Acta agriculturae slovenica, suplement 1(avgust 2004), 67–72.

http://www.bfro.uni-lj.si/zoo/publikacije/zbornik/suplementi/index.htm

Original scientific article
Izvirni znanstveni prispevek

MEAT QUALITY, BLOOD STRESS INDICATORS AND TRIMMED CUT YIELD COMPARISON OF BLACK SLAVONIAN PIG WITH MODERN PIGS IN THE PRODUCTION OF SLAVONIAN KULEN

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ABSTRACT

The muscle quality traits (pH_1 and pH_{24} and colour of *M. longissimus dorsi*), blood stress indicators (CPK – creatine phosphokinase, LDH – lactate dehidrogenase, AST – aspartat aminotransferase and glucose) and trimmed cut lean yield (proportion of selected lean meat of hams, loin, shoulders and neck) were evaluated for traditional Black Slavonian (BS) and modern pig genotypes: Large White × Swedish Landrace (LW×SL) and Large White × Swedish Landrace sired with Duroc (LW×SL)×D used for the production of Slavonian Kulen sausages. The BS pigs had the lowest serum CPK and AST activity which indicates their lower suspectability to stress ($P<0.05$). The pH values were inside normal pork quality range for all evaluated genotypes but the older BS and (LW×SL)×D pigs have more desirable loin colour (lower $L*$ and higher $a*$ values) for Slavonian Kulen processing. The trimmed cut lean yield (%) of hams was the lowest in BS pigs (29.31% of primal cut and 7.04% of carcass, $P<0.05$). The (LW×SL)×D group had the highest trimmed cut lean yield of loin (34.14% and 4.93%, $P<0.05$) and the LW×SL group had the lowest utilization of neck (22.31% and 1.12%, $P<0.05$). For shoulders there were no statistically significant differences. In total, the utilization of primal cuts for the production of Slavonian Kulen in BS group (26.75%) were considerably lower than in (LW×SL)×D group (32.33%, $P<0.05$) and utilization of carcass for production of Slavonian Kulen was higher within the (LW×SL)×D pigs (19.85%, $P<0.05$) than in BS (16.26%) and LW×SL (16.28%) pigs.

Key words: pigs / breeds / Black Slavonian pig / blood stress indicators / meat products / quality / Slavonian Kulen

PRIMERJAVA LASTNOSTI KAKOVOSTI MESA, KRVNIH INDIKATORJEV STRESA IN VSEBNOST PUSTEGA MESA PRI PRAŠIČIH ZA PROIZVODNJO IZDELKA SLAVONSKI KULEN ČRNE SLAVONSKE PASME IN MODERNIH PASEM

IZVLEČEK

Lastnosti mišičnega tkiva (pH_1, pH_{24}, barva *M. longissimus dorsi*), krvni indikatorji stresa (CPK–kreatin fosfokinaza, LHD–laktat dehidrogenaza, AST–aspartat aminotransferaza in glukoza) in vsebnost pustega mesa (delež pustega mesa v stegnu, ledjih, plečih in vratu) so bili ovrednoteni pri tradicionalni črni slavonski pasmi (BS) in pri modernih pasmah prašičev: large white × švedski landrace (LW×SL) ter large white × švedski landrace križan z duroc pasmo (LW×SL)×D, ki jih uporabljajo za izdelek slavonski kulen. Najnižjo aktivnost serumskega CPK in AST, ki sta kazalca občutljivosti za stres, so izmerili pri BS prašičih ($p<0,05$). Pri vseh proučevanih genotipih so bile pH vrednosti za kakovost svinjine v normalnih mejah, vendar pa so imeli prašiči pasem BS in (LW×SL)×D bolj primerno barvo mesa (nižje L* in višje a* vrednosti) za izdelke slavonski kulen. Vsebnost pustega mesa (%) v stegnu je bila najnižja pri prašičih BS (29,31% v kosu in 7,04% v klavnem trupu, $p<0,05$). Skupina (LW×SL)×D je imela najvišjo vsebnost pustega mesa v ledjih (34,14% in 4,93%, $p<0,05$), skupina LW×SL pa najnižjo vsebnost v vratu (22,31% in 1,12%, $p<0,05$). Vsebnost pustega mesa plečeta se med skupinami ni statistično značilno razlikovala. Uporabnost osnovnih kosov za izdelek slavonski kulen je bila pri skupini BS (26,75%) občutno slabša kot pri (LW×SL)×D skupini (32,33%, $p<0,05$), uporabnost klavnih trupov za izdelek slavonski kulen je bila pri prašičih pasme (LW×SL)×D (19,85%, $p<0,05$) boljša kot pri prašičih pasem BS (16,26%) in LW×SL (16,28%).

