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Full Length Research Paper

Chemical, sensory and microbiological characteristics of Sremska sausage (traditional dry-fermented Serbian sausage) as affected by pig breed

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Sremska sausage is a traditional dry-fermented sausage from Serbia made from the meat of local, late maturing pigs of the Mangalica breed, which had almost disappeared. Sremska sausage is today produced from the meat of modern pig breeds. Three variants were made from the meat and fatty tissue of 12-month-old white pigs (Swedish Landrace), Moravka pigs and Mangalica pigs. At the end of the production process, all sausages were characterized by a high level of fat and a low level of moisture. The content of non-protein nitrogen was higher in sausages made from the meat of Landrace pigs, and so was its total increase during ripening and storage. The dynamics of total plate counts, lactic acid bacteria, Gram positive, catalase positive cocci counts and electrophoretic profiles of proteins were very alike. At the end of ripening, most sensory parameters differed between breeds, however, sausages made from the meat of Mangalica had a significantly (P <0.05) better odour and poorer cross-section appearance. The quality of sausages from the meat of Mangalica was most consistent during storage, whereas in the Sremska sausage made from the meat of Moravka breed the majority of characteristics were significantly poorer.

Key words: Sremska sausage, pig breed, biochemical parameters, sensory quality.

INTRODUCTION

Sremska sausage is a Serbian dry-fermented sausage traditionally produced in the north-western part of Serbia (Srem region), where it was produced at village households. Sremska sausage is of pronounced red colour, tender texture, slightly hot taste, with a fermented meat odour and a mild note of spices and smoke. It was made from pig meat and back fat cut into pieces by hand and mixed with salt and spices. The mixture was filled into pig small intestines, smoked and dried 14 to 21 days depending on ambient conditions. Microflora of traditionally produced fermented sausages originated from the raw material or from the environment in which the sausages were made (Borović et al., 2010). Microorganisms responsible for the changes in the fermentation process are lactic acid bacteria (LAB), coagulase negative cocci and some types of yeasts (Hutkins, 2006).

The dominant flora of Sremska sausage are lactic acid bacteria and their number reaches the maximum from production days seven to 14 (Borović et al., 2010; Kozačinski et al., 2008). Traditionally, Sremska sausage was produced from the meat of local, late maturing, fatty pigs of the Mangalica breed, extensively bred on pastures in oak forests. In time, the breed has almost but disappeared and Sremska sausage is today made from

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Abbreviations: RH, Relative humidity; **NPN,** non-protein nitrogen; **SDS-PAGE,** sodium dodecyl sulphate-polyacrylamide gel electrophoresis; **TPC,** total plate count; **LAB,** lactic acid bacteria; **CFU,** colony-forming units

the meat of modern breeds. However, in line with modern trends aimed at reviving and advancing traditional food production processes, autochthonous meat products, made from local breeds, are gaining on importance. Moreover, numerous researches were conducted in order to determine the characteristics of traditional and natural fermented sausages throughout the world (Comi et al., 2005; Salgado et al., 2005; Soyer et al., 2005; Di Cagno et al., 2008; El Malti and Amarouch, 2009; Rašeta et. al., 2010; Vuković et al., 2011).According to Moretti et al. (2004) the chemical and sensory quality of products are related to the breed; they closely relate the quality of traditional salami Sant Angelo to Nero Siciliano breed. Ortiz-Somovilla et al. (2005) assert that Iberian pork sausages owe their high quality to the specific quality of meat and fatty tissue of Iberian pigs, slaughtered at a late age, with high weights and extensively fed.

On the contrary, Radman et al. (2005) claimed that kulen made from the meat of black Slavonian pigs is of poorer sensory quality than kulen produced from the meat of modern pig breeds. Toldra and Flores (1998) link flavour development with the activity of muscle proteinases and lipases. The level and activity of certain endogenous enzymes in meat differs depending on the pig breed and pig weight (Saraga et al., 1993; Flores et al., 1994; Toldra et al., 1996; Armero et al., 1999). During the ripening of fermented sausages, acidification helps to create the colour and coagulate proteins, affects the increase of firmness and cohesiveness of the product and has an important role in the activation of muscle proteinases (Molly et al., 1997; Cenci-Goga et al., 2008). Proteolysis as a consequence of the activity of muscle and microbiological proteinases and peptidases increases the yield of polypeptides, peptides and free amino acids which contribute to taste and flavour (Hierro et al., 1999; Spaziani et al., 2009). Lipolytic activity, as a consequence of microbiological and tissue lipases activity, causes the creation of flavour components such as free fatty acids, aldehydes, ketones and esters (Casaburi et al., 2008). Smoking and seasoning also contribute to the flavour of fermented sausages (Johansson et al., 1994). The goal of this paper was to determine the chemical, sensory and microbiological characteristics and to detect potential differences in the sensory quality of Sremska sausage produced from the meat of three pig breeds: Mangalica, Moravka and Landrace. Moravka breed was selected as an auto-chthonous Serbia pig breed in terms of meat and fat, bred in the central part of the country in the same period as Mangalica, while Landrace was chosen as a typical commercial pig breed in Serbia.

MATERIALS AND METHODS

Sausage manufacture and sampling

For the production of Sremska sausage, ham was used as well as shoulder meat and back fat in the ratio of 75:25 from 12-month-old: White pigs-Swedish Landrace (variant A), Moravka pigs (variant B) and Mangalica pigs (variant C). All animals were bred at the test farm of the Institute for Animal Husbandry (Belgrade). Meat was processed 24 h after slaughter and cooling, and was frozen at the temperature of -20°C and stored for 10 days before production.

