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Quality assessment of Srpska sausage from nine different manufacturers in Serbia

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A b s t r a c t: The aim of this study was to assess the quality of 11 different samples of Srpska sausage from 9 manufacturers in Serbia who responded to a public call of the Chamber of Commerce and Industry of Serbia in order to improve the brand of Srpska sausage. For characterising properties of the Srpska sausages chemical composition analysis and sensory descriptive analysis were used. The chemical analysis showed that all the samples had a meat protein content higher than the stipulated minimum (12%), that the total phosphorus content (expressed as P_2O_5, g/kg), the content of $NaNO_2$ (mg/kg), and the content of collagen in the meat protein (%) is lower than the maximum permitted level (8.00 g/kg, 150.00 mg/kg, and 20.00%, respectively). In the sensory analysis following attributes were evaluated: external appearance, cross-section appearance (including colour), texture, odour, flavour and overall sensory quality. The best-evaluated was a sample with a mean cumulative score of 87.23±8:33, and the worse-evaluated was a sample with a mean cumulative score of 51.65±10.05. There were not significantly differences between four samples with highest cumulative scores. The sausage with the highest score was evaluated as best by 35% of panellists, followed by third (25% of panellists), second and fourth (15% of panellists). The quality parameters of the highest ranked "Srpska sausage" will be submitted to the competent state authorities as amendments to the current Regulation.

Keywords: *Srpska sausage, Regulation, cooked sausage quality, chemical composition, sensory evaluation.*

Introduction

Unlike fermented and precooked-cooked sausages, which have a very long history, being mentioned in the Greek literary works about 500 BC and in the scriptures of Leo VI the Wise from the early 10th century, raw-cooked sausages are products of more recent times (*Vukovic*, 2006; *Trojan and Piotrowski*, 2007). According to some data, the first raw-cooked sausage from a mixture of pork and beef, so called frankfurter sausage, was made by the Viennese butcher Johann Georg Lahner in 1805 (*Vukovic*, 2006). Taking into account the production quantities of cooked sausages in many countries, including central Europe, they are the most common meat products. There are hundreds of these types of sausages worldwide that are often classified under a common concept – cooked, and the only differences between themselves are some local or regional characteristics (*Radetic*, 2000). By definition, raw-cooked sausages contain meat (muscle, fatty and connective tissue) and non-meat ingredients which are processed raw, i.e. uncooked by comminuting and mixing. The resulting viscous mix/batter is portioned in sausages or otherwise and thereafter submitted to heat treatment, i.e. "cooked"–"pasteurised", with or without smoking (*FAO*, 2007). Production technology of cooked sausages includes a complex of biochemical, chemical and physical changes, particularly the process that relates to a water binding capacity and adipose tissue (fat) emulsifying, which is often in a very close relationship with the process of comminution (*Radetic*, 2000).

In the group of cooked sausages, there are a large number of products that differ amongst themselves by its composition, the comminution grade of the stuffing, type and diameter of the casings. Based on the comminution grade of the stuffing, raw-cooked sausages are divided into finely chopped cooked sausages, coarsely chopped cooked sausages, cooked sausages with meat pieces and meat loaves (*Vukovic*, 2006). According to the current Regulation on the quality of ground meat, meat preparations and meat products (*Official Gazette of the Republic of Serbia*, 2015,2017), coarsely chopped

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cooked sausages are produced and placed on the market under the name of Srpska sausage, Moravska sausage, Tirolska sausage and Mortadella, or under a different name. The same Regulation defines Srpska sausage as a meat product derived from meat, firm fatty tissue and blood preparations with the addition of salt, the curing salt, water, spices, spice extracts, sugars, additives, smoke flavour and natural flavouring agents. Srpska sausage is stuffed itno the small intestine of pigs or adequate artificial casings, followed by pasteurisation and smoking as a heat treatment. Also, the quality of Srpska sausage is specified by its chemical quality parameters such as meat protein content, a content of collagen in meat proteins, total phosphorus content and nitrite content (*Official Gazette of the Republic of Serbia*, 2015, 2017; *Official Gazette of the Republic of Serbia*, 2013). In previous regulations on the quality of meat products, Srpska sausage was in a group of semi-durable sausages, it had to contain at least 25% of meat of all categories, 20−50% of meat batter and water up to 55%, and its production was defined by the manufacturer's specification, which was brought by manufacturer and which had to be approved by the competent Ministry (*Official Gazette of the Socialist Federal Republic of Yugoslavia,* 1968; *Official Gazette of the Socialist Federal Republic of Yugoslavia,* 1974, 1978, 1980). This indicates that the Srpska sausage belonged to the group of so-called "related products" and the non-meat proteins were allowed by this product which affected its quality, and therefore in the following regulations, it became necessary that the quality of Srpska sausage should be precisely defined.

Suitable formulations for production of meat products and the provision of uniform quality, within the unchanged use of this product, are one of the tasks with which the meat processing industry faces every day (*Sveinsdóttir et al.,* 2009). Quality and composition of meat product in all organised countries is regulated by regulations adjusted to consumer habits, technological capability and development of the country, control possibilities, religious demands (*Arihara*, 2006). Besides of regulations of the Republic of Serbia, that determine the chemical composition of the Srpska sausage, cooked sausages are extremely variable group of meat products, and therefore on the markets we can find sausages that do not meet the specified conditions, or Srpska sausages, that despite adequate chemical composition, do not satisfy certain sensory characteristics that are also an important indicator of quality (*Kurcubic et al.*, 2012).

The aim of this study was to assess the quality of 11 different samples of Srpska sausage, by determination of chemical composition and sensory evaluation, from 9 manufacturers in Serbia who responded to a public call of the Chamber of Commerce and Industry of Serbia in order to improve brand of Srpska sausage and competitiveness of domestic producers.