Ključne besede: prašiči / pasme / črna slavonska pasma / krvni indikatorji stresa / meso / mesni izdelki / kakovost / slavonski kulen

INTRODUCTION

The Slavonian Kulen is a traditional dried, fermented sausage, produced in the region of Slavonia, in the east of Croatia. It consists of a mixture of minced pork, salt and spices such as paprika and garlic, which is stuffed in pork blind gut (*caecum*). The sausage is then cold smoked (< 25 ºC), slowly dried and left to mature for five months or more. In the past, Slavonian Kulen was made principally from the Black Slavonian pig, a breed which originated, by Count Pfeifer, from Berkshire and Poland China crossed with Black Mangalitsa. Nowadays, this breed is rare and Slavonian Kulen is produced mainly from the meat of modern white pigs and various crosses. As a part of current trends in the protection of high quality traditional foods from specific regions, it becomes important to conserve the originality of Slavonian Kulen. In this way, it is reasonable to start breeding the Black Slavonian pigs again for the production of traditional Slavonian Kulen. The aim of the present research is to compare some blood and meat quality parameters and trimming cut lean yield of Black Slavonian pigs with modern pig crosses (Large White × Swedish Landrace and Large White × Swedish Landrace sired with Duroc) used in the production of Slavonian Kulen.

MATERIAL AND METHOD

Twenty eight heavy pigs were used in this experiment. All pigs were raised on the same farm under the similar conditions of housing and feeding. The first group included 10 Black Slavonian (BS) pigs with average live weight at the time of slaughter of 153.8 kg and approximatively 18 months of age. The second group included 10 Large White × Swedish Landrace (LW×SL) pigs (average live weight 141.3 kg and 16 months of age) and the last group included 8 Large White × Swedish Landrace sired with Duroc (LW×SL)×D pigs (average live weight 182.1 kg and 18 months of age). The groups were slaughterd separately. A day before a slaughter the pigs were transported to a abattoir located 10 km from farm. During lairage (12–18 h) the water, but not feed, was provided. The blood samples were collected for each of the 28 pigs at exsanguination using 7 ml blood evacuated tubes (BD Vacutainer™), for serum analysis creatine phosphokinase (CPK), lactate dehidrogenase (LDH), aspartate aminotransferase (AST) and glucose. Immediately after, blood collection tubes were stored in a cooler at + 4 °C. Within 20 min blood samples were centrifuged (5 min at 4 000 rpm). Serum obtained was put into cryotubes of 2 ml and stored at + 4 °C pending analysis. All analyses were performed within 24 hours employing Olympus AU 400 autoanalyser. The CPK, LDH and AST were assessed by enzyme kits (OLYMPUS AU® Series Reagents) at 37 ºC, by standard methods recommended by the International Federation of Clinical Chemistry (IFCC). Blood glucose level was measured by hexokinase method. The LDH and AST activity were expressed as U/L and CPK activitiy and glucose concentration as logU/L and mmol l^{-1}, respectively. The pH of *M. longissimus dorsi* was measured on the left side of carcass between 13^{th} and 14^{th} ribs by TESTO 230 pH meter (TESTO, Germany) with the penetration electrode (type 13) 1 (pH_1) and 24 h (pH_{24}) after slaughter. Meat colour was measured by transferable spectrophotometer MINOLTA CR 210 (Minolta Camera Co. Ltd. Japan) using the sistem CIELAB. Meat colour of *M. longissimus dorsi* was measured three times on fresh cut surface of meat fibers between 13^{th} and 14^{th} ribs and average was calculated. The left half of carcasses was weighted and cut by Weniger method (Weniger *et al*., 1963). The primal cuts of loin, ham shoulder and neck were weighted and separated for Kulen production. The weight of the right side of the primal cuts was calculated by duplicating the weight of the left side cuts. Primal cuts were then skinned, deboned and trimmed of visible fat and connective tissue and lean muscle parts were selected for further processing. Trimmed cut lean yield (%) was calculated as weight of selected lean meat in relation to: a) weight of primal cut × 100 and b) carcass weight × 100.

