Investigation of physicochemical and sensory properties of `Vlašićka´ sausage during storage

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SUMMARY

The objective of this paper was to examine the impact of a 60 day storage period on the physicochemical and sensory properties of „Vlašićka" sausage. The sausage samples were stored in refrigerator at temperature of 4°C and relative air humidity up to 75%. Analyses of physicochemical properties were conducted on the first, 15th , 30th , 45th and 60th day, while the analyses of sensory properties were conducted on the first, 30th and 60th day of storage. Analysis of variance shows that storage period of 60 days had a significant effect (p<0,05) on all parameters of sustainability except for the diameter and weight of „Vlašićka" sausage. The most pronounced changes during storage occurred in the decrease of pH level, increase of ullage and reduced water content. Sausages dried out during storage which resulted in the water loss and the concentration of dry substance and subsequently to the significant (p<0,05) increase of fat, ash and connective tissue and NaCl and the significant (p<0,05) decrease of residual nitrites. During the 60 day storage, Vlašićka sausage remained stable in terms of pH (4,65) and Aw (0,868) levels as well as saltiness (3,71). In terms of water content (>40%), total proteins (>16%) and connective tissue proteins (<20%) „Vlašićka" sausage has met the requirements of the Regulation. Downside of the tested sausage is an extremely high content of fat (40%). Sensory quality of „Vlašićka" sausage deteriorated over the 60 day period, but at the end of storage period it was equable and acceptable.

Keywords: *fermented sausage, physicochemical and sensory properties, storage*

INTRODUCTION

During storage the organolepthic, physococheмical and microbiological properties of sausages may deteriorate thus affecting the quality of the final product. Temperature is one of the basic and most important parameters during storage of the final product. In addition to temperature, the realtive humidity (RH), pH and Aw levels are crucially important for the growth and development of microorganisms and sensory characteristics of the product in different stages of production and storage. The Regulation on the quality of meat products does not recommend a minimum shelf life of the product. „Vlašićka" beef fermented sausage produced in Bosnia and Herzegovina has not been studied in terms of technological process or storage. The only study that has established certain quality parameters of the finished product was carried out by Bešić (2013). Results of this study show that „Vlašićka" sausage bought at the store contains an average of 25.25% water, with Aw of 0.838 and pH value of 5.00. Investigated sensory properties (exterior appearance, appearance and color of cross section, smell, taste, saltiness, acidity, aroma, hardness/tenderness and succulence) were hedonistically rated as „acceptable" (70%). The objective of the paper was to examine the effect of storage conditions on the physicochemical and sensory properties of „Vlašićka" sausage.

MATERIALS AND METHODS

After the production process in meat industry, samples of „Vlašićka" sausage were stored in the refridgerator at temeprature up to 4°C and air humidity up to 75%. Temperature and humidity in refridgerator were measured daily and by examining the data on these parameters it was established that temperature in refrigerator varied from +2.0°C to +3.9°C and air humidity from 44% to 69%. The declaration on „Vlašićka" sausage provides the following information: ingredients (beef meat, beef

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fat, nitrites, sugar and natural spices), date of production, shelf life, recommended storage temperature (up to +4°C), net weight (500 grams) and a note reading that it was packaged in a controlled atmosphere. A total of 27 sausages was stored and analyzed. To test the physicochemical and sensory properties each sample was used in three repetitions.

Physicochemical analyses – On the 1st, 15th, 30th, 45th and 60th day of storage the following parameters were measured: pH (by a pH meter; LabSwift – a_w, Novasina, Switzerland), Aw level (by an Aw meter; Eutech Instruments, the Netherlands), the loss of weight (expressed as a ratio between the currently measured weight and the initial weight of the product multiplied by 100), the reduction in diameter, the water content (BAS ISO method 1442,2007) and NaCl (Mohr method). Additional parameters measured in „Vlašićka" sausage on the first and 60th day of storage include: total fat content (BAS ISO 1443), total ash (BAS ISO 936, 2007), NaNO2 (by Grea and Mirna), total protein (BAS ISO 937,2007), hydroxiproline (BAS ISO 3496, 2007), collagen (hydroxiproline content multiplied by factor 8) and total content of connective tissue (from the ratio of collagen content – multiplied by 100 and divided by the content of total meat protein).

