UDK 636.084.5

Izvorni znanstveni članak
Original scientific paper

INFLUENCE OF DIETARY PROTEIN LEVEL ON THE QUALITY OF RAW AND CURED HAMS OF BLACK SLAVONIAN PIGS

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Summary

Two groups of pigs, each group comprising 16 Black Slavonian pigs, were fed up to 130 kg body weight in the first and the second fattening period. They were fed forage mixtures with lower level (12% and 10%) of crude protein (Group A) and higher level (14 % and 12 %) of crude protein (Group B). Compared to pigs from Group A, pigs from Group B had higher share of ham in carcasses (26.65% : 24.62%) and higher share of muscle tissue in carcasses (15.62% : 14.62%). Hams of pigs from Group B had thinner subcutaneous adipose tissue (3.10 cm : 3.80 cm), lower lightness level L* (35.30 : 39.50) of muscle tissue and lower fat content in muscle tissue (10.00 % : 12.00 %), whereas no significant differences were detected between the groups in terms of pH value, aw value, CIE a* and CIE b* values, and water and ash content. Hams of pigs from Group B received better grades for cross-section appearance (5.00 : 4.90) and firmness (8.50 : 8.00), whereas no significant differences between the groups were detected in terms of appearance, smell and taste.

Key words: nutrition, Black Slavonian pigs, ham quality, cured ham quality.

Introduction

In addition to the technology of ham processing, the quality of cured ham also depends on the quality of hams, i.e. quality of used raw materials. Factors influencing ham quality include genetic (pig genotype, sex) and paragenetic factors (body weight and age of pigs, housing system, conditions of keeping, nutrition, handling pigs before slaughter), that is, technology of pig fattening. Nutrition has strong influence on the quality of hams. It can influence not only the content of both muscle and adipose tissue in hams, but also its chemical composition, thus indirectly influencing physical and chemical properties as well as sensory properties of cured hams. In earlier research (Senčić et al., 2012) it was determined that housing system (semi-outdoor and outdoor) had impact on the quality of cured hams produced from Black Slavonian pigs.

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This paper is focused on influence of nutrition (crude protein level in forage mixtures) on the quality of Slavonian cured ham. Black Slavonian pig is one of the fat-meaty breed and was due to lower productivity, lower the level of protein in the diet compared to the meaty pig genotypes.

Material and methods

The research was conducted on hams and cured hams originating from 32 Black Slavonian pigs, 16 of which were fattened in semi-outdoor system with forage mixtures containing lower level of crude protein (group A), and 16 pigs were fed higher level of crude protein (group B). Pigs in group A were fed forage mixture containing 12.00% crude protein and 13.34 MJ ME/kg in the first phase of fattening (30-60 kg bodyweight), and 10.09% crude protein and 13.00 MJ ME/kg in the second phase of fattening (60-130 kg bodyweight). Pigs in group B were fed forage mixture containing 14.00% crude protein and 13.37 MJ ME/kg in the first phase of fattening (50-60 kg bodyweight), and 11.88% crude protein and 13.34 MJ ME/kg in the second phase of fattening (60-130 kg bodyweight). In addition to forage mixture, pigs were also fed fresh green alfalfa *ad libitum*. Each group of pigs comprised equal number of barrows and gilts. The content of hams in carcasses and tissue contained therein was determined by dissection carried out according to Weniger et al. (1963). Fresh hams were technologically processed, as described by Senčić (2009). Primary processing of hams, i.e. formation was carried out after 24 hour-period of cooling. Sacral bone and pelvic bones (the ischium, the ilium, and the pubis) were removed.

After removal of pelvic bones, ham muscles are rounded in a semi-circle, so that the lower edge is approximately 6 cm away from the head of the femur. Salting (dry curing) of hams was performed in a cold and airy room, at temperature 8-10 ºC and relative air humidity 85 %. Hams were manually rubbed with salt one at a time, first from internal and then from external side. Some salt was also put into the cut of ankle joint. The amount of salt was equal to 6-8 % of ham weight. Hams were cured for 30 days, at 6°C, and smoked in a traditional way, in a solidly built and airy room (*pušnica* - kiln). Beech and hornbeam wood was used for smoking. Cold smoking was applied (temperature 16 – 22°C) during 60

days. Ham ripening took place after smoking in a separate, cold and airy room (temperature 15°C, air humidity 75%) during 150 days.

