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POSTER

Carcass composition and meat quality of pigs from different pork chains in the production of Baranjski kulen (PGI)

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SUMMARY

Present study deals with carcass composition and meat quality of pigs originating from three pork chains for the production of Baranjski kulen (PGI). These pork chains differ in breed and rearing system. In the first pork chain, modern hybrid pigs were fattened intensively up to 160 kg average live weight, which they reach in 6 months. Second pork chain represented Duroc x Large White crossbreds reared in straw bedded (deep litter) facilities, slaughtered at approximately 180 kg live weight and at the age of 12 months. The last of investigated pork chains involved Black Slavonian (Crna slavonska) pigs fed only on pasture until they reached average live weight 110 kg (age = 12 months). The Carcass composition was presented as carcass weight and the weight (kg) of main joints used in the production of Baranjski kulen (ham, shoulder, loin) as well as their share (%) in the whole carcass. These joints were dissected into main tissues (muscle, fat and bones. Investigated carcass traits were all significantly affected by pork chain. Meat quality traits were taken 24 hours after the slaughter including: pH24; meat color (CIE L*a*b*); EZ_drip; cooking loss and Warner-Bratzler shear force. All of the meat quality traits differed significantly between the investigated pork chains with the exception of Warner-Bratzler shear force measured on *longissimus dorsi* muscle.

Comparação das características de carcaça e qualidade da carne de suínos Black Slavonian em função da duração do período de engorda

Palavras chave adicionais
Produção de suínos.
Sistemas de produção.
Qualidade dos produtos.

RESUMO

O presente estudo aborda a composição da carcaça e da qualidade da carne de suínos provenientes de três fileiras distintas de criação de porcos destinados à produção de kulen Baranjski (IGP). Estas fileiras diferem na raça e no sistema de produção. Na primeira fileira, usaram-se suínos híbridos modernos que foram engordados intensivamente até ao peso vivo 160 kg, em média, atingidos aos 6 meses de idade. Na segunda cadeia produtiva utilizou-se um genótipo cruzado, Duroc x Large White, sendo os suínos criados em instalações com cama de palha espessa, foram abatidos com aproximadamente 180 kg de peso vivo e idade de 12 meses. A última das fileiras produtivas investigada envolveu porcos eslavos pretos (Crna slavonska) alimentados exclusivamente em pastoreio, até chegarem aos 110 kg de peso vivo em média (idade = 12 meses). A composição das carcaças foi apresentada como o peso de carcaça e a proporção do peso dos cortes nobres (kg) principais usados na produção de kulen Baranjski (presunto, pá e lombo) bem como a percentagem relativa de cada um na carcaça inteira. Cada peça foi dissecada nos principais tecidos (músculo, gordura e osso). Os parâmetros avaliados nas carcaças foram todos significativamente afetados pela fileira de produção. Os parâmetros de qualidade na carne foram obtidos 24 horas após o abate, incluindo: pH24; cor de carne (CIE L * a * b *); perda por gotejamento pelo método EZ drip; perda por cozedura e força de cisalhamento Warner-Bratzler. Todos os parâmetros de qualidade da carne diferiam significativamente entre as fileiras investigadas com exceção da força de cisalhamento Warner-Bratzler medida no músculo *Longissimus dorsi*.

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INTRODUCTION

Baranjski kulen is a dry fermented sausage traditionally produced in eastern Croatia consumption of which has been greatly propagated by its entering in the register of protected geographical indications as Protected Geographic Indication (PGI) in 2015. The quality of pork meat is to a great extent dependent on the breed, genotype, feeding regime, pre-slaughter treatment and other interacting factors but also on certain features of a production system (Olsson & Pickova 2005). Bonneau & Lebret (2010) reported more than 80 pork production systems in European countries: about half of them are considered conventional, while other half can be regarded as alternative based on claims on eating quality, animal welfare, environment, local, etc. The claims on higher meat quality rely on the fact that it can be improved by choosing the appropriate pig breeds, rearing system and feeding strategy. For example, some production systems are based on local breeds kept in extensive rearing conditions, whereas in some systems conventional hybrids in intensive re-