The examined variants of Sremska sausage were manufactured in a small processing plant of the Institute for Animal Husbandry (Belgrade). All variants were produced on the same day and in an identical manner. Meat and fat were ground in a cutter (Seydelman K60, Germany) to 8 mm. The same amounts of ingredients were added to all sausage variants: 2.3 salt, 0.011 $NaNO_2$, 0.3 dextrose, 0.20 garlic and 0.5% sweet red paprika. The mixture was filled in pig small intestines of around 32 mm diameter. After stuffing, the sausages were hung on sticks and the ripening was carried out in a drying chamber under controlled conditions (Maurer, Germany) and under the following regime: day 1, relative humidity (RH) 90% at 21°C; day 2, RH 88% at 20°C with smoking, day 3, RH 85% at 20°C; during the following days RH was reduced by 1% on a daily basis (until day 14) and the temperature was constant at 16°C. Fermentation was spontaneous. After 14 days the sausages were vacuum packed and stored at 4 to 7°C up to 105 days.

Three sausages were taken from each variant for all analyses and each analysis was done in duplicate. Sampling of all variants of Sremska sausage was carried out on production days 0, one, three, seven and 14 and during storage on days 60 and 105 for microbiological analysis and to determine non-protein nitrogen (NPN) and pH value. Chemical analysis were conduct at the beginning (day 0) and end (day 14) of production. Electrophoretic analysis was carried out at days 0, seven, 14 and 105. Sausage colour was determined at the end of production. Sensory evaluation of sausages was conducted at the end of production and during storage, on days 60 and 105.

Proximate composition and pH value analysis

The chemical composition of meat was determined in the following manner: moisture content by drying samples at 105°C (ISO 1442:1997); protein content by Kjeldahl method and multiplying by factor 6.25 (ISO 937:1978); total fat content by Soxhlet method (ISO 1443:1973), and ash content by sample mineralization at 550 ± 25°C (ISO 936:1998).

pH value was measured by pH-meter Hanna, HI 83141 (Hanna Instruments USA). NPN content was determined according to the method of Hughes et al. (2002).

Microbiological analysis

Ten grams slices from each sausage variant were weighed aseptically, transferred to sterile saline diluent containing 1% peptone and homogenized for 2 min using Stomacher 400 (Seward, London, UK). Appropriate decimal dilutions of the samples were prepared using the same diluent and plated in duplicate on different growth media. Total viable counts were determined on plate count agar (PCA) (Merck, Darmstadt, Germany, incubated at 30°C for 72 h; Gram positive, catalase positive cocci counts on mannitol salt phenol-red agar (MSA, Oxoid, CM 0085) at 37°C for two days; lactobacilli counts on de Man Rogosa Sharpe (MRS, Oxoid, CM 0361) agar, microaerophilic incubated (Gas Pack, BBL, Germany) at 30°C for five days. Microbiological data were transformed into logarithms of the number of colony-forming units (cfu g^{-1}).

Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE)

Sarcoplasmic protein extracts were prepared according to the

Table 1. Changes in the basic chemical composition of the Sremska sausage during the ripening (%).

Ripening time	Variant	Proximate composition			
		Moisture	Protein	Lipid	Ash
Day 0	A	51.73 ± 1.09[a]	16.60 ± 0.18[a]	28.04 ± 1.43[a]	3.40 ± 0.05[a]
	B	49.26 ± 2.29[ab]	15.85 ± 0.80[ab]	31.29 ± 2.55[ab]	3.60 ± 0.16[a]
	C	48.91 ± 0.45[b]	15.69 ± 0.52[b]	32.29 ± 0.30[b]	3.44 ± 0.07[a]
Day 14	A	26.26 ± 0.29[ab]	23.55 ± 0.98[a]	44.25 ± 0.89[b]	6.06 ± 0.20[a]
	B	27.89 ± 1.00[a]	21.46 ± 1.13[b]	44.78 ± 0.09[b]	6.24 ± 0.12[a]
	C	25.11 ± 0.98[b]	23.09 ± 1.04[a]	44.98 ± 0.88[b]	6.05 ± 0.18[a]

[a,b]Mean values in the same column, for each day, with the different superscripts differ significantly (P<0.05).

method of Toldra et al. (1993). Four grams of sausage was homogenised with 40 ml of 0.03 M potassium phosphate buffer (pH 7.4) for 5 min. The homogenate was centrifuged for 15 min at 10 000g at 4°C. The supernatant included the sarcoplasmic proteins. Myofibrillar proteins were extracted from the resultant pellet by homogenising with a solution containing 8 M urea and 1% β-mercaptoethanol for 2 min using a Philips HR 2000 blender. The homogenate was recentrifuged under the same conditions and the supernatant contained the myofibrillar proteins. Samples were diluted with SDS-PAGE sample buffer.

Samples were heated at 100°C for 5 min prior to electrophoresis. A 15% separating gel with 4% stacking gel was used for sarcoplasmic proteins, and a 12% separating gel with 4% stacking gel was used for myofibrillar proteins. Both sarcoplasmic and myofibrillar fractions were analyzed by SDS-PAGE, according to the method of Laemmli (1970), using 20.5 x 10 cm TV200YK twin-plate electrophoresis unit (Consort, Belgium) together with electrophoresis power supply EV202 (Consort,Belgium). After electrophoresis, the gels were stained with Comassie brilliant blue R-250 (0.25%) in fixative (45% methanol, 10% acetic acid). The gels were destained using 45% methanol and 10% acetic acid. The molecular weights of the proteins were estimated by running standard proteins of known weight in each gel. The molecular weight standards used were phosphorylase B 97.4 kDa, albumin bovine 67 kDa, albumin egg 45 kDa, carbonic anhydrase 29 kDa, (SERVA Electrophoresis GmbH, Germany). 7 µl of both myofibrillar and sarcoplasmic protein solutions were applied onto the gels. Working conditions were 80 mA and 300 V during 4 h for sarcoplasmic proteins and 3 h for myofibrillar proteins. During that time the smallest components of the protein standard mixture were lost in the running buffer. The molecular masses of the protein bands were calculated from the Rf values by interpolation on the calibration curve constructed using the known markers.