Physico-chemical properties of cured hams were evaluated on 10 samples of equal numbers of male and female animals. The following physical and chemical properties were determined: pH_1 value (45 minutes post mortem) and pH_2 value (24 hours post mortem) of ham meat (M. semimembranosus) and pH of cured ham meat (M. semimembranosus) by means of "Mettler Toledo" pH metre, parametres of meat colour of fresh hams and cured hams ("L"", "a" and "b" values) by means of "Minolta CR-410" Chroma Metre, content of NaCl, water, crude proteins, crude fat and ash and a_w value. The thickness of subcutaneous fat tissue was measured at the longitudinal cross-section of cured ham, at its thickest part. Chemical analyses were carried out on samples of m. semimembranosus. Content of water was determined by drying a homogenized sample (200 g) at 105°C up to the constant weight. Loss of weight was expressed as percentage of water in the sample. The content of crude fat was determined by means of Soxhlet method, and the content of crude proteins was explored by means of Kjeldahl method. The ash content was determined by burning organic matter at 550°C until a constant weight. Ash content is expressed as percentage of the remaining weight of a sample. The a_w value in cured hams was measured by means of "HygroLab 3 (Rotronic)" by applying Aw Quick model on samples prepared by grinding and homogenization of 100 g from the central part of the cured ham.

The following sensory properties were graded: appearance (1-7 points), cross-section appearance (1-8 points), odour (1-10 points), firmness (1-10 points) and taste (1-15 points). Evaluation of sensory properties was carried out by a five-member expert board. Rating sensory properties of cured hams was the way he described Senčić (2009.).

Statistical analysis of data was performed using the computer program Stat. Soft. Inc. (2010.).

Results and discussion

Quality (composition) of hams in relation to nutrition provided to pigs is shown in the Table 1. Carcasses of pigs fed with forage mixture

containing higher level of crude proteins (group B) had higher share of hams in carcasses in relation to carcasses of pigs fed with lower level of crude proteins. No significant differences ($p>0.05$) were detected in absolute and relative share of muscle tissue in hams between the groups of Black Slavonian pigs. However, meat from hams from group B had higher share in carcasses in relation to ham meat from group A. According to a research conducted by Nieto et al. (2003), reduction of crude protein level in pig rations resulted in increased fat content in hams. However, Barea et al. (2008) and Senčić et al. (2010) did not detect influence of protein level in pig nutrition on the content of intramuscular and subcutaneous tissue in hams.

No significant differences ($p>0.05$) were detected in terms of pH_1 and pH_2 values of ham meat and colour parametres (CIE "L", "a" and "b") between the analyzed groups of pigs.

TABLE 1. – THE QUALITY OF HAMS OF BLACK SLAVONIAN PIGS IN RELATION TO DIETARY PROTEIN LEVEL

Indicators	Dietary protein level		Level of significance
	A-higher level (n=16)	B-lower level (n=16)	
	$\bar{X}$ ± s	$\bar{X}$ ± s	
Body mass of a pig, kg	130.40±6.70	130.37±6.84	NS
Cold carcass mass, kg	51.22±4.39	51.08±3.87	NS
Mass of the unformatted ham, kg	12.59±0.95	13.54±1.02	NS
Share of the ham in carcass, %	24.62±1.08	26.55±1.42	**
Thigh meat in carcass, %	14.62±1.10	15.62±1.38	*
Shares of muscle tissue in the ham: Kg %	 7.49±0.86 59.49±3.16	 7.95±0.62 58.81±3.42	 NS NS
pH_1 of meat (m. semimembranosus)	6.30±0.20	6.28±0.20	NS
pH_2 of meat (m. semimembranosus)	5.65±0.18	5.60±0.20	NS
Meat colour: CIE L* CIE a* CIE b	 47.40±2.00 6.80±2.20 0.88±1.90	 46.50±1.95 7.00±2.10 0.60±1.95	 NS NS NS

** $p<0.01$; * $p<0.05$; NS $p>0.05$

Physical and chemical properties of cured ham, in relation to nutrition, are shown in the Table 2.