Sensory evaluation – Evaluation of the sensory properties was performed by a panel of five assessors. The sensory properties (appearance, appearance of cross section, color of cross section, texture, smell and taste) of„Vlašićka" sausage were evaluated using quantitative descriptive analysis with a five point partially structured scale (1 = very poor, 2 = satisfactory, 3 = acceptable, 4 = good and 5 = excellent) during the first, 30th and 60th day of storage. Total quality was calculated using the following formula:

Total quality (%) = 2 x appearance + 4 x cross-sectional appearance + 3 x cross-sectional color + 4 x texture + 2 x smell + 5 x taste.

Statistical data processing – The data obtained for parameters during storage and sensory properties were analyzed by ANOVAs. Where the effect of storage conditions on these properties was significant, differences between the mean values were determined using the Tukey test. The significance of differences in physicochemical properties on the first and 60th day was analyzed using the T-test. The significance level of $p<0.05$ was used in all comparisons and will be used in this discussion as well. To make the correlation analysis of the existence of interdependence among variable we used the Pearson correlation coefficient. The correlation is significant for the error of first type 0.05 (two-way), if p-value which accompanies the correlation coefficient is less than 0.05. The strength of correlations between certain parameters was determined using the Šošić classification (2004). Used for statistical data processing was the SPSS 16,0 package (SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

The results of ANOV and Tukey test for the physicochemical properties of „Vlašićka" sausage are presented in Table 1, and for the sensory properties in figure 1. Table 2. presents the results of T-test for certain chemical properties on the first and 60th day of storage of „Vlašićka" sausage. Variance analysis has indicated the existence of statistically significant differences ($p<0.05$) during the storage period in pH, Aw, ullage, water content, NaCl, appearance, appearance of cross-section, color of cross-section and smell, but not ($p>0,05$) in weight, diameter, texture and taste of „Vlašićka" sausage. T-test has shown that some significant changes ($p<0.05$) occurred in all chemical parameters (contents of fat, ash, hydroxiproline, nitrites), except in the total protein content.

pH value of„Vlašićka" sausage significantly ($p<0,05$) reduced from the first (4.81) to the 30th (4.65) day of storage. Between the 30th and 60th day the pH level averaged 4.65 and did not change. This low pH level at the end of storage period classifies this sausage as strongly acidic. The result of the pH level for the first day of storage for „Vlašićka" sausage is similar to the results of Operta (2011) for Bosnian sujuka with the addition of starter cultures (4.84 and 4.83), of Kozačinska et al. (2008.) for traditional fermented sausages (4.90, 4.85 and 4.82), of Siriken et al. (2009) for Turkish sujuka (4.84-6.50), of Papadima et al. (1999.) for Greek traditional sausages (4.7-6.7) as well as to the results of Smailhodžić (2014) for the first day of storage of„Sarajevska" sausage (4.85). Significantly higher levels of pH were obtained by Bešić (2013) for „Vlašićka" sausage (5.00). However, if we compare the pH values obtained at the end of the storage period of„Vlašićka" sausage (4.65) with similar studies it can be noted that they significantly differ. Thus, for example, Smailhodžić (2014) obtained 4.92 for „Kreševka" and 4.97 for „Sarajevska" after 60 days of storage. Kamenik (2012) obtained a pH value of 5.11 after 120 days of storage and Daga (2008) of 5.44 after 40 days of storage which is considerably higher than the pH value of„Vlašićka" sausage.

a_w level of „Vlašićka" sausage significantly decreased during storage (from 0.880 to 0.868). Between

Table 1. Changes of physico-chemical properties in sausage „Vlašićka" during storage