Colour determination

Sausage colour was determined 14 days after the beginning of production by Chromameter CR-400 (Minolta Co. Ltd, Tokyo, Japan), in line with the CIE L*a*b* system (L* – lightness, a* – redness (+/− red-green), b* – yellowness (+/− yellow-blue)). The colour of the surface in question was measured at the upper, middle and lower third of the sausage, and the colour of the cross section at three fresh cuts (three measurements each in both cases). The presented data are mean values of nine measurements.

Sensory analysis

The evaluation of sensory characteristics of sausages was conducted by eight assessors with previous experience in the evaluation of dry-fermented sausages. Prior to each evaluation, preparatory meetings were held to discuss in detail the defined characteristics of sausages which were to be evaluated. A numeric-descriptive scale with nine-point system was used to evaluate sensory parameters such as appearance, cross section, colour, odour, texture and taste of sausages (1 – extremely unacceptable, 9 – extremely acceptable). The presented data are mean values of eight evaluations.

Statistical analysis

The results were processed by single-factor analysis of variance (ANOVA). The differences between individual averages were tested using Tukey's method. Significant differences were considered for $P < 0.05$. Calculations were done with software Statistica 6.0 PL, for Windows (Statsoft Inc.).

RESULTS AND DISCUSSION

Proximate composition

The chemical composition of Sremska sausage at the beginning and end of ripening is shown in Table 1. Sausages made from the meat of Mangalica (variant C) at the beginning (day 0) had the lowest moisture content and protein content, but also the highest fat content, which is a statistically significant difference in comparison with variant of meat from Landrace (P<0.05). The discrepancy was most likely a result of the different chemical composition of the meat of pigs of various breeds.At the end of ripening, sausages were characterised by a high fat content and low moisture content. Moisture content decreased to the level of 25.11% to 27.89%. Such a low moisture is typical for similar products in Greece, Hungary and Croatia (Kozacinski et al., 2008), and is a consequence of not only drying, but also of a higher fat content in the stuffing. At the end of ripening, all variants

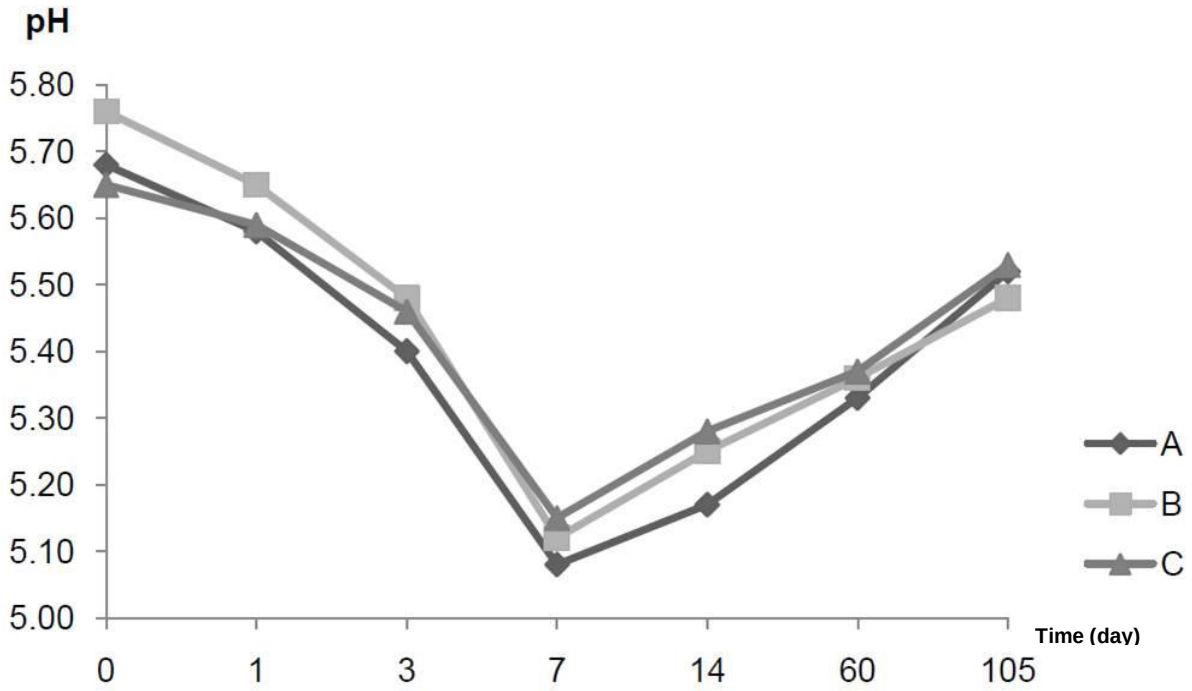

Figure 1. Changes in pH of Sremska sausage during ripening and storage.

contained more than 40% of fat, which adds to the gentle texture of Sremska sausage.

pH

During ripening, pH dropped moderately and reached the minimum on day seven of the process (Figure 1). The dynamics of change was very similar in all variants, where a decrease of around 0.1 units a day was determined. The same dynamics and similar final pH values in traditionally produced Sremska sausage, made from the meat of modern pigs, were reported by Kozačinski et al. (2008). In variant C, the pH drop was less intensive and the minimal recorded value was 5.15. After day 7, pH began with a mild but constant increase. Maximum values were recorded on day 105 and were very close 5.48 to 5.54.

