DOI: 10.7251/QOL1601005DZ **UDC:** 637.523.035.05

Original scientific paper

Chemical, Color, Texture and Sensory Properties of Čajna Kobasica, a Dry Fermented Sausage

Natalija Džinić, Maja Ivić, Marija Jokanović, Branislav Šojić, Snežana Škaljac, Vladimir Tomović,
Univerzitet u Novom Sadu, Tehnološki fakultet, Novi Sad, Srbija
Corresponding author: natadzin@uns.ac.rs

Abstract: The aim of this study was to conduct a comprehensive examination of quality parameters of dry fermented sausage (Čajna kobasica) from six different producers from the market in Vojvodina. The investigated parameters were chemical composition (moisture, total protein, relative content of connective tissue proteins RCCTP, free fat, ash, NaCl and nitrite content), pH value, aw value, instrumental color parameters (lightness *L**, redness *a** and yellowness *b**), instrumental texture parameters (hardness, springiness, cohesiveness and chewiness) and sensory properties (external appearance and/or condition of the packaging, appearance and composition of cut surface, color and stability of color, odour and taste and texture and/ or juiciness). It could be concluded that out of six examined brands of dry fermented sausage (Čajna kobasica), two brands did not meet the requirements prescribed under the Regulations, because of a higher level of RCCTP. The lowest *L** value was recorded in brand 4 (44.33). The brand 4 had the highest hardness and chewiness (22883.33g and 3857.58g, respectively), and the lowest springiness and cohesiveness (0.42 and 0.40, respectively). Parameters related to sensory properties showed significant variability ($p < 0.05$). Overall sensory quality of tested samples ranged from 3.53 (brand 1) to 4.18 (brand 4).

Keywords: dry fermented sausages, Čajna kobasica, chemical composition, texture properties, color properties, sensory properties

Introduction

Fermentation and drying can be considered to be the oldest way to preserve raw materials. Fermented meat products play an important role in many diets around the world. They are very appreciated by the consumers. Fermented sausages are widespread produced but the Europe is still the major producer and consumer of these fermented meat products (Vignolo et al. 2010). Čajna kobasica is a dry fermented sausage whose consumption has been extended in all of the Province of Vojvodina (Republic of Serbia). Čajna kobasica is prepared by mixing ground pork and beef meat, hard fat tissue along with additives. Additives which are used in the production of industrial dry fermented sausage Čajna kobasica are curing salts, sugars, spices, and starter cultures. Some producers add glucono delta-lactone (GDL) in mixtures as a acidifier or curing agent. Well mixed compound is stuffed into artificial collagen casing. The diameter is usually 36mm. After stuffing it undergoes cold smoking process. Afterwards it is left to dry and ripen for a period of up to 20-25 days, until it achieves optimum quality. The ripening stage, which takes place in ripening chambers under controlled temperature, relative humidity and air speed conditions, is the most demanding operation in the production of dry fermented sausages (Vignolo et al., 2010). The above-mentioned process parameters affect the textural, color and sensory properties of the final product. The color, texture and flavor of dry fermented sausages are factors critical to consumer acceptance (Popov Raljić et al., 1996).

There is no existing information in scientific literature on this dry fermented sausage (Čajna kobasica), which could contribute eficiently to its characterization. The purpose of this work was to examine, physico-chemical composition, instrumental measurements of color and texture and sensory properties of Čajna kobasica.

Materials and methods

Sausages examined in this work were selected randomly from six different producers from the market. Samples were labelled with a numeric code: the number (1-6) indicates the brand (producer). Three sausages (pieces about 300 to 400 g weight) of every selected commercial brand were randomly purchased at the supermarket.

After removing the casing, chemical analyses were made on every commercial brand of dry fermented sausage. All samples of dry fermented sausages were homogenised, frozen and kept at -20 °C until they were analysed. Moisture, total protein, RCCTP, free fat, ash, NaCl and nitrite content were determined according to methods recommended by International Organization for Standardization (ISO 1442:1998; ISO 937:1992; ISO 3496:2002; ISO 1444:1998; ISO 936:1998; ISO 1841-1:1999; ISO 2918:1999, respectively).

