)	Outdoor system (n=10)	Significant difference
	$\bar{x} \pm s$	$\bar{x} \pm s$	
Mass (kg)	7.00 ± 1.30	7.30 ± 1.50	NS
Subcutaneous fat (cm)	3.10 ± 0.80	2.40 ± 0.75	*
pH	5.70 ± 0.20	5.65 ± 0.25	NS
Color (CIE L*)	35.30 ± 2.00	39.50 ± 2.10	**
Color (CIE a*)	17.50 ± 2.15	20.00 ± 2.00	**
Color (CIE b*)	6.50 ± 2.00	6.45 ± 2.05	NS
a_w	0.85 ± 0.05	0.86 ± 0.04	NS
NaCl (%)	5.95 ± 1.50	6.00 ± 0.45	NS
Water (%)	54.00 ± 2.45	52.30 ± 2.50	NS
Crude proteins (%)	27.50 ± 2.20	27.70 ± 2.00	NS
Crude fat (%)	10.00 ± 2.25	12.00 ± 2.30	*
Crude Ash (%)	8.50 ± 2.10	8.00 ± 2.00	NS

*p<0.05 **p<0.01 NS = p>0.05

Results and discussion

Basic physicochemical characteristics of Slavonian hams are presented in Table 1. Hams of Black Slavonian pigs from the outdoor system were somewhat heavier than those of the pigs from the semi-outdoor system, but not significantly (p>0.05). It is related to somewhat heavier, i.e. more developed hams of the pigs from the outdoor system, as was determined earlier (Senčić et al., 2010b). Hams of the pigs from the semi-outdoor system had significantly (p<0.05) thicker subcutaneous adipose tissue and more intermuscular fat, whereas hams of the pigs from the outdoor system had more intramuscular fat, which is also indicated by the chemical composition of the muscle tissue.

Hams of the pigs from the semi-outdoor system did not significantly differentiate (p>0.05) in terms of pH value in comparison to hams of the pigs from the outdoor system. pH values of the hams from both groups (5.70 : 5.65) were similar to those from our earlier research of Slavonian hams (Senčić et al., 2010a). Vuković et al. (2005) listed that pH value of Sremska ham was between 6.45 and 6.65 after 12 months of maturing. Karolyi (2002) determined that pH value of Drniš ham was from 5.85 to 5.79. Martin et al. (1999) listed pH value of 5.94 for Iberian ham, and Chizzolini et al., (1996) listed the pH value of 5.83 for Parma ham. Differences in pH values between some authors depend, among other things, on types of muscles where it was measured, as well as on the length of the maturing

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period of dry hams. pH values of dry hams increase by protein decomposition and the increase in the content of non-protein nitrogen during maturing (Virgilli et al., 1999).

Meat and ham color parameters ("L" and "a" values) were similar to those in our earlier research (Senčić et al., 2010b) for Slavonian ham. Significantly higher ($p<0.01$) "L" values for color were determined for ham meat of the pigs from the outdoor system, which can be explained by a higher content of intramuscular fat. The meat of pigs from the outdoor system had a somewhat more intensive red color, which is indicated by higher "a" values". That is the consequence of more intensive color of muscles in hams of pigs from the outdoor system and it is related to a higher motor activity of the pigs, resulting in a higher quantity of myoglobin. In terms of "b" values for meat color, significant differences ($p>0.05$) were not determined.

In terms of water activity (a_w) and a NaCl content, there weren't determined significant differences ($p<0.05$) between the analyzed groups, and the obtained values were within the desirable limits. Water activity decreases to values between 0.8 and 0.9 during drying and maturing of the hams (Girard, 1992). The growth of most bacteria is inhibited when a_w is below 0.91 (Corry, 1973). Vuković et al. (2005) listed that a_w for Sremska hams was between 0.89 and 0.92, whereas Karolyi et al. (2009) determined a_w for Drniš ham to be from 0.781 to 0.805.

The average quantity of NaCl in hams in this research had optimal values (4-6%) listed by Živković and Hadžiosmanović (1996). Saltiness of hams depends on the amount of salt added, but also on the length of the period of drying and maturing (Wirth, 1986). Vuković et al. (2005) listed that Sremska ham contains 4.9-6.3% of NaCl, Baldini et al. (1993) list the quantity of 6.0% for Parma ham, and Karolyi (2002) the quantity of 6.45% of table salt.

Table 2 **Sensory characteristics of the Slavonian ham**

Indicators	Semi- outdoor system (n=10)	Outdoor system (n=10)	Significant difference
	$\bar{x} \pm s$	$\bar{x} \pm s$	
Appearance (1-7)	6.50 ± 0.50	6.65 ± 0.50	NS
Cross-section appearance (1-8)	5.00 ± 0.80	6.50 ± 0.75	**
Odor (1-10)	8.50 ± 0.60	9.00 ± 0.50	*
Firmness (1-10)	8.50 ± 0.80	8.00 ± 0.75	NS
Taste (1-15)	14.00 ± 0.55	14.50 ± 0.55	*

*p<0.05 **p<0.01 NS = p>0.05

Water content in hams of both groups was equal ($p>0.05$) and it was somewhat lower than in Sremska ham (58.9-61.9%), which was determined by Vuković et al. (2005), and it was lower than the content (61.80%) determined by Baldini et al. (1993) in Parma ham.

In terms of water content, crude protein and ash, there weren't determined significant differences ($p>0.05$) between the hams of pigs from semi-outdoor and outdoor system. The content of crude protein in ham meat (27.50% and 27.70%) was lower from the content (29.95%) which was determined earlier for Slavonian ham of pigs of meaty genotypes (Senčić et al., 2010b) and it was closer to the values (25.8%-27.20%) indicated by Vuković et al. (2005) for Sremska ham and the values for Parma ham (26.80%) indicated by Baldini et al. (1993).