All the studied parameters were assessed by analysis of variance (ANOVA) using SAS General Linear Models Procedures (SAS, 1999). Group means were compared by Tukey's multiple comparison test at level of significance at P<0.05 and P<0.01.

RESULTS AND DISCUSSION

Meat quality traits.

The pH and colour traits of *M.longissimus dorsi* from three genoypes of pigs are shown in Table 1.

Table 1. Least square means (LSM) and standard errors (S.E.) of meat quality traits and blood parameters in three different genotypes

	Genotype		
	LW×SL n=10 LSM ± S.E.	LW×SL×D n=8 LSM ± S.E.	BS n=10 LSM ± S.E.
Meat quality traits			
pH1	6.65a ± 0.05	6.83a ± 0.06	6.18b ± 0.05
pH24	5.46b ± 0.02	5.42b ± 0.02	5.87a ± 0.02
Lightness (Cie *L**)	56.08a ± 1.19	48.74b ± 1.33	49.93b ± 1.19
Redness (Cie *a**)	18.22c ± 0.42	22.40a ± 0.47	20.02b ± 0.42
Yellowness (Cie *b**)	5.75b ± 0.44	9.68a ± 0.49	4.67b ± 0.44
Blood parameters			
CPK logU/l	3.07a ± 0.083	3.19A ± 0.088	2.77B,b ± 0.088
LDH U/L	1446.1 ± 168.9	1285.3 ± 188.8	1382.8 ± 168.9
AST U/L	57.0a ± 3.23	48.7ab ± 3.86	45.0b ± 3.40
Glukose mmol l^{-1}1	5.53 ± 0.34	4.72 ± 0.38	5.37 ± 0.34

Means with different letters differed significantly. P<0.01 = A, B; P<0.05 = a,b,c

The pH_1 and pH_{24} values showed statistically significant difference (P<0.05) in the group of BS pigs, with the lowest pH_1 value and the highest pH_{24} value. If a pH_1<6.0 could be used to discriminate between normal and pale, soft and exudative (PSE) pork, as was proposed by

Virgili and Schivazappa (2002) for long matured dried meats production, the significantlly lower pH_1 values of BS loins were still inside normal quality range. The majority of pork white muscles on the carcass have ultimate pH values (pH_{24}) in the range 5.4 – 5.8 (Bendall and Swatland, 1988). For Italian heavy pigs to be processed into dry cured hams, the normal ultimate pH range is established between 5.6 and 6.0 (Virgili and Schivazappa, 2002). The ultimate pH values of BS pigs were significantlly higher than pH_{24} values of other two groups but could be also considered as normal. With respect to meat colour measurements, all parameters of colour (L^*, a^*, b^* values) were significantlly influenced by group. The highest ($P<0.05$) L^* value was reached in the LW×SL group, indicating lighter meat colour. The (LW×SL)×D and BS loins have a lower L^* component. The lower L^* value (i.g., darker meat colour) could be in connection with a higher percentage of muscle pigments (Serra *et al*., 1998), which content increase with age (Lawrie, 1998). On the contrary, the redness of meat (a^* parameter) was higher in both groups of older pigs with the darker meat colour, probably due to the same reason. Šimek *et al*. (2004) reported the higher a^* values in the pigs hibrids that have higher content of meat pigment. The b^* value was the highest in the (LW×SL)×D group.

Blood parameters.

A comparison of the means and standard errors of serum CPK, LDH, AST activity and glucose levels from BS and two modern pig genotipes are presented in Table 1. The lowest serum CPK activity was found in the BS group and it was statistically significant different than CPK activity in LW×SL group ($P<0.05$) and (LW×SL)×D group ($P<0.01$). Also, the AST value was the lowest in the BS group and was statistically significant different ($P<0.05$) than AST value in the LW×SL group. In the present study serum LDH activity and glucose level were not significantly different between groups. Generally it is accepted that stress is detrimental to animal welfare and meat quality (Santos *et al*., 1995). It is associated with changes in blood glucose level and serum enzymes activity such as CPK, LDH and AST. The cellular enzymes CPK, LDH and AST are commonly used as indicators of stress affecting muscle damage (Fàbrega *et al*., 2002). Several published reports which relate genotype, carcass and meat quality traits with a blood stress indices showed that continued physical activity, short lairage and halothane gene carriers elevated levels of all three enzymes. The lowest CPK and AST activity in the BS group indicate their lower susceptability to stress. Plasma glucose levels are considered as indirect indicator of stress, mediated via the catecholamines and/or glucocorticoids. At the same time, blood glucose level varies strongly with the nutritional state of the animal (Shaw and Tume, 1992) and depends on efficiency of homeostatic mechanism. Also, it is possible that during the 24 h of lairage, homeostatic mechanisms had restored glucose to the same level.