Materials and Methods

Nine different manufacturers, who responded to a public call of the Chamber of Commerce and Industry of Serbia, have made 11 different Srpska sausages in accordance with Article 75. and 77. of the current Regulation (*Official Gazette of the Republic of Serbia*, 2015, 2017). The filling is stuffed into anatural casing (pig small intestine – salted, calibrated, diameter 32−34 mm). Sausages were vacuum-packed in a packaging of 1.5 kg, stored at 2−4ºC until they were delivered for sensory evaluation and chemical analysis.

Twenty trained panellists participated in the sensory evaluation and were selected according to Serbia/ISO standard (*SRPS*, 2015; *SRPS*, 2012a). The evaluation was conducted in a sensory laboratory designed according to Serbian/ISO standard (*SRPS*, 2012b). The quantitative descriptive sensory analysis was used to evaluate the sensory profile of the samples (*SRPS*, 2001). Six attributes were used for sensory evaluation, including external appearance, cross-section appearance (including colour), texture (hardness, juiciness, chewiness and fattiness), odour, flavour and overall sensory quality. From this parameters, cumulative score for each sample was calculated by multiplying all scores by coefficients of importance and addition of adjusted ratings. Scores were in the range from 1 (unacceptable) to 5 (excellent), and the coefficients of importance were 2, 3, 5 and 6. The level of acceptability was half of the value obtained by multiplying the highest score by a coefficient of importance for each attribute. The example of the sensory ballot is shown in Table 1 (*Baltic*, 1994). Panellists marked with a number the intensity for each attribute.

Before sensory evaluation, a half of the sausages were boiled at 80°C for 5 min. The sausages were served with casings, cold and boiled. Then, the tips of the sausages were cut off and discarded. Slices (1 cm thick) were cut and used for evaluation. Each panellist tasted 2−3 slices from the same sausage. Samples were labelled with random three digit numbers and served in random orders.

Table 1. The example of sensory ballot for evaluation of Srpska sausage (*Baltic*, 1994)

Panellist code:		Date:	
Sample code:		Meat product:	
Attributes	Score 1–5 (A)	Coefficients of importance (B)	Adjusted rating (AxB)
External appearance		2	
Cross section appearance		6	
Texture		2	
Odour		3	
Flavour		5	
Overall sensory quality		2	
		Cumulative score:	

Chemical composition

After sensory evaluation, 3 samples from each Srpska sausage were taken for chemical composition analysis. Total protein content, total fat content, a content of $NaNO_2$, P_2O_5 and NaCl was determined using standard reference methods (*SRPS*, 1992; *SRPS*, 1998; *SRPS*,1999a; *SRPS*,1999b; *SRPS*, 1999c). Collagen content was calculated by multiplying hydroxyproline content (%) by factor 8 (hydroxyproline content was determined by method *SRPS*, 2002) and the proportion of collagen in meat proteins is further calculated as follows: content (quantity) of the collagen in proteins (%) = collagen content (%) × 100 / total protein content (%). Additionally, nutritional (water/protein and fat/protein ratio) and energetic (total energy content and the percentage of protein and fat energy) parameters of examined sausages were calculated.

Statistical analysis

Statistical analysis of the results was conducted using the software GraphPad Prism Version 5.00 for Windows (GraphPad Software, San Diego, California USA, www.graphpad.com). The results of sensory evaluation were expressed as mean±SD and reported in the table, while results of chemical analyses were shown in figures. One-way ANOVA and post hoc Tukey's test were performed to assess the significance of differences among samples of sausages. Values of $p<0.05$ and $p<0.01$ were considered significant.

Results and Discussion

Chemical analyses

The quality of cooked sausages is defined by the meat protein content, regarding total protein content and the relative content of the connective tissue protein in total proteins. Coarsely chopped cooked sausages should contain at least 12% of protein and maximum 20% of collagen in the meat protein (*Vukovic*, 2006). Average protein content in the examined Srpska sausages was 16.84±1.37%, while average content of collagen in the meat protein was 9.20±2.32%. All of the samples, by these parameters, were in accordance with the requirements set by the Regulation (2015, 2017) (Figure 1; Figure 2). Kurcubic et al. (2012) found that of the 94 examined coarsely chopped cooked sausages from different producers in Serbia, 11.11% of the samples had total protein content lower than allowed, and 25% of the samples had a content of collagen in the meat protein higher than permissible. Of these, 12 were Srpska sausages, from which two samples had a higher content of collagen in meat protein than allowed. Also, *Saicic et al.* (2006) found that of 67 coarsely chopped cooked sausages, 13.92% did not meet the quality requirements prescribed by current Regulation. *Krausse* and *Kotter* (1971) consider that the main factor that determines the quality of the meat products is the quantity and quality of protein. In this way, the quality of the sausages would be assessed, at the same time excluding the possibility of the presence of proteins derived from other foods (soy, milk), by determining the content of high value protein.