The pH values of sausages were measured using the portable pH meter (ConsortC931, Turnhout, Belgium) equipped with an insertion glass combination electrode (Mettler Toledo Greifensee, Switzerland). pH was measured both in the core and in the outer part of halved sausages. Means of three measurements are presented.

Water activity (aw) of samples was determined using Testo 650 measuring instrument. Means of three measurements are presented.

Color of each sample of the examined sausages was measured immediately after slicing 2 mm thick slice at room temperature . The CIE $L^*a^*b^*$ color coordinates (CIE, 1976) were determined using a Minolta chromameter (Model CR-400, Minolta Co., Ltd., Osaka, Japan) using D-65 lighting, a 2° standard observer angle and an 8-mm apperture in the measuring head to obtain L^*, a^*, and b^*scores. The chromameter was calibrated using a Minolta calibration plate (No. 11333090; Y = 92.9, x = 0.3159; y = 0.3322). One measurement was taken on nine fresh cut surfaces of sausages from each brand. Data presented are means of 9 measurements.

Texture profile analysis (TPA) was performed with a universal testing machine Texture Analyser TA HD (Stable Micro System, Godalming, England). The samples (six cylinders) 2 cm high and 2.54 cm (1 inch) in diameter, taken from the central part of sausage slices, were equilibrated to room temperature. A double compression cycle test was performed up to 50% compression of the original portion height. A time of 5 s was allowed to elapse between the two compression cycles. Force-time deformation curves were obtained with a 250 kg load cell applied at a cross-head speed of 1 mm/s. The following parameters from the force–time curves were determined: hardness (g) maximum force required to compress the sample, springiness ability of the sample to recover its original form after deforming force was removed, cohesiveness, extent to which the sample could be deformed prior to rupture and chewiness (g), work required to masticate the sample before swallowing.

A panel consisting of seven trained members of different ages performed sensory evaluation. The panelists were asked to test the dry fermented sausages for the following characteristics: external appearance and/ or condition of the packaging, appearance and composition of cut surface, color and stability of color, smell and taste and texture and/ or juiciness. Each panelist was given three slices (3 mm thick) of each sample, cut with a slicing machine and served on white plastic dishes. Water and unsalted bread were allowed to cleanse the palate between samples. Assessments were carried out under natural light at a room temperature. Evaluations were performed according to a 5-point scale descriptive system, from 0 to 5, with sensitivity threshold of 0.25 points. Each mark was ascribed a distinctive quality level, as follows: 5–extraordinary, typical, optimal quality level; 4–observable deviations or insignificant quality defects; 3–drawbacks and defects of quality; 2–distinct to very distinct drawbacks and defects of quality; 1–fully changed, nontypical properties,

product unacceptable; 0–visible mechanical or microbiological contamination, atypical product and similar. The overall sensory quality of sausages was evaluated according to the following expression: Overall sensory quality = (external appearance of sausage x2 + appearance and composition of cut surface x5 + color and color maintenance on the cutting x3 + odor and taste x7 + texture and juiciness x3) / 20.

Differences between the sausages produced by different producers were analysed through an analysis of variance ANOVA (Statistica 12.6 - StatSoft, Inc. 2014). The Duncan's post hoc test was used for comparison of mean values.