Properties	1. day	15. day	30. day	45. day	60. day	(p<0,05)
pH	4,81±0,015 a	4,71±0,005 b	4,65±0,026 c	4,64±0,005 c	4,65±0,005 c	0,000
a_w	0,880±0,0w01 a	0,870±0,002 ab	0,867±0,001 b	0,867±0,008 b	0,868±0,003 b	0,017
Mass (g)	516,00±6,000	508,00±6,000	506,66±6,027	505,00±5,000	504,00±6,000	0,169
Diameter (mm)	47,76±0,305	47,50±0,173	47,33±0,152	47,25±0,408	47,16±0,465	0,247
Weight loos (%)	-	1,54±0,152 c	1,93±0,015 b	2,14±0,156 a	2,32±0,030 a	0,000
Moisture(%)	28,87±0,239 a	27,40±0,195 b	26,56±0,329 bc	25,99±0,075 cd	25,56±0,585 d	0,000
NaCl (%)	3,29±0,260 b	3,50±0,01 ab	3,58±0,017 ab	3,65±0,055 a	3,71±0,020 a	0,016

Means within same rows with different letters (a-d) are significantly different (p<0,05).

the first and 30th day of storage the a_w value significantly decreased (p<0,05), and thereafter remained the same with no significant changes. Significantly lower values of water activity in „Kreševka" (0.799) and „Sarajevska" (0.813) after 60 days of storage were obtained by Smailhodžić (2014). In her study of Bosnian sujuka from ripening chamber Operta (2011) reported an Aw value of 0.892 which is approximately the Aw value of „Vlašićka" sausage (0.880) on the first day of storage. Daga (2008) states that on the 40th day of storage Aw value was 0.890 which is significantly higher compared to „Vlašićka" sausage (0.868) on the 60th day of storage. Bešić (2013) states that the Aw value of „Vlašićka" sausage was 0.838, which is significantly lower than the Aw value of the tested sausage. With respect to the stability criterion by Leistner and Roedel (1975) as well as Dibirasulaev et al. (2005), „Vlašićka" sausage had pH<5.2 and Aw<0.91at the beginning and at the end of storage, which means that it remained stable and durable in long storage.

Table 2. Results T-test of chemical properties sausage „Vlašićka" during storage

Properties	1. day	60. day	Statistically signficant differences (p<0,05)	
	$\bar{x} \pm SD$	$x \pm SD$		
Fat (%)	38,84 ± 0,311	40,92 ± 0,858	0,017	*
Proteins (%)	26,60 ± 0,264	27,00 ± 0,300	0,158	NS
Ash (%)	4,39 ± 0,010	4,50 ± 0,017	0,001	*
Hydroxyproline (%)	0,62 ± 0,005	0,67 ± 0,010	0,002	*
Kollagen (%)	4,98 ± 0,046	5,36 ± 0,080	0,002	*
Kollagen/Total proteins x100 (%)	18,75 ± 0,036	19,85 ± 0,263	0,002	*
Nitrite (mg/kg)	8,63 ± 0,251	5,06 ± 0,051	0,000	*

Means within same rows (*) are significantly different (p<0,05); NS- Not significant

During storage Vlašićka sausage lost an average of 12g, and changes in weight between the first (516g) and 60th day (504g) were not statistically significant (p>0.005). Variance analysis determined a statistically significant (p<0.05) increase in ullage until the 45th day (from 1.54% to 2.14%), but from the 45th to 60th day (2.32%) there were no significant changes (p>0.05).

The diameter of the sausage did not significantly change (p>0.05) between the first (47.76 mm) and 60th day (47.16 mm). In her studies Smailhodžić (2014) states that during a two month storage „Sarajevska" sausage lost 25.13 g (10.74%) and „Kreševka" 30.67 g (10.48%) in weight (ullage), which is significantly more compared to „Vlašićku" sausage. The weight loss is primarily accounted for by evaporation of water. The reason for evaporation of water lies in low relative air humidity in the refrigerator during storage which ranged from 44% to 69%.

The water content during storage of Vlašićka sausage significantly decreased, from 28.78% (first day) to 25.56% (60th day). Significant changes in the decrease of water content occurred until day 45, but not thereafter. The loss of water during storage can be associated with evaporation, i.e. relative air humidity in refrigerator lower than 75%. The average relative humidity in refrigerator was 57.55%, and average temperature 3°C.