Additional indicators of sausages quality are water/protein ratio and fat/protein ratio. For Kranjska sausage, it is determined that the water/protein ratio should be 3.3, and the fat/protein ratio 2.4 (*Anon.*, 2016). These ratios for 11 Srpska sausages were ranged from 2.98 to 4.55 and from 0.98 to 1.61, respectively (Table 2). Thus, according to the parameter water/protein ratio, even 54.55% of the examined sausages did not meet the conditions, while in terms of fat/protein ratio, all sausages met the requirement. According to *Krausse* and *Kotter* (1971), if the percentage of the protein content,

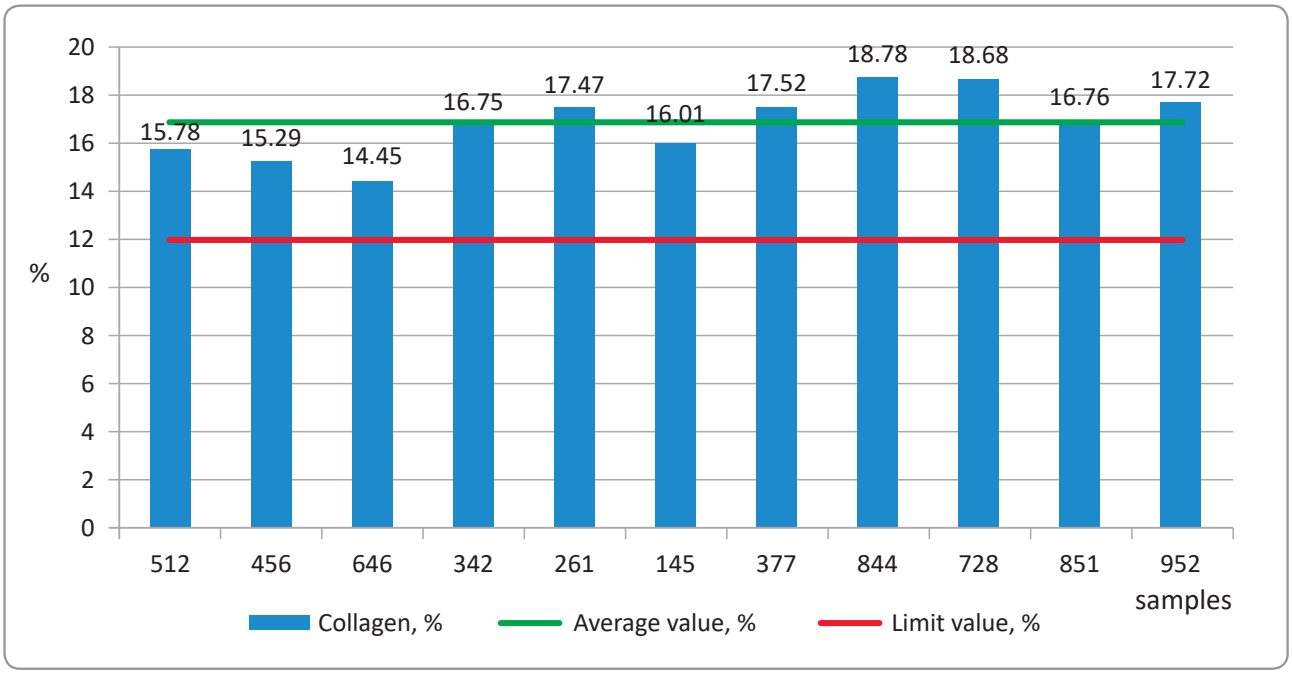

Figure 1. Protein content of examined Srpska sausages

which does not include the connective tissue protein, is satisfactory, the ratio of fat/protein and water/protein of the meat product can be disregarded.

Sausages are considered to be products with a highfat content. The fat content in the examined samples of Srpska sausages ranged from 16.28% (sample 646) to 26.69% (sample 851) (average fat content of 11 samples was 22.68±3.54%), where 81.82% of sausages had a fat content higher than 20% (Figure 3). *Dojcinovic et al.* (2015) found that most of the finely chopped cooked sausages on the market in Banja Luka (frankfurters and Parisian sausages) had fat content in the range of 15–20% (44.74% and 46.15%, respectively). National Food Survey figures for 1995 estimate that meat and meat products currently contribute 18.1 g of fat or 23% to the total daily intake of which 4.9 g is derived from carcass meat, 2.2 g from uncooked poultry meat, 26 g from bacon and ham, and 8.4 g from other meat