TABLE 2. – PHYSICAL AND CHEMICAL PROPERTIES OF CURED HAMS (M. SEMIMEMBRANOSUS) OF BLACK SLAVONIAN PIGS IN RELATION TO DIETARY PROTEIN LEVEL (n = 10)

Indicators	Dietary protein level		Significance of differences
	A-higher level (n=10)	B-lower level (n=10)	
	$\bar{X}$ ± s	$\bar{X}$ ± s	
Weight of cured ham, kg	6.80±1.35	7.00±1.30	NS
The thickness of subcutaneous adipose tissue, cm	3.80±0.75	3.10±0.80	*
pH	5.75±0.20	5.70±0.20	NS
Colour: CIE L* CIE a* CIE b*	 39.50±2.00 18.00±2.00 6.50±1.95	 35.30±2.00 17.50±2.15 6.50±2.00	 ** NS NS
aw	0.85±0.04	0.85±0.05	NS
NaCl, %	6.00±0.40	5.95±1.50	NS
Water, %	52.00±1.50	54.00±2.45	*
Crude proteins, %	27.55±2.00	27.50±2.20	NS
Crude fat	12.00±2.20	10.00±2.25	*
Crude ash, %	8.45±2.00	8.50±2.10	NS

** $p<0.01$; * $p<0.05$; NS $p>0.05$

No significant differences ($p>0.05$) were detected between the analyzed groups of pigs in terms of cured ham weight. Cured hams originating from pigs fed with lower level crude protein mixtures (group A) had significantly ($p<0.05$) thicker subcutaneous adipose tissue. No significant differences ($p>0.05$) were detected between the analyzed groups of pigs in terms of pH value of cured hams. The pH value of cured hams in this research is similar to the values (5.97-5.85) reported by Karolyi et al. (2009) for *Drniš pršut* (cured ham produced in Drniš area, Croatia) and Chizzolini et al. (1996) for Parma

prosciutto (5.83), and lower than the values (6.45-6.65) reported by Vuković et al. (2005) for cured ham produced in Srijem, Croatia. Differences in pH value of cured hams among particular hams depend, among other, on the period of ripening. Extended ripening period and protein decomposition result in higher content of non-protein nitrogen, which leads to increased pH values of dry hams (Virgilli et al., 1999).

Ham meat from group A was significantly ($p<0.01$) lighter in colour (L* value) in relation to ham meat from group B. This is probably related to higher content of intramuscular fat, which is also indicated by chemical composition of cured hams (Table 3). No significant differences ($p>0.05$) were established between the groups in terms of redness (a*) and yellowness (b*). Values for colour parameters (L*, a* and b*) of cured hams in this research are similar to values determined in earlier research on the quality of Slavonian cured ham (Senčić et al., 2012). L* values for meat colour in this research are somewhat lower, whereas a* and b* values are significantly higher than values reported by Bosi et al. (2000) for Parma cured ham and Cilla et al. (2006) for dry hams originating from Duroc crossbreeds.

No significant differences ($p>0.05$) between the analyzed groups of hams were detected in terms of water activity (a_w) and NaCl content, and obtained values were within desirable limits. Optimal values for NaCl in cured hams are between 4 and 6% (Živković and Hadziosmanović (1996). Baldini et al. (1993) determined salt content in Parma ham by 6.0%, Karolyi et al. (2002) salt content of 6.45% in Drniš prosciutto, and Vuković et al. (2005) content of 4.9 to 6.3% in srijem ham. The study Vuković et al. (2005) value for a_w srijem ham was between 0.89 and 0.92, and research Karolyi et al. (2009) for drniš ham from 0.781 to 0.805. Cured hams originating from pigs fed with forage mixture containing higher level of crude proteins (group B) had a significantly higher ($p<0.05$) content of water and less fat in relation to cured hams from pigs fed with lower level of crude proteins. No significant differences ($p>0.05$) between the analyzed

groups of pigs, i.e. cured hams were detected in terms of crude protein level and ash content.