In her research, Smailhodžić (2014) states a similar decrease of water content from 21.05% to 17.76% in „Sarajevska" and from 21.00% to 17.45% in „Kreševka" during the 60 day storage. Siriken et al. (2009.), in the

case of Turkish sujuka, state a variation in water content from 29.80% to 47.60% which is a significantly higher water content compared to „Vlašićka" sausage. Operta et al. (2007) state in their research that the water content in Bosnian sudžuk in industrial conditions and at the end of production averaged 24.08%, which is significantly less compared to „Vlašićka" sausage (28.78%) on the first day of storage. According to the research of Operta et al. (2008) the water content in Bosnian sudžuk made in household conditions of the second and third category of meat after the 20th day was significantly higher and amounted to 36.18%. Kayaardi and Gök (2003) state for Turkish sujuka that after 21 days of ripening it also had a higher content of water (about 36%). Kozačinski et al. (2008) report the average water content at the end of production by batches: 31.73%, 32.59% and 35.75% which is significantly higher water content compared to that of „Vlašićka" sausage (28.78%) at the beginning of storage. In his study Bešić (2013) reported an average water content in „Vlašićka" sausage of 25.25%, which is less than the water content in the studied sausage.

The results of T-test have indicated that during storage of „Vlašićka" sausage its content of fat significantly ($p<0,05$) increased - from 38.84% to 40.92%. The high fat content reflects the high fat content in the recipe. Similar results were obtained by Samilhodžić (2014) – the fat content in „Sarajevska" sausage increased from 41.84% to 43.07%, and in „Kreševka" from 44.39% to 45.62%. Čaušević et al. (1985) reported that the fat content in the finished sujuka was 27.35% which is significantly lower than the fat content in „Vlašićka" sausage on the first day of storage. The obtained values of fat content in „Vlašićka" sausage are higher compared to the results reported by Gajić (2000), according to which the sudžuk contained 36.64% fat. In studies of Operta et al. (2007) the average fat content in sudžuk of industrial type amounted to 41.96%, which is similar to the fat content in Vlašićka sausage at the end of storage. Operta and Smajić (2012b) state that the average fat content for all variants of sudžuk was 25.28%, which is significantly different from the values obtained for „Vlašićka" sausage on the first day of storage.

Ash content significantly ($p<0.05$) increased during storage of „Vlašićka" sausage, from 4.37% to 4.50%. Smailhodžić (2014) reported in her study that there were no significant changes in ash content during the storage of sausages. Ash content on the 60th day of storage in „Sarajevska" (4.82%) and „Kreševka" (4.97%) sausages was higher compared to the ash content in „Vlašićka" sausage (4.39%). In his study Gajić (2000) reported an ash content of 2.38% which is significantly lower than the ash content in „Vlašićka" sausage. Tupajić (1991) states that the average ash content in sudžuk from industrial sector amounted to 4.92%, which is similar to the results of this study. Comi et al. (2005) state in their study on natural fermented Italian sausages that the ash content in three different fermentations was 4.23%, 4.30% and 4.03%, which is close to the values obtained for „Vlašićka" sausage (4.39%) on the first day of storage.

Applying the T-test it was proven that the protein content remained almost the same (first day=26.60; 60th day= 27.00%) throughout the storage period. The protein content determined in similar studies conducted by Smailhodžić (2014) was somewhat higher in „Sarajevska" (32.42%) and „Kreševka" (29.90%) sausages at the end of a 60 day storage period. Operta et al. (2012) reported an average protein content in sudžuk type A of 32.33% and in sudžuk type B of 32.61%. These values are higher than the values of protein content obtained on the first day of storage of „Vlašićka" sausage (26.60%). In the studies cited by Gajić (2000) the protein content averaged 23.91% with variations from 22.57% to 25.11% and it was lower compared to „Vlašićka" sausage. Operta and Smajić (2012b) report in their studies that the average content of proteins for all variants of Bosnian sudžuk amounted to 26.57%, with variations from 24.92% to 28.32%, which is close to the obtained values of proteins in „Vlašićka" sausage (26.60%) on the first day of storage. In the case of Greek traditional sausage, Papadima et al. (1999) reported that they contain an average of 19.19%, and in the study of natural fermented Italian sausages Comi et al. (2005) reported that they contain 19.13%, 21.67% and 20.50% proteins, which is significantly less relative to the obtained values for „Vlašićka" sausage on the first day of storage.