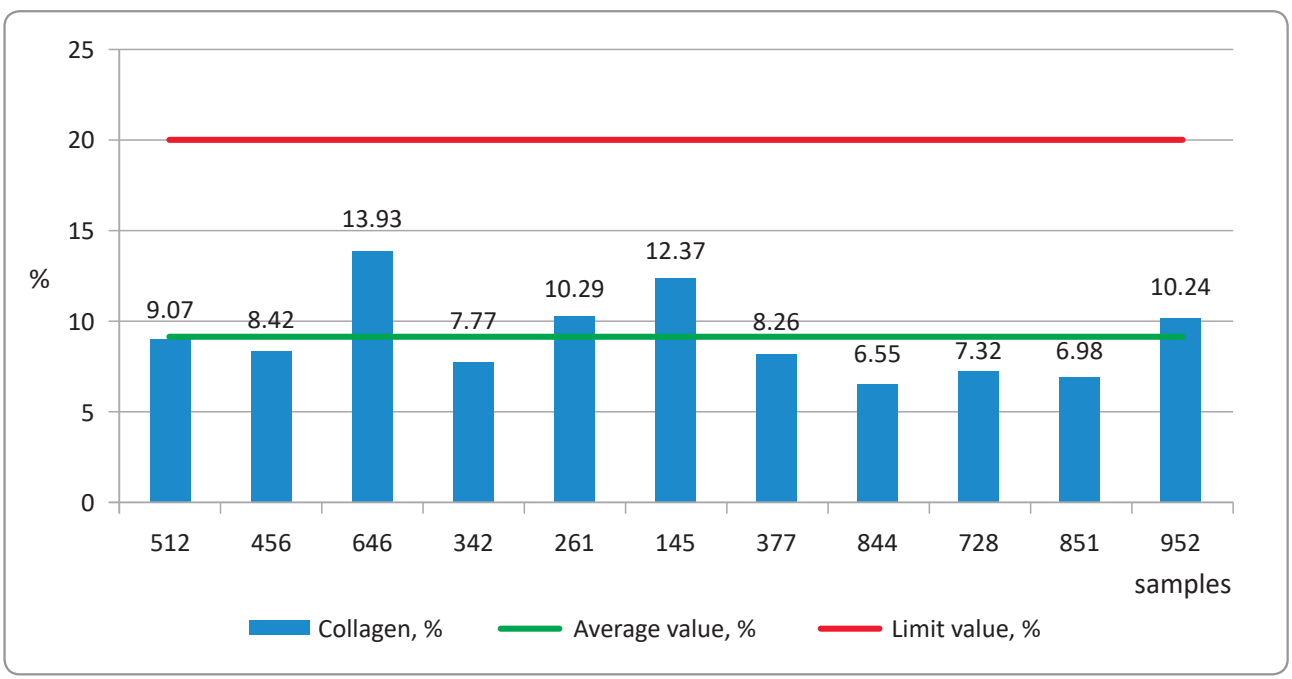

Figure 2. Collagen content in meat proteins of examined Srpska sausages

Table 2. Selected nutritional and energetic parameters of examined sausages

Sample	water: protein ratio	fat: protein ratio	total energy (kJ)	protein energy (%)	fat energy (%)
512	3.77	1.39	1089.87	24.25	75.75
456	3.75	1.60	1176.62	21.76	78.24
646	4.55	1.13	855.45	28.29	71.71
342	3.53	1.23	1054.49	26.60	73.40
261	3.56	0.98	936.92	31.23	68.77
145	3.42	1.61	1241.80	21.59	78.41
377	3.02	1.52	1298.75	22.59	77.41
844	2.92	1.27	1210.19	25.99	74.01
728	2.89	1.28	1210.40	25.85	74.15
851	3.19	1.59	1286.39	21.82	78.18
952	3.20	1.26	1139.69	26.04	73.96

products (*Ministry of Agriculture, Fisheries and Food,* 1996; *Sheard et al*., 1998).

The calculated total energy content of examined samples of sausages was between 855.45 kJ and 1298.75 kJ (Table 2), and in all sausages, more than 20% of energy come from protein. The nutritive value of the meat products originates mainly from proteins and fats, they do not contain carbohydrates or their quantity in the meat products is negligible. Calories intake by eating sausages come from degradation of proteins and fats, and these sources of energies are physiologically favourable for the human body (*Oluski*, 1974).

Salt is involved in water holding, texture, colour, taste and aroma development and enhancement of the microbiological safety of cooked sausages. The salt content is usually between 1.5% and 2.5%, but lower and higher contents are frequently seen (*Toldrá*, 2010; *Albarracín*, 2011). Consumption of 100 g of examined Srpska sausages implies average intake of 2.14±0.31 g of salt (Figure 4). Estimated average salt intake in the adult population of Novi Sad is relatively high at 12.12±4.79 g compared to the recommended amount of 5 g per day (*Popovic*, 2013). While, the average total daily sodium intake per individual in developed countries is 4–5 g of Na (10–12 g of NaCl), which is up to 25 times greater than the minimum adult requirement (0.5 g of NaCl) (*Albarracín*, 2011).

The content of nitrite in 11 Srpska sausages ranged from 0.03 mg/kg to 99.45 mg/kg (average nitrite content of 11 samples was 46.91±30.99), thus all the samples had nitrate content lower than the maximum stipulated limit (Figure 5). Nitrite is added to most cooked sausages at levels of 120–150 mg/kg, but there is a constant trend to reduce these levels (*Toldrá*, 2010). The average total phosphates content (which includes the natural phosphorus and added phosphorus content) of examined Srpska sausages was 4.60±0.53 g/kg and all 11 samples were in accordance with the requirements set by the Regulation (8 g/kg) (Figure 6). Additionaly, the Serbian regulation on additives defines the amount of added phosphates (P_2O_5) as 5 g/kg (0,5%) (*Official Gazette of the Republic of Serbia*, 2013). Also, *Kurcubic et al.* (2012) showed that total P_2O_5 content (g/kg) in all of 272 examined samples was compatible with the values permitted by the Regulation, indicating a strict adherence to regulations when using phosphate as one of the technologically most important additives in the production of cooked sausages. In most countries, the use of phosphates is allowed and the levels used vary from 0.15% to 0.3%, given as P_2O_5 (in the EU, the maximum is 0.5%) (*Toldrá*, 2010).

Sensory evaluation

Appearance determines how consumers perceive quality and significantly influences purchasing behaviour (*Resurreccion*, 2004). Sensory analysis is a useful and irreplaceable method for precise determination of the quality of food products (*Radovanovic and Popovic-Raljic*, 2001). By using descriptive method it is possible to define the quality characteristics of the selected product and to identify potential product defects (*Grujic et al*., 2010). Mean values for each evaluated sensory attribute of the 11 studied sausages are shown in Table 3. Assessing of the external appearance of Srpska sausages depend on the adjustment of the casings and whether there