TABLE 3. – SENSORY PROPERTIES OF CURED HAMS OF BLACK SLAVONIAN PIGS IN RELATION TO DIETARY PROTEIN LEVEL

Indicators	Dietary protein level		Significance of differences
	A-higher level (n=10)	B-lower level (n=10)	
	$\bar{X} \pm s$	$\bar{X} \pm s$	
Appearance	6.45±0.45	6.50±0.50	NS
Cross-section appearance	4.50±0.55	5.00±0.60	*
Firmness	8.00±0.55	8.50±0.60	*
Odour	8.45±0,55	8.50±0.60	NS
Taste	14.00±0,50	14.00±0.55	NS

* $p<0.5$; NS $p>0.05$

Sensory properties of cured hams (Table 3) were similar in both analyzed groups of cured hams, and very significant differences ($p<0.01$) were determined only in terms of cross-section appearance. Cured hams originating from pigs fed with forage mixture containing lower level of crude proteins had somewhat higher content of subcutaneous adipose tissue, which resulted in lower grades for cross-section appearance.

Conclusion

The level of crude protein in forage mixtures has a significant influence on the share of hams and ham meat in carcasses and hams. Pigs fed with forage mixture containing higher level of crude protein have a very significantly ($p<0.01$) higher share of hams in carcasses and significantly ($p<0.05$) higher share of ham meat in carcasses, and they produce hams with significantly ($p<0.05$) thinner subcutaneous fat tissue, with very significantly ($p<0.01$) lower lightness level of muscular tissue and significantly ($p<0.05$) lower fat content in muscular tissue. Hams of

pigs fed with higher level of crude protein in forage mixtures have significantly ($p<0.05$) better cross-section appearance and firmness. Hams of Black Slavonian pigs in both analyzed groups received high grades for odour and taste, but no significant differences ($p>0.05$) were detected for these properties. Given the quality cured hams Black Slavonian pigs to the first and second part of fattening, to be fed diets with higher levels of crude protein (14% and 12%).

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UTJECAJ RAZINE PROTEINA U KRMNIM SMJESAMA NA KVALITETU BUTOVA I ŠUNKI OD CRNIH SLAVONSKIH SVINJA

Sažetak

Po 16 crnih slavonskih svinja hranjeno je do 130 kg tjelesne mase, u prvom i drugom periodu tova, krmnim smjesama s nižom razinom (12% i 10%) sirovih proteina (skupina A) i s višom razinom (14 % i 12 %) sirovih proteina (skupina B). Svinje skupine B u odnosu na one skupine A imale su veći udio butova u polovicama (26,65% : 24,62%) i veći udio mišićnog tkiva buta u polovicama (15,62% : 14,62%). Šunke svinja skupine B imale su tanje potkožno masno tkivo (3,10 cm : 3,80 cm), manji stupanj svjetloće L* (35,30 : 39,50) mišićnog tkiva i manji sadržaj masti u mišićnom tkivu (10,00 % : 12,00 %), dok u pogledu pH, aw vrijednosti, CIE a* i CIE b* vrijednosti, sadržaja vode i pepela, nisu utvrđene značajne razlike između skupina. Šunke svinja skupine B imale su veću ocjenu za izgled presjeka (5,00 : 4,90) i čvrstoću (8,50 : 8,00), dok u pogledu vanjskog izgleda, mirisa i okusa nisu utvrđene značajne razlike između skupina. Šunke od crnih slavonskih svinja obje analizirane skupine imale su visoke ocjene za miris (8,45:8,50) i okus (14,00:14,00).

Ključne riječi: hranidba, crne slavonske svinje, kvaliteta butova, kvaliteta šunki.

Primljeno: 08.11.2012.