aring are used with only limited specifications such as prolonged fattening period or specified minimum age at slaughter, improved housing etc. In present study, the most influential factors (breed, age at slaughter, slaughter weight, feeding regime, rearing system) are combined into the pork chains aimed at the production of meat which could be claimed on higher quality, hence suitable for the production of Baranjski kulen (PGI); the aim of this study is to investigate the differences in carcass and meat quality traits of pigs originating from these pork chains.

MATERIAL AND METHODS

Animals/Production chains

The pigs from present study were obtained from three pork chains for the production of Baranjski kulen, differing in breed and rearing system. In the first pork chain (PC1), modern hybrid pigs were fattened intensively up to 160 kg average live weight, which they reached in 6 months. Second pork chain (PC2) was represented by Duroc x Large White crossbred pigs reared in straw bedded (deep litter) facilities fed ad libitum commercial diets, slaughtered at approximately 180 kg live weight at the age of 12 months. The last of investigated pork chains (PC3) involved Crna slavonska (Black Slavonian) pigs kept in extensive conditions; fed only on pasture until they reached approximate live weight of 110 kg (age = 12 months). From each pork chain 16 pigs (8 gilts and 8 barrows) were selected for the investigations of carcass composition and meat quality.

Carcass composition and meat quality traits

After slaughter, carcass measurements and meat quality traits were determined. According to the specification of Baranjski kulen (PGI), only three pork cuts are used as raw meat basis for further processing into the final product; ham, loin and shoulder. These cuts were separated by knife into main tissues (lean, subcutaneous fat with skin and bones) using manual method of dissection as for EU reference method described by Walstra & Merkus (1996) and presented as the weight (kg) and share (%) in the whole carcass. Following meat quality traits were determined: ultimate pH (pH_{24}) measured in *longissimus dorsi* (LD) and *semimembranosus* (SM) muscles; EZ drip as described by Christensen 2003; meat color (CIE L* a* b*, Commission Internationale de l'Eclairage, 1976) measured by Minolta CR-300 (Minolta Camera Co. Ltd., Osaka Japan) at LD muscle cut and Warner-Bratzler Shear Force (WBSF), which was determined on thawed LD muscle cooked in the water bath until internal temperature 73°C and cooled overnight. WBSF was determined on minimally 6 subsamples using TA.XT*plus* texture analyzer (Stable Micro Systems, UK).

Statistical analysis

GLM procedure of Dell Statistica v. 12 software (Dell Inc. 2015) was used to examine the effect of Production chain on carcass composition and meat quality traits of investigated pigs. The groups were compared using Tukey's range test ($p<0.05$).

RESULTS AND DISCUSSION

All of the carcass traits significantly differed (**Tables I** and **II**). The heaviest carcasses had the pigs from PC2, followed by pigs from PC1and PC3 pork chains. The presented results show that despite almost 30 kg difference in cold carcass weight between PC1 and PC2 pigs in favor of the later, there were no significant differences between the two in the weights of ham, shoulder and loin cuts as well as in the weight of belonging muscle, with the exception of loin cut where no difference was observed for the muscle weight. This indicate that the most of the differences in carcasses between PC1 and PC2 pigs can be attributed to the amount of fatty tissue in the carcass. Pigs from PC3 had the lightest carcasses and consequently lower weights of almost all investigated carcass traits with the exception of fat weight in ham and shoulder which was significantly different only in comparison with the PC2 pigs.

Regarding the shares of the most valuable cuts (taken together), it can be seen that their percentage was higher in the pigs from PC1 than in the pigs from other two pork chains, which did not differ among each other; this is valid also for the percentages of ham

Table I. Means and standard deviations for carcass traits in absolute terms (kg) of pigs from different pork chains (Média e desvio padrão para parâmetros da carcaça em termos relativos nas diferentes fileiras de porco).