Results

The mean values of the chemical components of the six dry fermented sausages are presented in Table 1. According to Serbian Regulations, moisture content in dry fermented sausages must be lower than 35% (Serbian Regulations 94/2015). All the moisture content was lower than 35%, they ranged from 20.22% (brand 4) to 30.87% (brand 1). Vukašinović et al. (2012), in commercial dry fermented sausages (Čajna kobasica), found that moisture content ranged from 17.22% to 36.12%, while Rede et al. (1995) registered moisture content between 25.54% and 27.56%. The lowest protein content with significant difference ($p < 0.05$) was recorded in brand 2 (21.42%) and the highest numerical value had brand 5 (26.12%). The protein content in dry fermented sausages must be above 20% (Serbian Regulations, 94/2015). The protein content in investigated samples of Čajna kobasica were similar to the registered values in earlier studies (Džinić et al., 2015). Vukašinović et al. (2012), in the same type of sausage, found that total protein content varried between samples (17.17%-31.69%). According to Serbian Regulations (94/2015), RCCTP must be lower than 15%. The RCCTP was not within the values recommended in the Regulations for brand 2 (18.11%) and brand 3 (16.78%). The level of free fat varied between sausages and ranged from 36,77% (brand 5) to 48,31% (brand 2). Petrović et al. (2011) found similar values in *Petrovska klobasa*, traditional fermented sausage, which ranged from 34.09% to 46.01%. The ash content of all brands ranged from 4.41% to 5.23%. NaCl levels were significantly different ($p < 0.05$) between sausage brands, except between brand 4 (3.85%) and brand 5 (3.84%). NaCl contents were lower in comparison with the values recorded in other studies (Rede et al., 1995). The concentration of residual nitrite varied ($p < 0.05$) between sausages. The lowest concentration of nitrite (5.75 mg/kg) was found in brand 6 and the highest in brand 1 (13.84 mg/kg).

Table 1. Chemical composition of dry fermented sausages (Čajna kobasica)[ab]

Brand	Moisture content (%)	Protein content (%)	RCCTP (%)	Free fat content (%)	Ash content (%)	NaCl (%)	Nitrite content (mg/kg)	pH	aw
1	30.87 ±0.29[a]	23.74± 0.36[b]	10.61 ±0.17[d]	39.76 ±0.46[c]	5.07 ±0.14[ab]	3.00 ±0.02[d]	13.84 ±0.04[a]	4.92 ±0.01[c]	0.876 ±0.004[a]
2	23.84 ±0.01[d]	21.42 ±0.24[c]	18.11 ±0.19[a]	48.31 ±0.83[a]	4.41 ±0.06[c]	3.16 ±0.04[c]	6.03 ±0.14[d]	4.85 ±0.01[d]	0.848 ±0.001[b]
3	26.09 ±0.28[c]	23.84 ±0.42[b]	16.78 ±0.67[b]	42.38 ±0.87[b]	4.95 ±0.18[b]	3.53 ±0.10[b]	9.64 ±0.12[b]	4.67 ±0.01[e]	0.851 ±0.008[b]
4	20.22 ±0.01[e]	25.31 ±0.59[a]	10.90 ±0.47[d]	47.75 ±0.40[a]	5.23 ±0.06[a]	3.85 ±0[a]	5.98 ±0.33[d]	5.06 ±0.01[a]	0.793 ±0.003[c]
5	30.46 ±0.08[b]	26.12 ±0.53[a]	13.32 ±0.46[c]	36.77 ±0.58[d]	5.08 ±0.12[ab]	3.84 ±0.01[ba]	9.07 ±0.08[c]	4.99 ±0.01[b]	0.874 ±0.002[a]
6	30.67 ±0.17[ab]	25.77 ±0.47[a]	10.09 ±0.47[d]	37.00 ±0.78[d]	5.10 ±0.03[ab]	3.59 ±0.01[b]	5.75 ±0.03[d]	4.85 ±0.02[d]	0.876 ±0.004[a]

[a] Mean value with standard deviation
[b] Different letters in the same column indicate significant differences ($p < 0.05$)