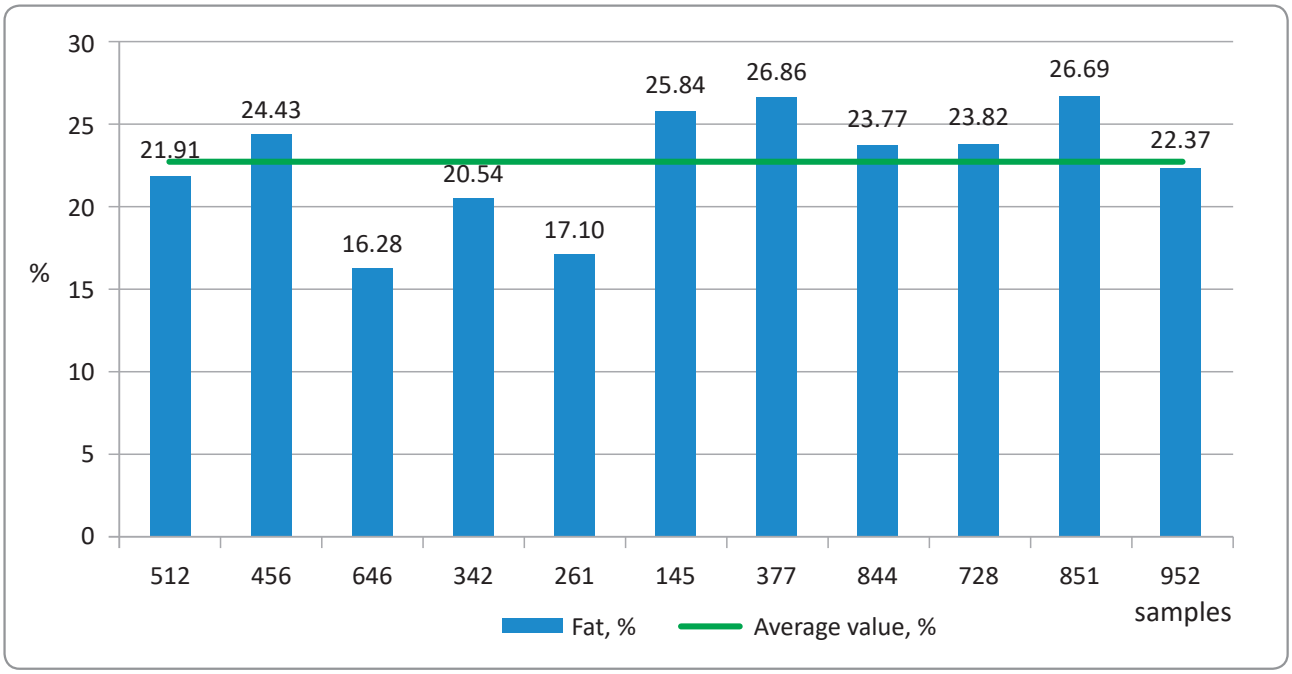

Figure 3. Fat content of examined Srpska sausages

is a separation of jelly and grease, while evaluation of cross sectional appearance takes into consideration that the meat is uniform with stable colour and that the components of the filling are evenly distributed and connected (*Official Gazette of the Republic of Serbia*, 2015, 2017). With the lowest scores for external and cross sectional appearance (including colour) were evaluated samples 145 and 377 (fat content >25%), while the highest scores obtained samples 844 and 952. According to these attributes, all samples were acceptable. The appearance of cooked sausages can be influenced by pH, meat source, packaging conditions, freezing history, the rate of thawing, fat content, added ingredients (salt, nitrite, phosphate) and preservation treatments. Additionally, these factors change the ratio of different forms of myoglobin; the main pigments responsible for the ultimate colour of meat (*Whyte*, 2006).