Trait	Modern hybrid intensive production (PC1)	Du x LW deep litter (PC2)	Black Slavonian pasture (PC3)
Cold carcass weight (kg)	$127.15^{b} \pm 5.68$	$150.60^{a} \pm 16.39$	$86.00^{c} \pm 14.98$
Ham weight (kg)	$16.82^{a} \pm 0.72$	$17.13^{a} \pm 2.14$	$9.43^{b} \pm 1.64$
Ham muscle weight (kg)	$12.48^{a} \pm 0.74$	$11.85^{a} \pm 1.52$	$5.99^{b} \pm 0.86$
Ham fat weight (kg)	$2.98^{b} \pm 0.46$	$3.91^{a} \pm 0.89$	$2.52^{b} \pm 0.77$
Shoulder weight (kg)	$10.28^{a} \pm 0.54$	$9.96^{a} \pm 1.17$	$5.99^{b} \pm 0.93$
Shoulder muscle weight (kg)	$7.20^{a} \pm 0.43$	$6.65^{a} \pm 1.01$	$3.85^{b} \pm 0.46$
Shoulder fat weight (kg)	$1.76^{a} \pm 0.14$	$2.41^{b} \pm 0.52$	$1.60^{a} \pm 0.54$
Loin weight (kg)	$10.81^{a} \pm 0.82$	$10.93^{a} \pm 1.20$	$5.67^{b} \pm 1.35$
Loin muscle weight (kg)	$6.18^{a} \pm 0.60$	$5.50^{b} \pm 0.82$	$2.38^{c} \pm 0.67$
Loin fat weight (kg)	$2.98^{a} \pm 0.44$	$3.31^{a} \pm 0.66$	$1.98^{b} \pm 0.64$

^{abc}Values between columns with different superscripts are statistically different (Tukey's HSD, $P<0.05$)

Table II. Means and standard deviations for carcass traits in relative terms (%) of pigs from different pork chains (Média e desvio padrão para parâmetros da carcaça em termos absolutos nas diferentes fileiras de porco).

Trait	Modern hybrid intensive system (PC1)	Du x LW deep litter (PC2)	Black Slavonian pasture (PC3)
Three main joints (%)	29.84^{a} ± 1.13	25.25^{b}± 0.53	24.53^{b} ± 1.06
Ham (%)	13.24^{a} ± 0.58	11.36^{b} ± 0.45	10.98^{b} ± 0.50
Ham muscle (%)	74.19^{a} ± 2.52	69.25^{b} ± 3.93	63.77^{c} ± 2.46
Ham fat (%)	17.76^{a} ± 2.80	22.78^{b} ± 3.72	26.19^{c} ± 3.37
Shoulder (%)	8.09^{a} ± 0.38	6.62^{b} ± 0.42	7.00^{b} ± 0.58
Shoulder muscle (%)	70.02^{a} ± 2.14	66.63^{ab} ± 5.25	64.77^{b} ± 5.51
Shoulder fat (%)	17.14^{a} ± 1.74	24.34^{b} ± 5.05	26.10^{b} ± 5.64
Loin (%)	4.86^{a} ± 0.50	3.66^{b} ± 0.41	2.74^{c} ± 0.40
Loin muscle (%)	57.13^{a} ± 3.32	50.32^{b} ± 5.27	41.78^{c} ± 3.08
Loin fat (%)	27.50^{a} ± 2.89	30.12^{b} ± 4.11	34.38^{b} ± 4.38

^{abc}Values between columns with different superscripts are statistically different (Tukey's HSD, P<0.05)

Table III. Means and standard deviations for meat quality traits of pigs from different pork chains (Média e desvio padrão para parâmetros de qualidade da carne nas diferentes fileiras de porco).