Salgado et al. (2005) stated that the initial pH dropped in different raw cured sausages, varies in a broad interval of 0.16 to one pH unit or more. After the pH drop, there was an increase in pH values during ripening, usually in the range from 0.2 to 0.4 units, but larger variations were also possible. Our experiment determined a pH increase of 0.36 units in C variant sausages, to 0.44 units in variant A. It is possible that the pH increase was caused by the formation of various alkaline compounds such as biogenic amines (Roig-Sagués et al., 1999). On the other hand, Salgado et al. (2005) quoted authors who point out that pH increase in the latter stages of the ripening process appears to be more related to the decrease in lactic acid content than to the formation of low molecular weight nitrogen compounds.

Microbiological analysis

Total plate count (TPC) was approximately 5 log cfu g^{-1} for all variants (Figure 2), which indicates that the raw mixture was produced in good sanitary conditions. TPC mostly stagnated on day one, as a result of the low temperature of raw materials, which during day one it slowly warmed up to 21 °C. After the first day of production, TPC slightly grew until day 14 of the process, when it reached 7.73 cfu g^{-1} (variant B) to 8.73 cfu g^{-1} (variant A). After the sausages were packed in vacuum bags, on day 14 of production a mild TPC drop was recorded until day 60, most likely caused by anaerobic conditions. During further storage, TPC stagnated and the recorded values were quite similar in all variants, from 7.29 cfu g^{-1} (variant B) to 7.56 cfu g^{-1} (variant A).

LAB count (Figure 3) on day one either stagnated or slightly decreased, and during the next two days it marked intensive increase by around one logarithmic unit a day, reaching approximately 7 log cfu g^{-1} on day three. LAB growth was slower until day seven, and especially between days 7 and 14. LAB maximum was attained on production day 1 4 with values from 7.81 cfu g^{-1} (variant

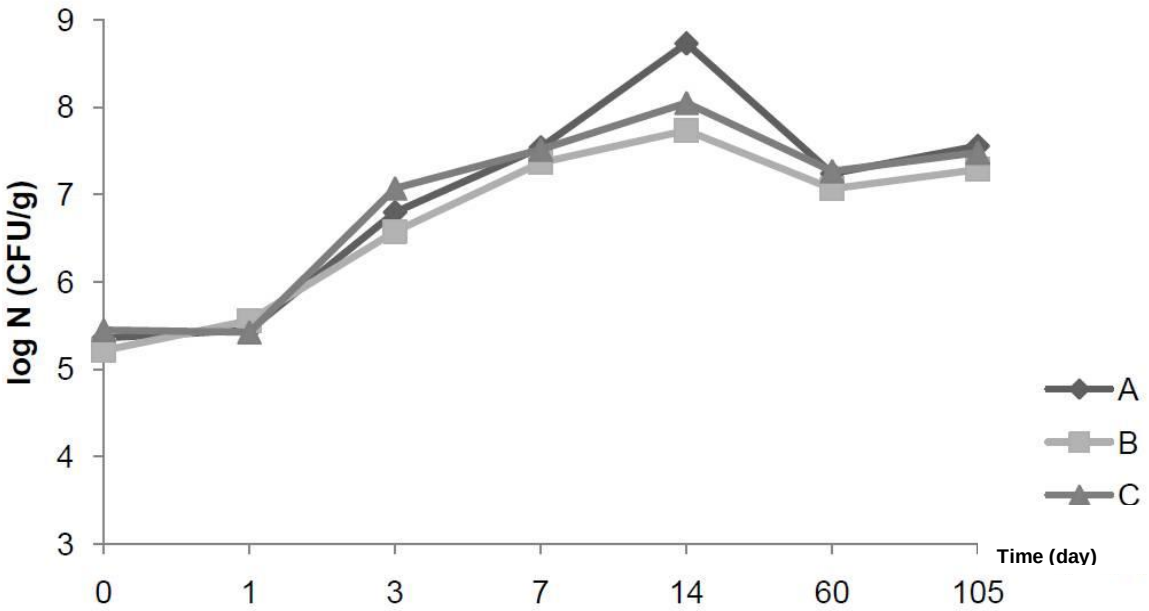

Figure 2. Total plate count growth dynamics during ripening and storage of Sremska sausage.