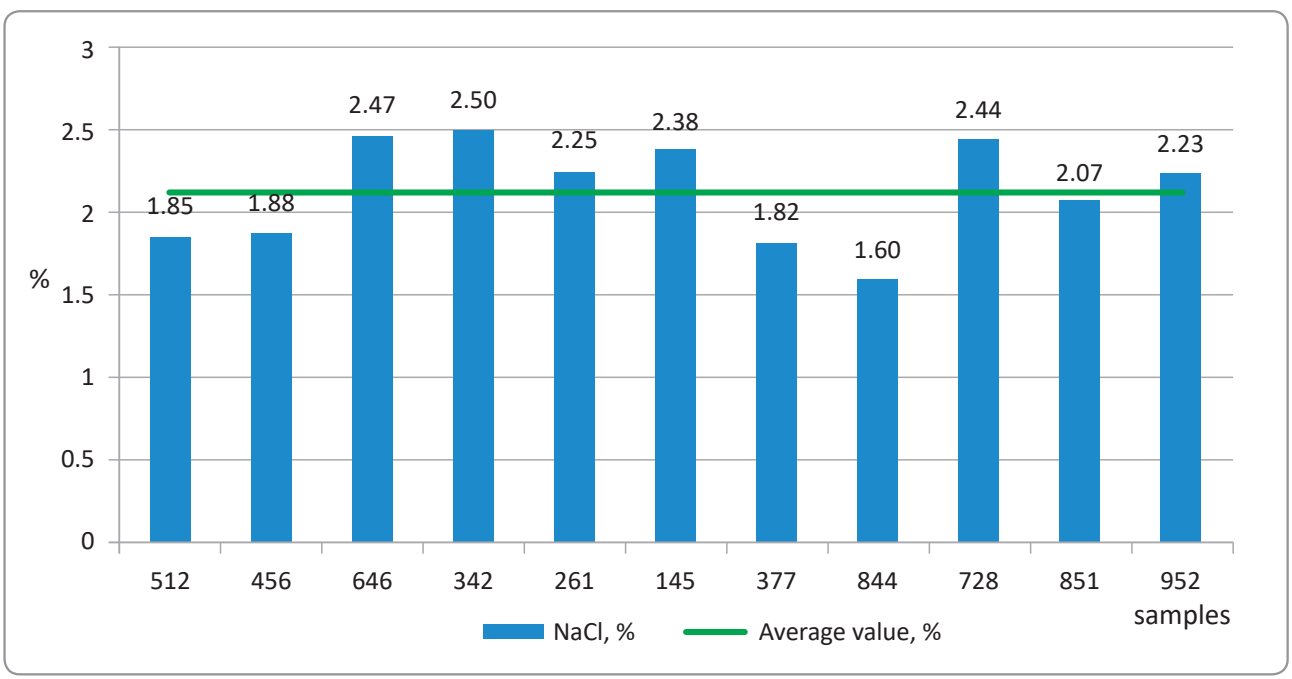

Figure 4. Sodium chloride content of examined Srpska sausages

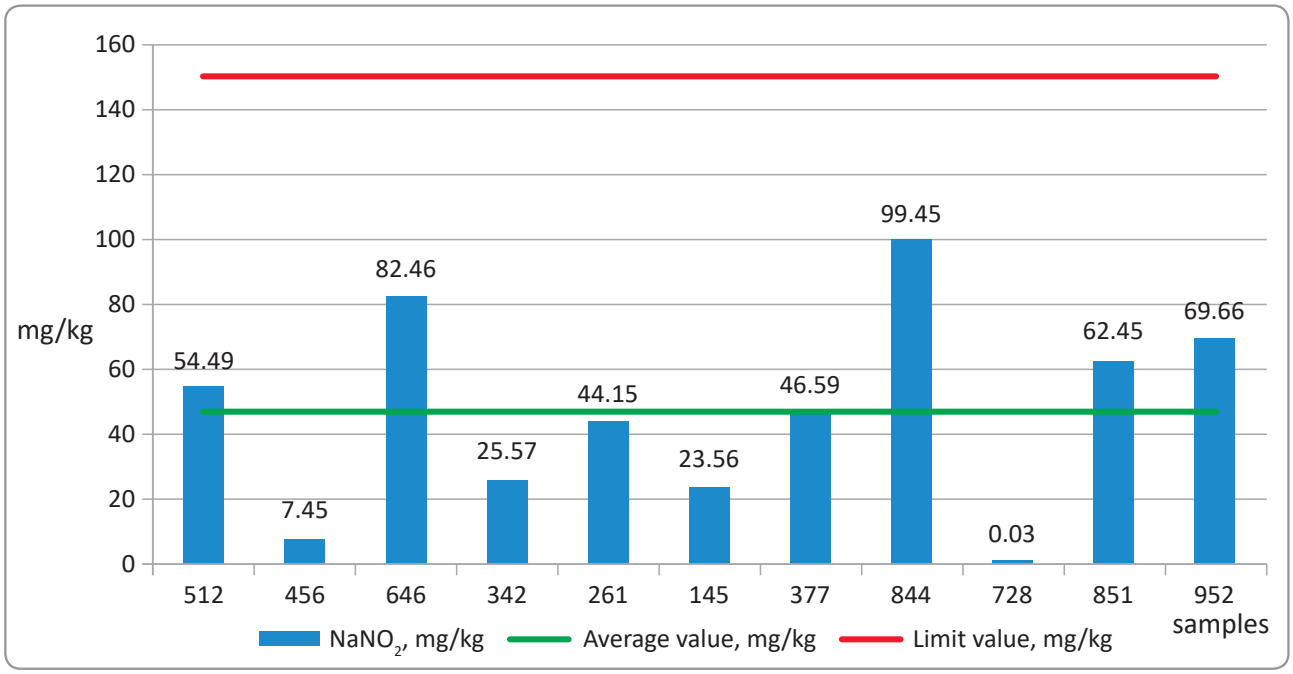

Figure 5. Sodium nitrite content of examined Srpska sausages

Texture includes a variety of characteristics, such as hardness, juiciness, chewiness and fattiness and among them, hardness is the most important to the consumer (*Grujic et al*., 2014). Samples 145 and 377 were evaluated with the lowest scores for texture (6.00±1.56 and 6.05±1.19, respectively), while the highest score was assigned to a sample of 952 (8.60±0.82) and by this attribute, sample 952 significantly differed from samples 145 and 377 ($p<0.01$). Factors that contribute to the texture of cooked sausages are the content of connective tissue, fat content, phosphates and especially salt. Many authors showed that salt influence on hardness and juiciness of sausages and that a reduction in salt (NaCl) content of less than 2.0% resulted in sausages of less firm texture (*Matulis et al.*, 1995; *Ruusunen et al*., 2003). Namely, in meat products, salt contributes to water and fat binding by expanding the filament