Trait	Modern hybrid intensive system (PC1)	Du x LW deep litter (PC2)	Black Slavonian pasture (PC3)
pH_{24} – SM muscle	5.62^{b} ± 0.12	5.87^{a} ± 0.12	5.69^{b} ± 0.13
pH_{24} – LD muscle	5.63^{b} ± 0.10	5.80^{a} ± 0.09	5.86^{a} ± 0.16
CIE L*	51.87^{a} ± 2.37	52.55^{a} ± 3.22	44.16^{b} ± 3.43
CIE a*	7.85^{b} ± 0.94	7.99^{ab} ± 1.70	9.26^{a} ± 1.76
CIE b*	1.73^{b} ± 0.75	1.12^{b} ± 0.96	2.80^{a} ± 0.96
EZ_drip (%)	7.62^{a} ± 2.02	6.10^{b} ± 1.61	1.16^{c} ± 0.41
Cooking loss (%)	34.46^{a} ± 0.93	31.84^{b} ± 2.03	32.87^{ab} ± 2.56
WBSF (N)	56.79 ± 6.22	60.24 ± 11.63	55.77 ± 9.02

^{abc}Values between columns with different superscripts are statistically different (Tukey's HSD, P<0.05).

and shoulder taken as separate cuts. The loin percentage differed between all three pork chains; the highest loin percentage was found in the pigs from PC1, the lowest in PC3. Significant differences were found in muscle percentage of the dissected cuts between the pigs from pork chains; from the highest to lowest: PC1, PC2 and PC3. The only exception was muscle percentage in the shoulders of pigs from PC2 which did not differ from other two pork chains. The share of fat in all of the investigated cuts was the lowest in the pigs from PC1. The differences between the pigs from PC2 and PC3 in that respect was significant in the case of ham while no differences were established in the case of shoulder and loin. The results of present study confirm the general pattern shown by Lebret et al. (2014) in which feeding practices and rearing systems influence carcass composition of different pig breeds through relative deposition of muscle and fatty tissue.

Table III shows meat quality traits. The values of pH_{24} measured in SM and LD muscles differed between the investigated pork chains but indicated no deteriorations in meat quality. Meat lightness (CIE L*) measured on LD muscles of pigs from PC3 chain was significantly lower than in other measured pigs. In addition, the pigs from same pork chain had higher level of redness (CIE a*) and yellowness (CIE b*). Drip loss in meat samples of pigs from PC3 was lower than in other two pork chains whose samples indicated excessive water release. The pig meat with pH_{24} values between 5.4 and 6, drip loss lower than 5% and CIE L* between 42 and 50 most of the authors consider as favorable (Warner et al., 1997; Kušec et al., 2005). Due to the paler color (L* above 50) and excessive water loss pork originating from PC1 and PC2 chain appear to be less suitable for the production of high quality traditional products. Although pork from PC3 chain had significantly lower EZ drip, the cooking loss had intermediate values falling between other two significantly differing pork chains. At the same time, the texture of investigated samples was not affected by pork chain. Cooking loss is a very complex trait influenced by many interacting factors including water holding capacity (WHC) and intramuscular fat (IMF) content, but there is still no unambiguous interpretation of these effects (Jonsäll et al. 2001). The meat of Crna slavonska pigs is known for its exceptionally high IMF and low WHC (Karoly et al. 2007). Present results confirm earlier studies showing that local breeds of pigs kept outdoor exhibit slow growth rates, low lean meat percentage and high share of fat in their carcasses, but also high meat quality (Bonneau & Lebret 2010; Pugliese & Sirtori 2012). Although the pigs from PC2 and PC3 were reared in production systems allowing the

claims on enhanced quality, the technological quality traits were mainly inferior when compared with meat from Crna slavonska breed (PC3).

CONCLUSION

In present study, the production systems were set up in a way that each chosen breed could fully express its genetic potential; the results show advantage of hybrid pigs in carcass traits, but meat quality was clearly more favorable in Crna Slavonska breed which makes them a better choice for the production of Baranjski kulen (PGI). Further investigation of sensory and chemical characteristics of the product originating from these pork chains are suggested.

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