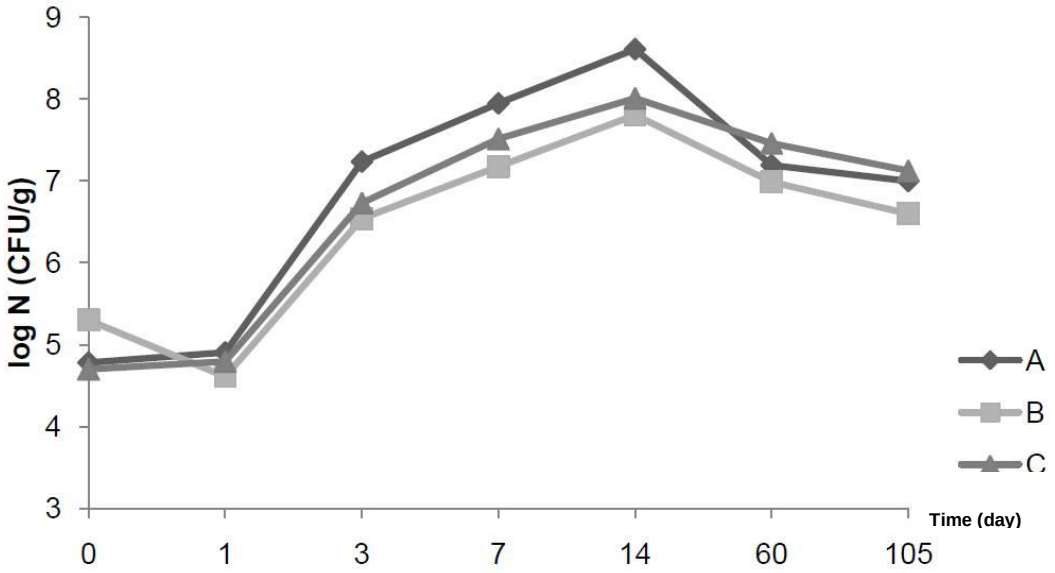

Figure 3. Lactic acid bacteria growth dynamics during ripening and storage of Sremska sausage.

B) to 8.61 cfu g^{-1} (variant A). After day 14 the lactobacilli count reduced. Moretti et al. (2004) and Casaburi et al. (2007) made similar conclusions in Italian slow-fermented sausages.

Micrococcus sp. reduced nitrate to nitrite and ensured colour development. They also contributed to the flavour of the fermented meat product (Johansson et al., 1994) (Johansson et al., 1994). Gram positive, catalase positive cocci counts (Figure 4) were lower than LAB and at the beginning of the process they ranged from approximately 3.84 log cfu g^{-1} for variant C and 4.41 log cfu g^{-1} for variant A. Their number during Sremska sausage processing stayed at a similar level. The number of Gram positive, catalase positive cocci in Sremska sausage was lower than in similar dry-fermented sausages produced in Italy (Casaburi et al., 2007; Spaziani et al., 2009), but it

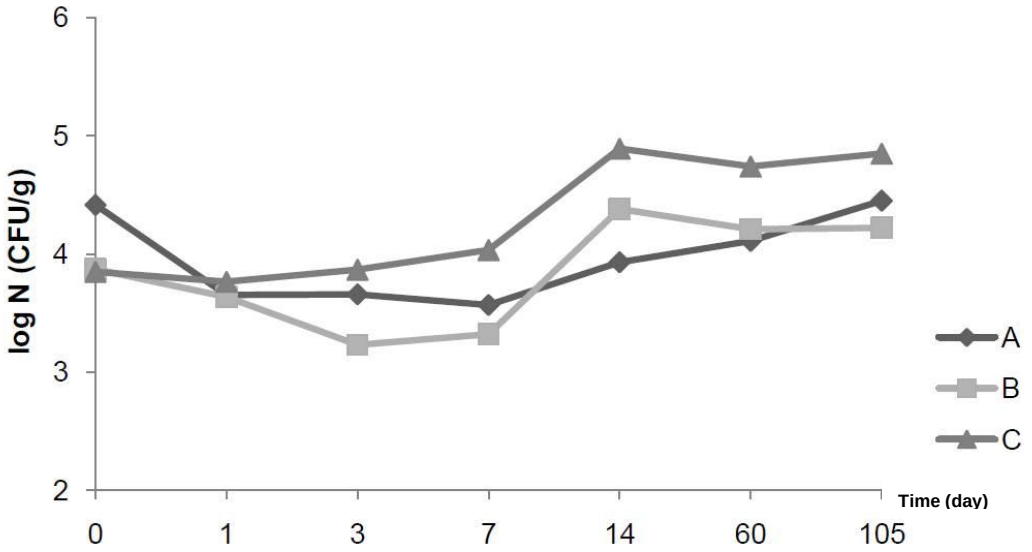

Figure 4. Gram positive and catalase positive cocci growth dynamics during ripening and storage of Sremska sausage.