Color characteristics of investigated samples, expressed in CIE *L*a*b** system, are shown in Table 2. The analysed dry fermented sausages showed significant differences ($p < 0.05$) for color parameters lightness *L** (44.33-53.64), redness *a** (13.08-18.59) and yellowness *b** (7.84-10.23), although the variability among different brands can be considered low, especially for *L** values (C.V. among brands is 6.88%; 12.81% and 11.29%, respectively). The higher *L** values were found in previous work (Popov Raljić et al. 1990). Gimeno et al. (2000) studying Chorizo de Pamplona, a Spanish dry fermented sausage, found similar *L** values (46.87-54.29), but higher *a** (20.44-26.12) and *b** values (10.99-17.70). Dellaglio et al. (1996) investigated Felino, an Italian dry cured sausage and found lower *L** (39.15-42.79) and *b** values (5.68-8.90) and higher *a** values (22.13-30.08). Some authors concluded that moisture content affects the *L** value (Bozkurt and Bayram, 2006). In our study, significant correlation ($p < 0.05$) was found between color parameter *L** and moisture content. However, no significant correlations were found between color parameters and protein or fat content.

Table 2. Instrumental color measurement of dry fermented sausages (Čajna kobasica)[ab]

Brand	L*	a*	b*
1	53.64±3.22[a]	13.08±1.78[d]	9.32±0.80d[bc]
2	46.19±3.68[bc]	18.59±1.76[a]	7.95±1.08[d]
3	46.55±1.86[bc]	17.07±0.98[ab]	8.68±0.57[cd]
4	44.33±2.71[c]	16.66±1.32[b]	10.00±1.20[ab]
5	45.87±1.20[bc]	18.13±0.47[b]	10.23±0.43[a]
6	47.99±2.79[b]	14.76±2.55[c]	7.84±1.06[d]

[a] Mean value with standard deviation
[b] Different letters in the same column indicate significant differences ($p < 0.05$)

Textural properties of dry fermented sausages are shown in Table 3. Some significant differences ($p < 0.05$) can be observed between different commercial brands. The parameter hardness ranged from 8210.98g (brand 1) to 22883.33g (brand 4) and the C.V. among different commercial brands was 44%. Gimeno et al. (2000), in commercial Spanish dry fermented sausages found a C.V. of 13.75%, while Dellagio et al. (1996) in commercial Italian dry cured sausages found a C.V. of 67.4% for hardness. Springiness, cohesiveness and chewiness showed a coefficient of variation lower compared to hardness (C.V. = 10% for springiness, C.V. = 16% for cohesiveness and C.V. = 25% for chewiness). Regarding the obtained results it can be concluded that consistency of dry fermented sausages was quite different among different brands on the market. After fermentation, drying is a major factor affecting texture properties (González-Fernández et al. 2006). It was found from Pearson correlation tests that hardness, springiness and cohesiveness were related ($p < 0.001$) to moisture content with correlation coefficient of -0.74, 0.93 and 0.93, respectively. Negative correlation coefficient between hardness and moisture content indicated that the increase in moisture content affected the hardness decrease. However, Bozkurt and Bayram (2006) reported the correlation coefficient between moisture content and hardness of -0.93, while Gómez and Lorenzo (2013) reported the value of -0.62. Likewise, hardness, springiness and cohesiveness are significantly correlated ($p < 0.001$) with aw (hardness $r = -0.88$, springiness: $r = 0.86$, cohesiveness $r = 0.86$). Textural properties have been related in meat products to pH, fat and salt values (Gimeno et al., 2000). Hardness, springiness, cohesiveness and chewiness showed no significant correlations with pH. The explanation for this could be in the significant difference ($p < 0.05$) in pH values within the brands. The investigated texture parameters springiness

and cohesiveness were affected significantly ($p < 0.001$) by fat levels (springiness: $r = -0.91$, cohesiveness $r = -0.88$). In our study, no significant difference was found in the correlation between hardness and fat content among different commercial brands. On the other hand, some studies of dry fermented sausages showed significant negative correlation between textural parameter hardness and fat level (Gimeno et al., 2000; Liaros et al., 2009; Olivares et al., 2010; Corral et al., 2014). It can be observed from the obtained results the positive correlation between salt content and parameters hardness and chewiness (hardness: $r = 0.65$, $p < 0.01$, chewiness: $r = 0.83$, $p < 0.001$). Decrease in texture parameters hardness and chewiness with NaCl reduction have been previously reported in fermented sausages (Gimeno et al., 1999; Corral et al., 2016). The total protein content had no significant correlation with any of the textural parameters, with the exception of chewiness ($p < 0.001$).