Ham meat of the pigs from the outdoor system had a significantly ($p<0.05$) higher content of crude fat (12.00%) in comparison to ham meat of the pigs from the semi-outdoor system (10.00%).

Sensory traits of Slavonian hams are presented in Table 2.

In terms of the appearance and firmness of the hams, there weren't determined significant differences ($p>0.05$) between the analyzed groups. Hams of the pigs from the semi-outdoor system differed significantly from those of the pigs from the outdoor system in terms of the grade of the appearance because they had a thicker layer of subcutaneous adipose tissue and more intermuscular adipose tissue. Odor and taste of hams of the pigs from the outdoor system was significantly ($p<0.05$) better than the same characteristics of ham meat of the pigs from the semi-outdoor system were, which can be connected to a larger consummation of herbs rich in polyunsaturated fatty acids, antioxidants and other substances.

Conclusion

Production systems (outdoor and semi-outdoor) have significant effect on some quality characteristics of hams of Black Slavonian pigs. An outdoor system, in interaction with pig genotype, can improve significantly the quality of Slavonian hams. Hams of the pigs from the outdoor system have a thinner subcutaneous adipose tissue, but also a higher content of crude fats in muscle tissue, a higher degree of lightness (CIE "L") and redness (CIE "a") of the muscle tissue, then a better cross-section appearance, odor and taste. Hams of Black Slavonian pigs, from both analyzed production systems, have a somewhat lower content of crude protein in muscle tissue and a higher content of crude fats, in comparison to reference citations for Slavonian hams of the pigs of meaty genotypes. Slavonian ham of Black Slavonian pigs, with its particular characteristics, especially with expressed sensory traits (odor and taste) and a high content of intramuscular fat, can become a recognizable brand on chosen markets.

Qualität des slawonischen Schinkens von schwarzen slawonischen Schweinen aus dem halboffenen und offenen Haltungssystems

Zusammenfassung

In die Untersuchung sind je 10 Schinken von schwarzen slawonischen Schweinen aus dem halboffenen und offenen Haltungssystem eingeschlossen. Schweine aus beiden Gruppen wurden bis zur Körpermasse 130 kg gemästet. Die Herstellungssysteme der Schweinehaltung (offenes und halboffenes System) hatten einen bedeutenden Einfluss auf einige analysierte Eigenschaften bei Schinken von schwarzen slawonischen Schweinen. Schinken von Schweinen aus offenem System hatten in Bezug auf Schinken der Schweine aus halboffenem System einen bedeutend größeren "L" Wert (39,50 : 35,30) und den "a" Wert (20,00 : 17.50) für die Farbe, einen größeren Anteil der Rohfette (12.00 : 10,00), eine bessere Bewertungsnote für das Aussehen des Schnittes (6,50 : 5,00), Geruch (9,00 : 8,50) und Geschmack (14,50 : 14,00). Es wurden keine bedeutenden Unterschiede zwischen den Schinken von Schweinen aus dem offenen und halboffenen System in Bezug auf den pH Wert festgestellt (5,70 : 5,65), weiters in Bezug auf den "b" Wert für die Farbe (6,50 : 6,45), aw (0,86 : 0,85), Gehalt von NaCl (6,00% : 5,95%), Wasser (52,30% : 54,00%), rohe Proteine (27,70% : 27,50%) und Asche (8,00% : 8,50%), sowie die Bewertung des äußeren Aussehens (6,65 : 6,50) und der Festigkeit (8,00 : 8,50). Der Einfluss der Herstellungssysteme auf die Qualität der Schinken resultierte aus der Interaktion der Haltungsbedingungen, Futtersystem und Genotyp der Schweine auf die Qualität der Keulen, dh. des Rohstoffes für die Herstellung der Schinken.

Schlüsselwörter: *slawonischer Schinken, schwarzes slawonisches Schwein, halboffenes System, offenes System*

Qualità di prosciutti di Slavonia fatti di maiale nero allevato nel sistema semiaperto ed aperto

Somario

La ricerca si focalizza su 10 prosciutti di maiale nero di Slavonia dal sistema d'allevamento semiaperto e su 10 di quell'aperto. I maiali di ambedue gruppi sono stati allevati fino al peso di 130 kg. I sistemi di produzione d'allevamento di maiali (semiaperti e aperti) hanno avuto un'influenza significante su alcune delle caratteristiche analizzate dei prosciutti fatti del maiale nero di Slavonia. I prosciutti fatti dei maiali dal sistema aperto in paragone con i prosciutti dal sistema semiaperto hanno avuto notevolmente più grande il valore "L" (39,50 : 35,30) ed il valore "a" (20,00 : 17,50) per il colore, più grande percentuale di grassi crudi (12,00 : 10,00), il voto migliore per l'aspetto di sezione (6,50 : 5,00), aroma (9,00 : 8,50) e gusto (14,50 : 14,00). Non sono state determinate maggiori differenze tra i prosciutti di maiali del sistema semiaperto e quell'aperto, per quanto riguarda il valore pH (5,70 : 5,65), il valore "b" per il colore (6,50 : 6,45), l'aw (0,86 : 0,85), la percentuale del NaCl (6,00% : 5,95%), d'acqua (52,30% : 54,00%), di proteine crude (27,70% : 27,50%), di ceneri (8,00% : 8,50%), la valutazione dell'aspetto esterno (6,65 : 6,50) e la durezza (8,00 : 8,50).

Parole chiave: *prosciutto di Slavonia, maiale nero di Slavonia, sistema semiaperto, sistema aperto*

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