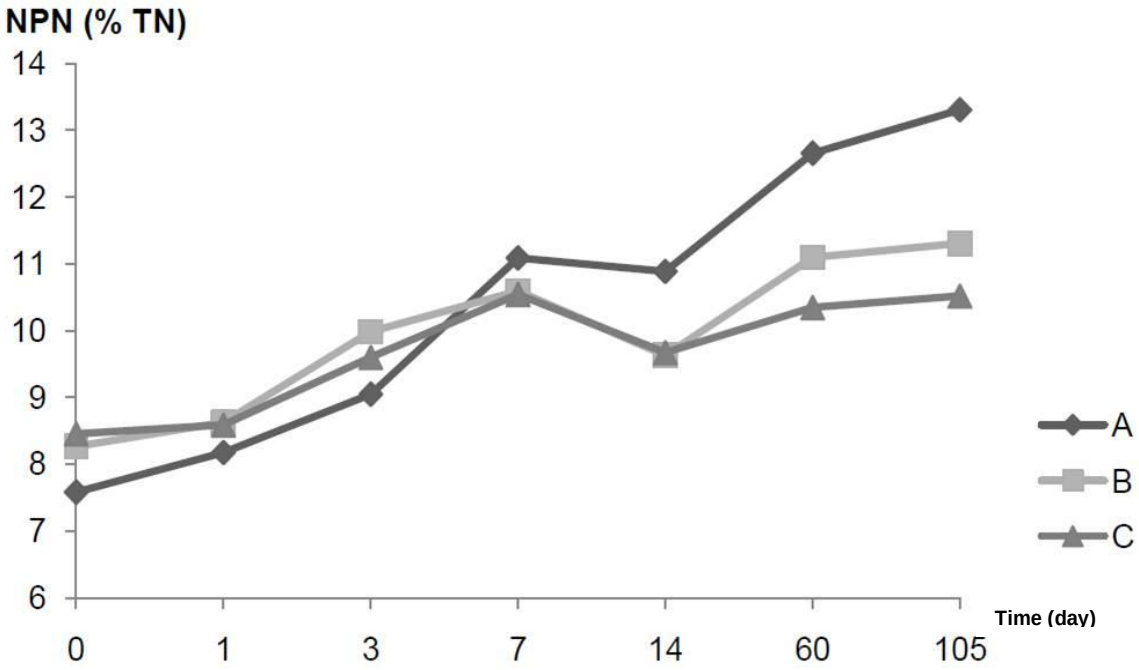

Figure 5. Changes in NPN* content throughout the ripening of Sremska sausage *NPN content as % of total nitrogen (TN). NPN, Non-protein nitrogen.

remained within the framework cited by Kozačinski et al. (2008).

Non-protein nitrogen

Changes in NPN content expressed as % of total nitrogen (TN) during the ripening are shown in Figure 5. The content of NPN increased during the first seven production days, which correlates with the pH drop in sausages. Similar results were cited by Flores et al. (1997). In the period from days seven to 14, the content of NPN stagnated, and then during the storage period in

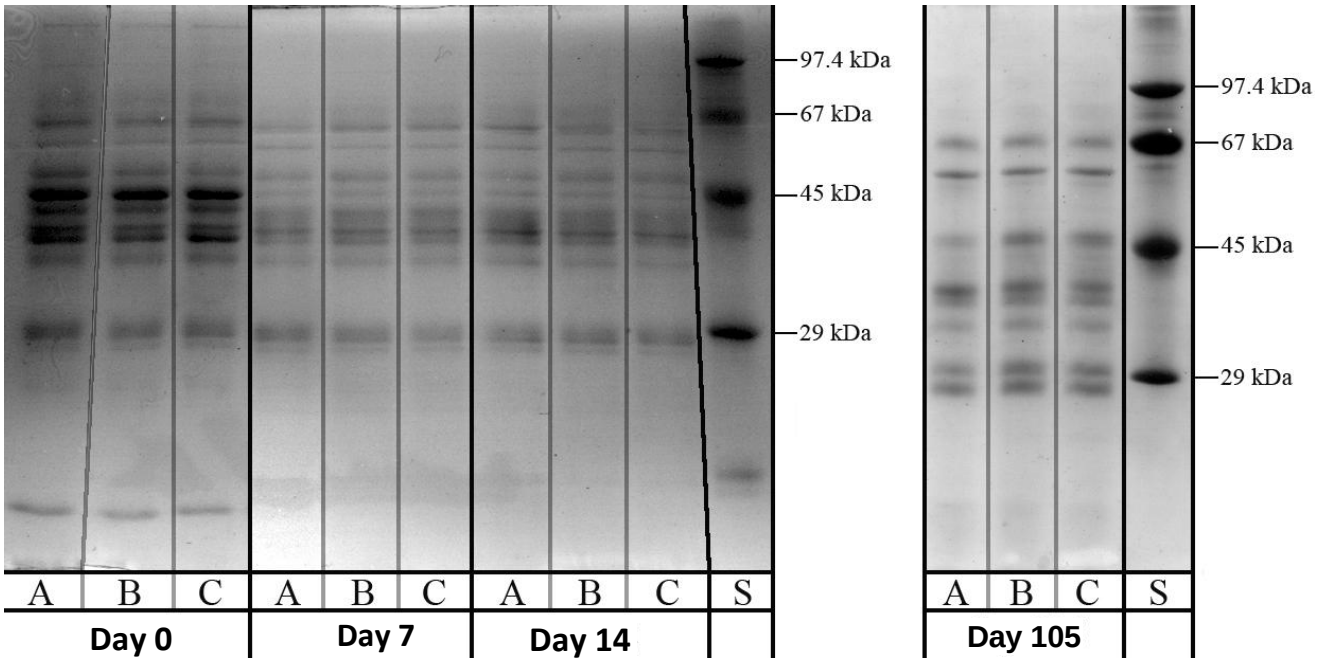

Figure 6. SDS-PAGE profile of sarcoplasmic proteins throughout the ripening and storage period of Sremska sausage. SDS-PAGE, Sodium dodecyl sulphate-polyacrylamide gel electrophoresis.

vacuum it increased but slightly due to low temperature and anaerobic conditions which slowed down proteolysis.

The intensity of proteolysis was very similar during the first seven days of ripening in all sausage variants. In the period between days seven and 14, proteolysis was depressed and a slight NPN drop was recorded in all variants, however there were distinct differences between sausages made from the meat of various pig breeds. The intensity of proteolysis was the highest in variant A, followed by B, while in variant C it was the lowest. Total rise in the NPN content in the period 0 to 105 days stood at 75.48, 36.84 and 23.61% of TN (A, B and C). Rosell and Toldrá (1998) also reported a more pronounced proteolytic activity in the meat of white pigs, when compared to Iberian breeds.

SDS–PAGE

The electrophoretic image of sarcoplasmic proteins (Figure 6) was very similar in all examined variants throughout the experiment and it can be said that in this respect there were no significant differences between sausage variants A, B and C. Intensive degradation of sarcoplasmic components, especially in the zone of molecular masses between 30 and 44 kDa, was most intensive during the first seven days of ripening. Degradation of creatine kinase was pronounced, and it corresponded to the molecular mass band of 44 kDa, as well as the molecular mass band of 14 to 16 kDa, which completely disappeared after day seven of ripening.