Table 3. Textural properties of dry fermented sausages (Čajna kobasica)[ab]

Brand	Hardness (g)	Springiness	Cohesiveness	Chewiness (g)
1	8210.98±297[d]	0.52±0.01[b]	0.59±0.01[a]	2499.03±97[c]
2	8668.51±892[d]	0.45±0.03[d]	0.47±0.04[b]	1843.66±74[d]
3	15341.39±984[b]	0.48±0.02[c]	0.48±0.05[b]	3492.70±354[ab]
4	22883.33±982[a]	0.42±0.01[e]	0.40±0.03[c]	3857.58±409[a]
5	10921.41±789[c]	0.55±0.03[a]	0.61±0.01[a]	3637.95±328[a]
6	9940.63±1234[dc]	0.53±0.02[ab]	0.59±0.01[a]	3132.98±465[b]

[a] Mean value with standard deviation
[b] Different letters in the same column indicate significant differences ($p < 0.05$)

Table 4. Multivariate correlations between parameters[ab]

	pH	aw	Moisture	Fat	NaCl	Protein	RCCTP
Hardness	0.30	-0.88[b]	-0.74[a]	0.45	0.65[a]	0.32	-0.14
Springiness	-0.08	0.86[b]	0.93[b]	-0.91[b]	-0.06	0.41	-0.31
Cohesiveness	-0.07	0.86[b]	0.93[b]	-0.88[b]	-0.13	0.34	-0.35
Chewiness	0.24	-0.33	-0.09	-0.26	0.83[b]	0.78[b]	-0.37

[a] Significant at $p < 0.01$
[b] Significant at $p < 0.001$

The results of the sensory analysis are shown in Fig. 1. The average sensory score for external appearance and/or condition of the packaging of these dry fermented sausages ranged from 4.00 (sample 1) to 4.94 (sample 4). The sensory score for appearance and composition of cut surface ranged from 3.50 (sample 1) to 4.38 (sample 6). Sample 1 had the lowest score for the parameter color and stability of color (3.31), while sample 6 had the highest score (4.31). The lowest score for sensory property odour and taste was for sample 3 (3.25), while the highest score was for sample 4 (4.00). The sensory property texture and/ or juiciness ranged from 3.88 (sample 6) to 4.50 (sample 4). Sample 4 had the highest TPA hardness and chewiness values and the lowest TPA springiness and cohesiveness values. It was possible to identify a positive correlation between the sensory property texture and/or juiciness and instrumentaly obtained TPA parameters hardness and chewiness (hardness: $r = 0.86$, $p < 0.001$; chewiness: $r = 0.54$, $p < 0.05$). On the other hand, textural parameters springiness and cohesiveness and textural scores obtained by panelists were in a signifi-

cantly negative correlation (springiness: r = -0.56, p < 0.05; cohesiveness: r = -0.58, p < 0.05). The lowest score for overall sensory quality was found in sample 1 (3.53), and the highest in sample 4 (4.18).