By mere increase of hydroxiproline from 0.62% to 0.67%, the content of collagen, i.e. connective tissue in total proteins significantly ($p<0,05$) increased as well. Collagen content increased from 4.98% to 5.36%, and connective tissue in relation to total proteins from 18.75% to 19.85%. The content of connective tissue in „Sarajevska" (13.12%) and „Kreševka" (12.42%) was significantly lower compared to the content of connective tissue in „Vlašićka" sausage. This shows that raw material used to produce „Vlašićka" sausage was of poor quality, i.e. meat contained more collagen than in the case of „Sarajevska" and „Kreševka" as reported by Smailhodžić in her study (2014). Siriken et al. (2009) state that Turkish sujuka contained 0.40%-1.21% hydroxiproline (0.89% on average) and 3.20% - 9.68% collagen

(7.17% on average), and the values of these parameters for the studied sausage range within these limits. Santamaria et al. (1992) and Beltran et al. (1993) state that some fermented sausages contain 040% - 050% hydroxiproline which is less compared to the values obtained for „Vlašićka" sausage (0.62%) on the first day of storage. Operta and Smajić (2012b) state that the average content of hydroxiproline in Bosnian sudžuk was 0.28% with variations from 0.20% to 0.43%, while the average content of collagen in Bosnian sudžuk from traditional smokehouse amounted to 2.24% with variations from 1.64% to 3.48%, which is significantly lower compared to the studied sausage.

Increase of certain substances such as fat, ash and salt is a result of the evaporation of water, i.e. the reduction of water content (table 1) and the concentration of dry matter. It should be noted that „Vlašićka" sausage met the requirements of the Regulation (82/13) as it contained less than 40% water, more than 16% proteins and less than 20% proteins from connective tissue in the finished product. The biggest drawback of „Vlašićka" sausage is that it has a very high content of fat (about 40%).

The research results have shown a significant increase in the content of NaCl in „Vlašićka" sausage during storage, especially in the period between the 1st (3.29%) and 45th day (3.65%). From the 45th to the 60th day, the content of salt amounted to 3.71% and did not change significantly ($p>0.05$). Regardless of the increase it can be stated that „Vlašićka" sausage had acceptable saltiness. When we compare the obtained values of NaCl content in „Vlašićka" sausage with the values obtained by Tupajić (1991) for the content of salt (NaCl) in sudžuk from the industrial (4.27%) and private sector (5.16%), it can be concluded that the salt content in „Vlašićka" sausage is significantly smaller. The obtained values of the content of NaCl in „Vlašićka" sausage (3.71%) are lower than those in „Sarajevska" (4.02%) and "Kreševka" (4.11%) sausages on the 60th day of storage which were presented by Smailhodžić in her research (2014). Additionally, the obtained values of the average content of NaCl in studied sausages were significantly lower compared to those obtained by Operta et al. (2012) in their studies of sudžuk type A (4.74%) and type B (4.41%). Siriken et al. (2009) reported that Turkish sujuka contained 3.70% - 5.85% NaCl, which is more compared to the values of „Vlašićka" sausage (3.29%) on the first day of storage. As for Greek traditional sausages, Papadima et al. (1999) state that they contain 2.36% to 4.13% NaCl, which is similar to the results of „Vlašićka" sausage.