Hughes et al. (2002) stated that endogenous muscle enzymes and acid and salt induced denaturation were responsible for initial degradation of sarcoplasmic protein fractions.

All variants of Sremska sausage showed similar electrophoretic profiles of myofibrillar proteins during ripening and storage (Figure 7). Mild acidification, minimum pH from 5.08 to 5.15, affected the low level of myofibrillar proteins degradation. Verplaetse (1992) demonstrated a clear depressing effect of higher pH values on proteolysis. However, in the period from days 0 to 105, the degradation of a component which corresponds to the myosin-heavy chain (MHC) was clearly observed. Several authors have reported a decrease in myosin-heavy chain concentration during the ripening of dry sausages (Spaziani et al., 2009) and even its complete degradation (Hughes et al., 2002; Casaburi et al., 2007). As a consequence of proteolysis of the myosin-heavy chain and co-migration of other degradation products, there was an increase in the intensity of bands in the molecular mass zone of α- actinin (97 kDa) as well as of around 60 kDa.

Degradation of actine (45 kDa) and bands below it, which most likely correspond to tropomyosin and myosin-light chain, was particularly intensive during the first seven days of ripening. Actin degradation is a result of activities of endogenous proteinases (Molly et al., 1997), but proteolysis is also intensified by proteinases of microorganisms, which is in line with our results referring

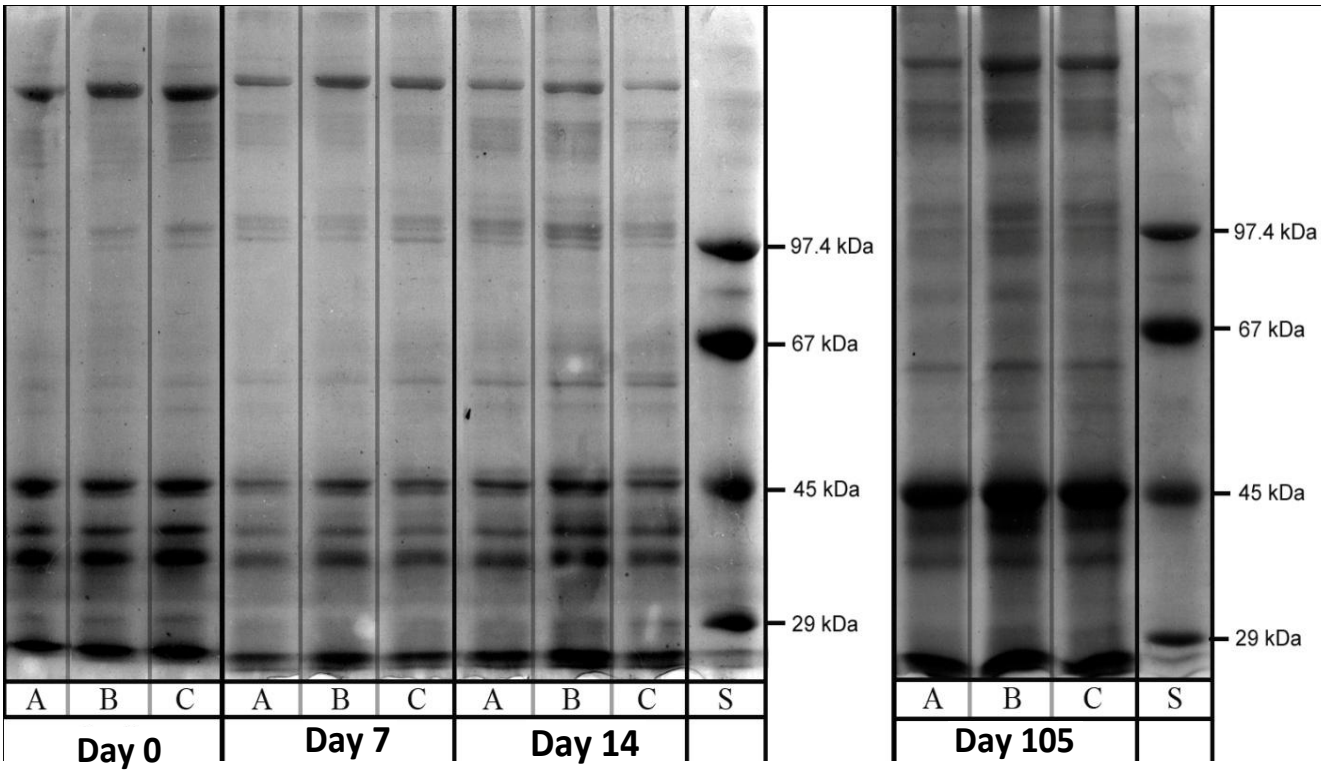

Figure 7. SDS-PAGE profile of myofibrillar proteins throughout the ripening and storage of Sremska sausage. SDS-PAGE, Sodium dodecyl sulphate-polyacrylamide gel electrophoresis.

Table 2. Results of colour assessment of Sremska sausage.

Variant	Appearance			Cross-section		
	Lightness (L*)	Redness (a*)	Yellowness (b*)	Lightness (L*)	Redness (a*)	Yellowness (b*)
A	30.4 ± 2.2[a]	15.0 ± 1.2[a]	16.7 ± 3.2[a]	40.8 ± 1.8[a]	17.0 ± 1.5[a]	19.2 ± 2.4[ab]
B	29.4 ± 1.7[a]	15.6 ± 1.8[a]	16.1 ± 2.6[a]	39.6 ± 2.8[a]	17.8 ± 1.7[a]	17.5 ± 1.9[b]
C	30.7 ± 3.1[a]	15.3 ± 3.2[a]	17.1 ± 4.7[a]	41.7 ± 2.5[a]	17.4 ± 2.4[a]	19.5 ± 2.5[a]

[a,b]Means with different superscripts in the same columns indicate significant difference (P<0.05).

to the dynamics of LAB count, pH reduction and NPN increase during the first seven days of ripening.