Processing yield

Trimmed cut lean yields (%) of primal cuts for production of Slavonian Kulen separately and in the whole carcass within the three groups of pigs are shown in Table 2.

Regarding to trimmed lean yield (%) of primal cuts and carcass for the production of the Slavonian Kulen, the utilization of selected lean meat of hams was the lowest in BS pigs (29.31% and 7.04%, $P<0.05$). The (LW×SL)×D group had the highest trimmed cut lean yield of loin (34.14% and 4.93%, $P<0.05$) and the LW×SL group had the lowest utilization of neck (22.31% and 1.12%, $P<0.05$). For shoulders there were no statistically significant differences ($P>0.05$). In total, the utilization of primal cuts for the production of Slavonian Kulen in BS group (26.75%) was considerably lower than in (LW×SL)×D group (32.33%, $P<0.05$) and utilization of carcass for production of Slavonian Kulen was the highest within the (LW×SL)×D group of pigs (19.85%, $P< 0.05$). The observed differences result from carcass traits and higher proportion of adipose tissue in carcasses of Black Slavonian pigs (e.i. *M.gluteus* average depth of meat M/mm = 64 and average depth of fat S/mm = 63 compare to M/mm = 73 and S/mm = 30, on average in (LW×SL)×D pigs, Karolyi and Salajpal, unpublished data). Particular scientific data about trimmed cut lean yield in the production of Slavonian Kulen are not available. The only comparison could be made to the results of Benčević *et al*. (1971), who found 22,6% of utilization of lean meat in halves of Black Slavonian pigs, which is higher than our results (16.26%). The observed discrepancies could be related to the fact that in the previous investigation the measured utilization included production of Kulen and other sausages but also to differences in the experimental variables, such as animal weight or method used for trimming lean meat.

Table 2. Processing yields (%) of primal cuts and carcass of three group of pigs for the production of Slavonian Kulen (LSM ± S.E.)

	Trimmed cut lean yield for kulen production	Genotyp		
		LW×SL n=10 LSM ± S.E.	LW×SL×D n=8 LSM ± S.E.	BS n=10 LSM ± S.E.
Hams	% primal cut	35.75a ± 1.19	39.24a ± 1.33	29.31b ± 1.19
	% carcass	8.40a ± 0.29	8.93a ± 0.33	7.04b ± 0.29
Loin	% primal cut	24.98b ± 2.04	34.14a ± 2.28	25.38b ± 2.04
	% carcass	3.21b ± 0.25	4.93a ± 0.28	3.77b ± 0.25
Shoulders	% primal cut	22.26 ± 1.45	21.59 ± 1.62	21.37 ± 1.45
	% carcass	3.54 ± 0.22	3.78 ± 0.24	3.52 ± 0.22
Neck	% primal cut	22.31b ± 2.69	33.22a ± 3.00	37.52a ± 2.69
	% carcass	1.12b ± 0.15	2.20a ± 0.16	1.93a ± 0.15
Total	% primal cut	28.15ab ± 1.15	32.33a ± 1.29	26.75b ± 1.15
	% carcass	16.28b ± 0.70	19.85a ± 0.78	16.26b ± 0.70

Means with different letters differed significantly, P<0.05 = a,b

CONCLUSIONS

The lowest CPK and AST values in the BS genotype indicate their superior stress resistent ability. Regarding to meat quality traits, the pH_1 and pH_{24} measurements did not indicate inferior pork quality to any of investigated genotipes but the meat colour of older BS and (LW×SL)×D pigs was more desirable (lower $L*$ and higher $a*$ values) for Slavonian Kulen processing. The BS pigs have the lowest trimmed cut lean yield of hams but in total did not differ significantly from LW×SL pigs. Pigs from (LW×SL)×D line had more trimmed cut lean yield of loin and generally performed the best utilization of carcass for the production of Slavonian Kulen.

ACKNOWLEDGEMENTS

This work was supported by Ministry of Science, Education and Sports, Project number TP-01/0178-40. The autors would like to thank members of PZ ¨Kulen Šokac¨ for their cooperation and help with this project.

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