During the storage of „Vlašićka" sausage there was a significant ($p<0.05$) reduction in the content of residual nitrites. At the beginning of storage, the content of residual nitrites in „Vlašićka" sausage amounted to 8.63 mg/kg and on the 60th day of storage 5.06 mg/kg. The reduction of residual nitrites is a normal process that is explained by the fact that residual nitrites reduce during storage due to nitrite binding in myoglobin. The reason for the lower content of residual nitrites during storage of „Vlašićka" sausage could be linked to the information provided by the authors Pegg and Shahidi (2000) according to which nitric oxide reacts faster with myoglobin in the creation of the color of meat products if the pH value is lower. In this case there will be less residual nitrites. „Vlašićka" sausage had a low pH value which facilitated better binding of nitrites and myoglobin and leaving a small quantity of residual nitrites. Additionally, the optimum temperature for the binding of nitrites and myoglobin is between 2 and 4°C, thus the conditions in refrigerator for storing „Vlašićka" sausage were exactly such. Gajić (2000) reports a significantly lower content of residual nitrites (4.47 mg/kg) for sudžuk compared to the content of residual nitrites found in the studied sausage on the first day of storage. Smailhodžić (2014) states that at the beginning of storage the content of residual nitrites in Sarajevska sausage amounted to 7.79 mg/kg and was lower compared to the content of residual nitrites in „Kreševka" (9.80 mg/kg), which is similar to the content of nitrites on the first day of storage of „Vlašićka" sausage. According to Smailhodžić (2014), on the 60th day of storage the content of residual nitrites, just like in „Vlašićka" sausage, reduced to 4.21 mg/kg in Sarajevska sausage and to 3.16 mg/kg in „Kreševka". Comi et al. (2005) in their study of natural fermented Italian sausages state that the content of nitrites in three different fermentations was 8.83 ppm, 8.83 ppm and 8.67 ppm, which is approximately the content of nitrites in „Vlašićka" sausage (8.63 mg/kg) on the first day of storage. In their study, Operta and Smajić (2012a) reported

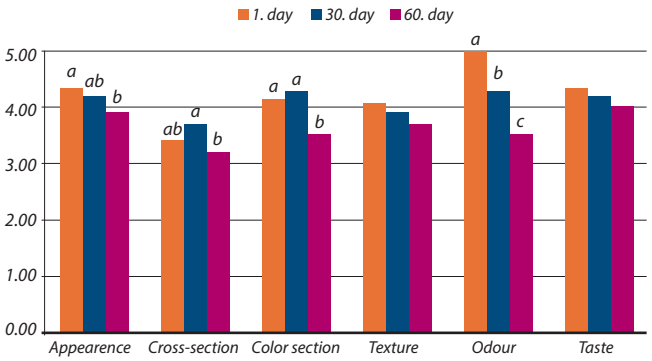

Figure 1. Changes of sensory porperties in sausage „Vlašićka" during storage

Means with different letters (a-c) are significantly different ($p<0,05$)

that the average content of residual nitrites in Bosnian sudžuk was 7.58 mg/kg (ppm), or slightly lower than in the studied sausage on the first day of storage.

During the storage of „Vlašićka" sausage the sensory quality deteriorated. ANOVA has shown that there is a significant effect ($p<0.05$) of storage period on the appearance, cross-sectional appearance, cross-sectional color and the smell of „Vlašićka" sausage. There were no statistically significant differences ($p>0.05$) in texture and taste.

The appearance of „Vlašićka" sausage on the first day of storage was rated with an average of 4.33 points, and on the 60th day with a significantly ($p<0.05$) lower rate – 3.90 points on average. In total, over the 60 day period of storage the appearance of „Vlašićka" sausage deteriorated from „good" to „acceptable".

Cross sectional appearance on the first day was rated with 3.40, on the 30th day with 3.70, and on the 60th day with 3.20 points. Significant ($p<0.05$) changes were identified between the 30th and 60th day of storage. From the beginning to the 60th day the cross sectional appearance kept the rate „acceptable", and at the same time it was the least acceptable property during storage.

Cross sectional color on the first and 30th day was rated with „good" (4.13; 4.30 points), but it significantly ($p<0.05$) deteriorated to the 60th day when it was rated as „acceptable" (3.50 points).

Although the texture of „Vlašićka" sausage changed during the storage from „good" (1st day=4.06) to „acceptable" (30th day= 3.90; 60th day= 3.70), these changes were not statistically significant ($p>0.05$).

The most acceptable property at the beginning of storage was the smell, but it sustained most pronounced changes during storage. On the first day of storage the smell was rated with „excellent" (maximum 5.00 points). A significantly lower ($p<0.05$) average rating relative to the first day (4.30 points) and the score „good" was given to the smell on the 30th day. During the next 30 days the smell significantly ($p<0.05$) worsened again scoring just „acceptable" (3.50 points).

In „Vlašićka" sausage there were no changes in taste during storage and palatability was rated as „good" (4.33; 4.20; 4.00 points). At the end of storage period the taste was the most acceptable property.