Colour determination

The surface of sausages (Table 2) was of very similar lightness (L*), redness (a*) and yellowness (b*). Sausage from the meat of Moravka were somewhat lighter at the cross-section when compared to the variant made from the meat of Landrace, and even more so to those made from Mangalica. These results affirm the sensory colour evaluation, where colours A and B received similar grades, while variant C was graded a little lower. The measured values of the yellow colour (b*) were statistically less significant at variant B cross-section.

Sensory analysis

Results of sensory readings presented in Table 3 indicate that breed affects the sensory characteristics of Sremska sausage.

The appearance of all examined sausage variants at the end of ripening was very good. The cross-section of sausages made from the meat of Mangalica was assessed as the poorest. The coherency of meat and fatty tissue was poorer, which was most likely a consequence of higher pH value (5.15) at the end of fermentation, but also of the softer texture of Mangalica fatty tissue. Product colour correlated with the colour of the meat used in production. The meat of Mangalica is darker than the meat of Landrace and Moravka. Due to drying and oxidation processes, the colour of the product

Table 3. Sensory evaluation results of Sremska sausage.

Sensory characteristic	Time (day)	Variant		
		A	B	C
Appearance	14	7.62±0.52^{aA}	8.00±0.53^{aA}	8.25±0.71^{aA}
	60	7.00±0.53^{aB}	7.12±0.64^{aB}	8.12±0.99^{bA}
	105	7.00±0.00^{abB}	6.00±0.53^{aC}	8.00±0.00^{bA}
Cut appearance	14	7.87±0.64^{aA}	7.12±0.83^{abA}	6.62±0.74^{bA}
	60	7.37±0.92^{aAB}	7.25±0.71^{aA}	6.87±0.99^{aA}
	105	7.12±0.35^{aB}	6.87±0.35^{aA}	6.75±0.71^{aA}
Colour	14	7.50±0.75^{aA}	7.50±0.75^{aA}	7.12±0.35^{aA}
	60	7.25±0.71^{aA}	7.25±1.03^{aA}	7.00±0.75^{aA}
	105	7.62±0.52^{aA}	7.50±0.75^{aA}	6.87±0.35^{aA}
Odor	14	7.12±0.99^{aA}	7.50±0.75^{aA}	8.37±0.74^{bA}
	60	4.75±0.71^{aB}	6.75±0.88^{bB}	7.62±0.52^{cB}
	105	5.00±0.53^{aB}	6.37±0.52^{bB}	7.62±0.74^{cB}
Taste	14	7.87±0.35^{aA}	8.00±0.92^{aA}	7.87±0.99^{aA}
	60	7.37±0.74^{aA}	5.37±0.74^{bB}	7.62±0.74^{aA}
	105	7.75±0.46^{aA}	5.37±0.52^{bB}	7.62±0.74^{aA}
Texture	14	6.50±0.75^{aA}	5.75±0.71^{aA}	6.37±0.74^{aA}
	60	6.37±0.74^{aA}	3.62±6.75^{bB}	6.75±0.71^{aA}
	105	6.50±0.75^{aA}	3.62±0.52^{bB}	6.62±0.52^{aA}

^{ab} Values in the same column for the same property, with different superscripts are significantly different (P<0.05).
^{AB} Values in the same row with different superscripts are significantly different (P<0.05).

grew darker during fermentation, therefore sausages made from the meat of Mangalica were assessed as too dark, and received a somewhat lower grade. Odour is a sensory indicator most affected by the choice of breed. The most typical and the best sausage was the one made from the meat of Mangalica. The odour of this variant was rich and very pronounced, and received a much higher grade. The taste of all three variants was very similar and was graded from 7.87 to 8.00. Texture is most poorly graded parameter in all variants, most notably in variant B - 5.75.

During storage, the overall sensory quality of the product reduced, but the dynamics of this change varied. Sausages made from Mangalica were of the most stable quality, and only a change of odour was statistically confirmed in this variant. On the other hand, in sausages made from the meat of Moravka most of the qualities were significantly poorer. The most pronounced deterioration was observed in taste and texture. The texture of variant B was poor, insufficiently firm and mushy as soon as day 14, while during storage it deteriorated to an almost unacceptable level from the consumers' point of view. It may be concluded that sausages made from the meat of Mangalica are of very good sensory quality, which is in line with Ortiz-Somovilla et al. (2005) and Moretti et al. (2004). Sausages made from the meat of Moravka had poorer sensory characteristics, as affirmed by a stance of Radman et al. (2005) that the meat of certain breeds is not suitable for the production of fermented sausages.

Conclusion

The results of this research indicate that pig breed affects the chemical and sensory characteristics of Sremska sausage. Proteolysis, in regard to the NPN content as % of total nitrogen, was more intensive in sausages made from the meat of Landrace when compared to the sausages made from the meat of old pig breeds. The breed affects most of the sensory characteristics, most notably the following: cross-section, odour and texture. Based on the sensory analysis we may conclude that Moravka is the least suitable pig breed for th production of this type of dry-fermented sausage because the sensory characteristics (texture, taste, odour and

appearance) significantly deteriorate during storage. Landrace and Mangalica are very alike in terms of their sensory characteristics. Sausages made from the meat of Mangalica are superior in terms of odour and are of the most stable quality during storage.

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