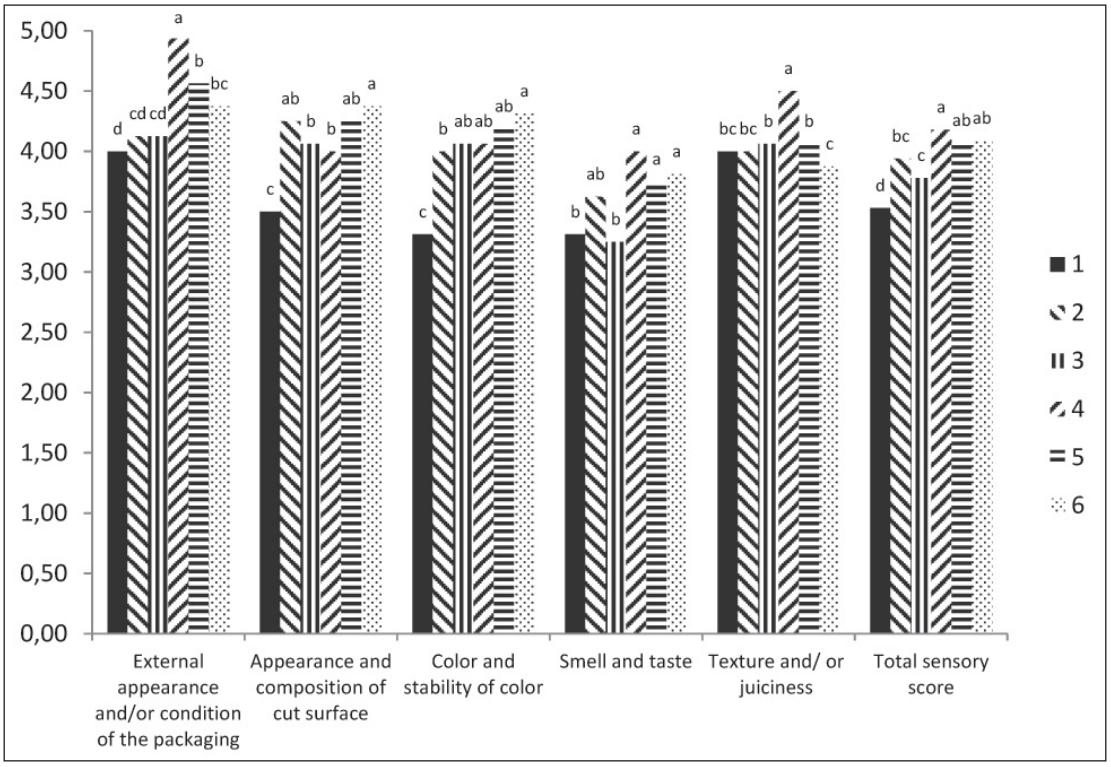

Figure 1. Average sensory scores of the dry fermented sausages (Čajna kobasica). Mean values with different letter differs significantly (p < 0.05)

Conclusion

This study describes the compositional, color, textural and sensorial profile characteristics of dry fermented sausage (Čajna kobasica). We can conclude on the grounds of the results of our study that two samples (sample 2 and sample 3) did not meet the requirements prescribed under the Regulations (94/2015). The reason for the incompatibility of two samples was a higher level of RCCTP. All the examined brands had a content of moisture or total protein, which were in concordance with the requirements in the Regulations (94/2015). The sample 4 had the lowest aw value (0.793) and also the lowest moisture content (20.22%). The highest pH value was recorded in sampe 4 (5.06). The same sample had the lowest lightness value (44.33). Also, sample 4 had the highest hardness and chewiness levels (22883.33g and 3857.58g, recpectively). The highest overall sensory quality was recorded in sample 4 (4.18).

Acknowledgements

This research was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, project No TR31032.

References

Bozkurt, H. & Bayram, M. (2006). Colour and textural attributes of sucuk during ripening. Meat Science 73, 344–350.

CIE (1976). International Commission on Illumination, Colorimetry: Official Recommendation of the International Commission on IlluminationPublication CIE No. (E-1.31). Paris, France: Bureau Central de la CIE.

Corral, S., Salvador, A., Belloch, C. & Flores, M. (2014). Effect of fat and salt reduction on the sensory quality of slow fermented sausages inoculated with Debaryomyces hansenii yeast. Food Control, 45, 1-7.

Corral, S., Salvador, A., & Flores, M. (2016). Effect of the use of entire male fat in the production of reduced salt fermented sausages. Meat Science, In Press, doi:10.1016/j.meatsci.2016.02.005.

Dellaglio, S., Casiraghi, E., & Pompei, C. (1996). Chemical, physical and sensory attributes for the characterization of an Italian dry- cured sausage. Meat Science, 42, 25-35.