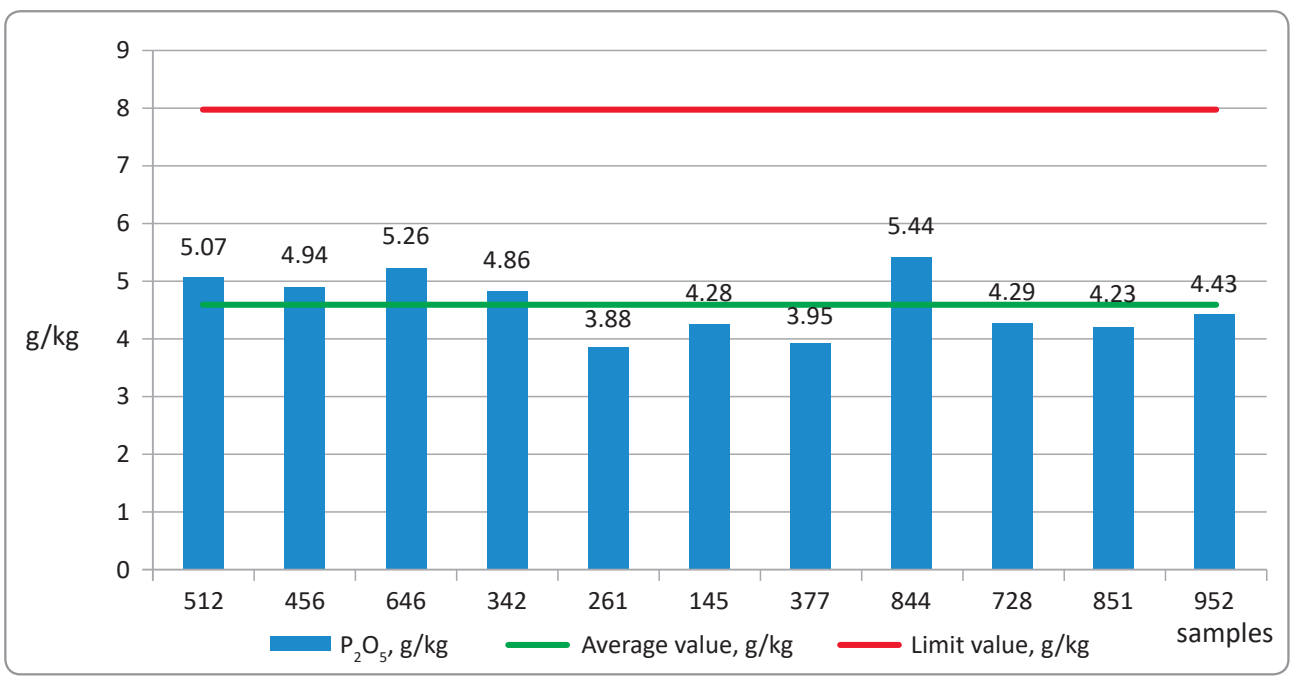

Figure 6. Total P_2O_5 content of examined Srpska sausages

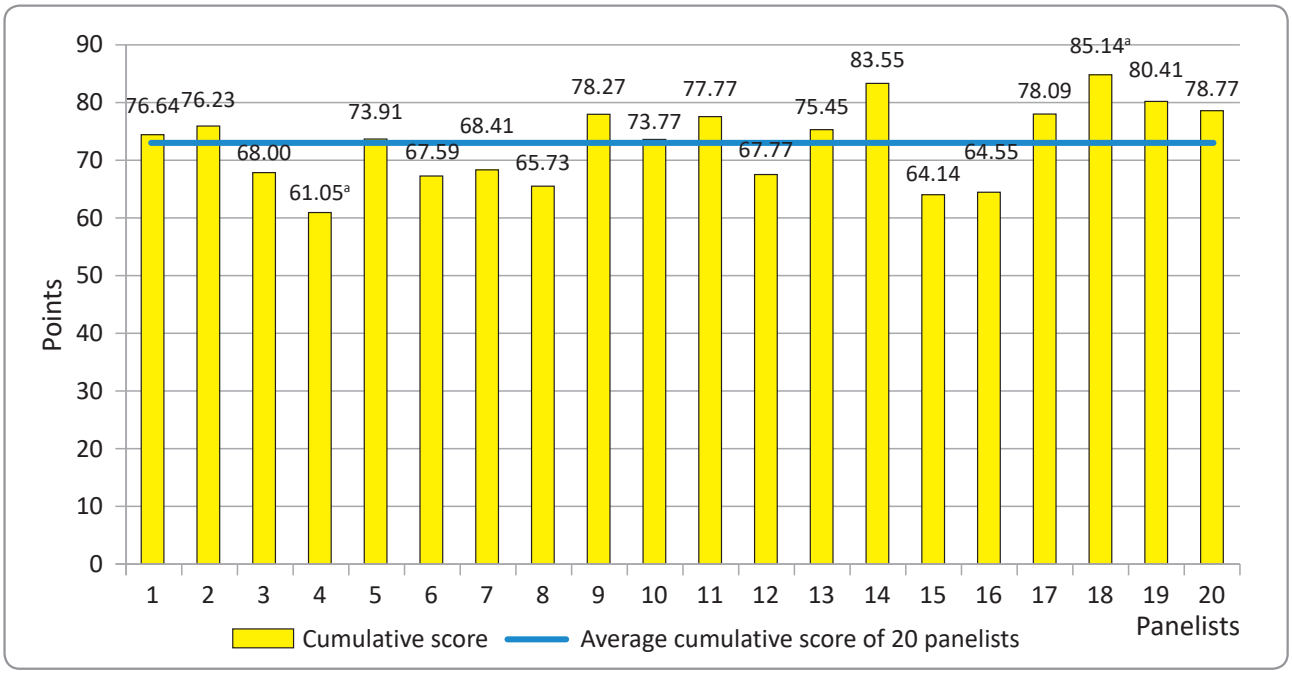

Figure 7. Cumulative scores of 20 panelists for 11 samples of Srpska sausage ([a] $p<0.05$)

lattice of myofibrils and (*Ruusunen et al*., 2003). by partially solubilizing the myofibrillar proteins

Sample 377 is assessed with lowest scores for the odour, flavour and overall sensory quality, while for the same parameters highest scores obtained sample 952. Also, the sample 952, by these parameters, was not significantly different from the samples 844, 728 and 851 ($p>0.05$). In addition, for flavour and overall sensory quality, sample 377 was below the limit of acceptability and by these two properties was significantly different from all other samples ($p<0.01$), except for samples of 261 and 145. Sausage odorants come from raw materials (e.g. spices and flavourings) or are generated through chemical reactions during cooking. It is shown that fat level influenced the release of volatile compounds