Analysis of variance has shown that there were statistically significant changes ($p<0.05$) in total quality. Total quality of „Vlašićka" sausage on the first day was 82.60%, on the 30th day 81.30% and on the 60th day it was significantly lower ($p<0.05$) amounting to 72.90%. In a study by Operta (2005) the trade manufacturers' sudžuk was best rated for sensory quality, i.e. it was categorized as the first class (81.00%) and rated as "desirable". Sudžuk made by individual producers was "desirable" in terms of general impression; however, a fair test categorized it as the second class with an average of 69.40%. According to the same study, industrial producers' sudžuk had the poorest quality scoring an average of 49.40% which placed it in the category of „no class", i.e. it was considered „undesirable". On the basis of Operta's study (2005) the examined „Vlašićka" sausage can be placed in the first class, as the sensory quality of this sausage got significantly higher scores. Results of the acceptability of sensory properties of „Vlašićka" sausage are similar to the results obtained by Operta in her study (2011) of Bosnian sudžuk produced in traditional smokehouse with acceptability of 82.66%, and somewhat higher acceptability of 83.44% scored by sudžuk produced in ripening chamber. In her study Smailhodžić (2014) reports significantly lower values for the total quality of „Sarajevska" (64.13%) and „Kreševka" (60.46%) sausages compared to the examined „Vlašićka" sausage. In a study of „Vlašićka" sausage, Bešić (2013) states that all evaluated sensory properties were „acceptable", which is consistent with the evaluation of the sensory properties of „Vlašićka" sausage in this study.

Identified in Vlašićka sausages were some significant correlations whose intensity ranged from strong to extremely strong. pH value of „Vlašićka" sausage was in an extremely strong relation with the water content ($r=0.92$). Slightly stronger relations were found between the values of pH and Aw ($r=0.93$). The higher the pH values, the higher the scores for smell ($r=0.82$) and taste ($r=0.69$) were. pH value significantly decreased with the increase of NaCl content ($r=-0.74$). The higher the Aw value the significantly better the score for smell ($r=0.77$). However, with the reduction of water activity in „Vlašićka" sausage the content of water significantly reduced ($r=0.87$) while the content of NaCl increased ($r=-0.67$). The water content was in an extremely strong correlation with the smell ($r=0.94$); in very strong correlation with the content of NaCl ($r=-0.75$), taste ($r=0.79$) and total quality ($r=0.76$); and in strong correlation with the appearance ($r=0.69$). The higher the content of NaCl in „Vlašićka" sausage the poorer the score for smell ($r=-0.78$). In her studies Smailhodžić (2014) determined similar correlations between the content of NaCl and all sensory properties. The higher the content of NaCl in „Sarajevska" sausage the lower the scores for texture, though the cross sectional appearance was more desirable. In the case of „Kreševka" sausage, with

the increase of the content of NaCl the appearance was rated significantly poorer. Bešić (2013) states in his studies that Aw value had no significant effect on the acceptability of the sensory properties of fermented beef sausages, while sausages with a lower pH value and less moisture content had more acceptable all sensory properties which is inconsistent with the results for „Vlašićka" sausage.

CONCLUSIONS

Based on the results of research of the effects of a 60 day storage period on the quality of "Vlašićka" sausage, the following conclusions can be made: the storage period of 60 days significantly influenced the change of most of the physicochemical and sensory properties of "Vlašićka" sausage. Changes in Aw and pH value occurred up to the 30th day, while those in water content, NaCl and weight occurred to the 45th day of storage. Significant changes in the content of basic substances are an effect of the evaporation of water and the concentration of dry substance which is caused by the low relative air humidity during storage in the refrigerator. During 60 days of storage, "Vlašićka" sausage remained stable in terms of pH and Aw value. Drawbacks of "Vlašićka" sausage include a particularly high content of fat (>40%) and connective tissue (≈20%). Changes in the appearance and the cross sectional color and appearance occurred after 30 days of storage which is not the case with the texture and taste. Continuous changes during storage occurred in smell. In spite of the fact that the sensory quality of "Vlašićka" sausage deteriorated during storage of 60 days, its sensory properties remained acceptable.

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