Džinić, N., Ivić, M., Šojić, B., Jokanović, M., Tomović, V., Okanović, Đ., & Popov Raljić, J. (2015). Some quality parameters of dry fermented sausages (Čajna kobasica). Procedia Food Science, 5, 77-80.

Gimeno, O., Astiasarán, I., & Bello, J. (1999). Influence of Partial Replacement of NaCl with KCl and CaCl2 on Texture and Color of Dry Fermented Sausages. Food Chemistry, 47, 873-877.

Gimeno, O., Ansorena, D., Astiasarán, I. & Bello, J. (2000). Characterization of chorizo de Pamplona: instrumental measurements of colour and texture. Food Control, 69, 195-200.

Gómez, M. & Lorenzo, M.J. (2013). Effect of fat level on physicochemical, volatile compounds and sensory characteristics of dry-ripened "chorizo" from Celta pig breed. Meat Science, 95, 658-666.

González-Fernández, C., Santos, E. M., Rovira, J. & Jaime, I. (2006). The effect of sugar concentration and starter culture on instrumental and sensory textural properties of chorizo-Spanish dry-cured sausage. Meat Science 74, 467–475.

ISO (1998) Determination of moisture content, 1442:1998. ISO, Geneva, Switzerland.

ISO (1992) Determination of nitrogen content, 937:1992. ISO, Geneva, Switzerland.

ISO (2002) Determination of hydroxyproline content, 3496:2002 . ISO, Geneva, Switzerland.

ISO (1998) Determination of free fat content, 1444:1998. ISO, Geneva, Switzerland.

ISO (1998) Determination of total ash, 936:1998. ISO, Geneva, Switzerland.

ISO (1999) Determination of chloride content-Part 1: Volhard method, 1841-1:1999. ISO, Geneva, Switzerland.

ISO (1999) Determination of nitrite content, 2918:1999. ISO, Geneva, Switzerland.

Liaros, N.G., Katsanidis, E. & Bloukas, J.G. (2009). Effect of the ripening time under vacuum and packaging film permeability on processing and quality characteristics of low-fat fermented sausages. Meat Science, 83, 589-598.

Olivares, A., Navarro, J.L., Salvador, A., & Flores, M. (2010). Sensory acceptability of slow fermented sausages based on fat content and ripening time. Meat Science, 86, 251-257.

Petrović, Lj, Džinić N, Ikonić. P, Tasić. T, & Tomović, V. (2011). Quality and safety standardization of traditional fermented sausages. Tehnologija mesa, 52, 234-244.

Popov-Raljić, J., Vukas, S., Sušić, M., Tojagić, S., Džinić, N. (1990). Senzorna svojstva i instrumentalno merenje sušenih kobasica. Tehnologija proizvodnje i kvaliteta sušenih-fermentovanih kobasica, Novi Sad, 105-122.

Popov Raljić, J., Kelemen Mašić, Đ., Džinić, N., Sušić, M., Tešanović, D. (1996). Senzorna svojstva sušenih fermentovanih kobasica. Tehnologija mesa, XXXVII, 3-4, 150- 152.

Pravilnik o kvalitetu usitnjenog mesa, poluproizvoda od mesa i proizvoda od mesa, Službeni Glasnik RS, br.94/2015.

Rede R., Vukas, S., Džinić, N. (1995). Uticaj starter kultura na svojstva sušenih kobasica. Tehnologija mesa, XXXVI, 4, 270-274.

Vignolo, G., Fontana, C. & and Fadda, S. (2010). Semidry and Dry Fermented Sausages. In: Handbook of Meat Processing, edited by F. Toldra (pp. 379-398). Ames, Iowa: Blackwell Publishing.

Vukašinović, M.V., Kurčubić, V.S., Kaljević, V.M., Mašković, P.Z., & Petrović, M.D. (2012). Examinations of certain chemical characteristics of fermented dry sausage quality parameters. Veterinarski glasnik, 76, 73-84.

Recived: 24.02.2016
Accepted: 20.05.2016.