Table 3. Sensory evaluation of 11 Srpska sausages

Sample	Attributes						
	External appearance	Cross sectional appearance	Texture	Odour	Flavour	Overall sensory quality	Cumulative score
512	7.35 ± 1.35^{abcd}	21.45 ± 4.38^{ABa}	7.95 ± 1.47^{AB}	10.20 ± 1.86^{abcA}	16.63 ± 3.37^{ABaCD}	7.05 ± 1.28^{aAbcB}	70.63 ± 11.92^{ABaCD}
456	8.65 ± 1.04^{ABC}	23.40 ± 3.97^{bCD}	7.55 ± 1.57^{Ca}	12.30 ± 1.92^{BCD}	18.38 ± 4.31^{bEFc}	7.65 ± 1.69^{CDE}	77.93 ± 12.30^{EFG}
646	8.40 ± 1.19^{eDf}	22.05 ± 3.12^{EF}	8.25 ± 1.21^{DE}	11.68 ± 2.36^{dEF}	19.38 ± 3.33^{GHI}	7.75 ± 1.02^{FGH}	77.45 ± 10.58^{HIJ}
342	7.85 ± 1.27^{E}	22.35 ± 3.83^{GH}	7.20 ± 1.32^{bc}	10.73 ± 1.90^{Ge}	17.50 ± 2.92^{dJK}	7.05 ± 1.10^{dIefJ}	72.68 ± 10.02^{KLbM}
261	7.00 ± 1.62^{AeFGHg}	19.20 ± 4.71^{bIcJK}	7.10 ± 1.21^{de}	9.15 ± 2.62^{BdHIJK}	14.38 ± 4.58^{bGLMNO}	6.05 ± 1.70^{CFKLMN}	62.88 ± 14.77^{EHNOPQ}
145	5.95 ± 1.85^{aBDEIJKL}	15.60 ± 4.63^{ACEGLMNO}	6.00 ± 1.56^{ACDFGHI}	8.93 ± 2.60^{CELMNO}	13.75 ± 4.33^{EHdPQRS}	5.65 ± 1.76^{aDGdOPQR}	55.88 ± 14.82^{AFIKRSTU}
377	6.95 ± 1.47^{CfMNOh}	15.30 ± 4.34^{BDFHPQRS}	6.05 ± 1.19^{BaEJKLM}	7.80 ± 2.16^{aDFGPQRS}	10.75 ± 2.94^{AFIJTUVW}	4.80 ± 1.32^{AEHISTUV}	51.65 ± 10.05^{BGJLVWXY}
844	8.90 ± 1.02^{bFIM}	24.00 ± 3.08^{ILP}	8.40 ± 0.88^{FJ}	12.45 ± 1.76^{bHLP}	21.13 ± 2.98^{BLPT}	8.50 ± 0.89^{beKOS}	83.38 ± 8.62^{aNRV}
728	8.85 ± 1.23^{cGJN}	$23.25\pm4,.23^{cMQ}$	7.80 ± 1.58^{GK}	12.08 ± 2.20^{IMQ}	20.50 ± 4.02^{aMQU}	8.05 ± 1.47^{LPT}	80.53 ± 13.32^{OSW}
851	8.80 ± 1.15^{dHKO}	24.75 ± 3.21^{JNR}	8.55 ± 1.05^{bdHL}	12.75 ± 1.92^{cJNR}	21.13 ± 2.36^{CNRV}	8.60 ± 0.75^{cfMQU}	84.58 ± 8.67^{CbPTX}
952	8.55 ± 1.32^{gLh}	25.95 ± 2.44^{aKOS}	8.60 ± 0.82^{ceIM}	13.13 ± 1.88^{AeKOS}	22.25 ± 2.80^{DcKOSW}	8.70 ± 1.08^{BJNRV}	87.23 ± 8.33^{DMQUY}

Legend: [A-Y] Within a column, values with a common superscript letter are significantly different, $p<0.01$
[a-h] Within a column, values with a common superscript letter are significantly different, $p<0.05$

during mastication, but only if mastication lasts more than 1 min. In addition, fat content could influence sausage flavour by changing the water/fat ratio and modifying the concentration in each phase of compounds such as salt and emulsifying proteins but also the concentrations of odour and taste active compounds (*Carrapiso*, 2007). Also, for sausage flavour, an important step of processing is cooking (*Carrapiso*, 2007). Besides, salt is usually reported to enhance the total flavour intensity of meat products (*Matulis et al*., 1995; *Ruusunen et al*., 2003).

The sample 377 was evaluated by the lowest cumulative score, at the level of acceptability and differed significantly from all samples ($p<0.01$), except samples 261 and 145. The best-evaluated sample, a sample of the best quality was 952, with a mean cumulative score of 87.23±8.33. However, samples 844, 728 and 851 also had a score higher than 80 and did not significantly differ from sample 952 ($p> 0.05$). The mean cumulative score for all 20 palenellists was 73.16±6.85. Most of the panellists, 35% of them, assessed that the best sausage was sample labelled with 952, 25% of panellists chose sample 728, while 15% chose samples 844 and 851. Panellist no. 4 was the strictest in the evaluation, with a mean cumulative score of 61.05±12.36, while the most lenient evaluator was panellist no. 18, with a mean cumulative score of 85.14±13.89. ($p<0.05$) (Figure 7).

Conclusions

Manufacturers in Serbia should be encouraged to produce the best possible Srpska sausage, which would not satisfyonly the requirements set by Regulation but also meet the nutritional and health needs of the consumers and their perception of quality.

Improving the quality of Srpska sausages can be achieved in several ways.One of them is related to the Regulation on labelling of agricultural and food products with the national code of higher quality "Serbian quality" (no. 90/2016). In addition, Srpska sausage could be protected by trademark or indication of geographical origin by The Intellectual Property Office of the Republic of Serbia. Regardless of the way for improving the quality, for Srpska sausage, it should be made standard modelled on Codex Alimentarius standards or some other standards.

Quality parameters of the highest ranked "Srpska sausage" from this study will be, on behalf of the Council of Technologists producers of meat and meat products, submitted to the competent state authorities as amendments tothe current Regulation on the quality of ground meat, meat preparations and meat products.

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