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Nutritive and sensory quality of commercial dry - fermented sausages - "ČAJNA" type with different salt content

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Abstract

The aim of this study was to evaluate the quality of dry-fermented pork sausages – "čajna" type from the market, with similar composition and different salt content. Physicochemical parameters of selected samples were determined and sensory quality parameters were evaluated. In samples M and D, with significantly higher ($P \leq 0.05$) sodium chloride content, higher values of color parameter a* and breaking force and lower values of pH and water activity were found compared to samples T and L. Sample D had the highest protein (25.51%) and sodium chloride content (5.04%), and the lowest fat content (30.04%). Samples M and D had significantly higher sensory quality, especially odor, aroma, taste, consistency and cross-section, compared to other samples. These samples were evaluated as sausages with a pronounced pleasant aroma, taste and odor characteristic for dry-fermented products, with pleasant salinity, appropriate for the product. Although the dry-fermented sausage samples with a lower salt content had more acceptable nutritive values, their sensory quality was lower than expected.

Keywords: dry-fermented sausage; sodium chloride; nutritive value; sensory analysis

1. INTRODUCTION

Salt is a part of everyday human nutrition as a naturally present ingredient in food, as well as an addition during production in industrial conditions and during the preparation of household meals. Sodium chloride is traditionally used for meat preservation, and it is a basic ingredient in the industrial preparation of meat products. The average salt content in products depends on the recipes of the manufacturer, tradition, or habits of consumers in different parts of the world. Dry-fermented sausages, as a particularly valued category of meat products, are obtained from minced meat of good quality, solid fat tissue and additives. The salty taste of fermented sausages is a consequence of Na^{+} cations and Cl^{-} anions, which change the ionic strength of the medium and lead to the release of aromatic volatile molecules. Products with a low salt content can be evaluated as products of poorer quality, or tasteless products, considering that sodium ions act as modifiers or enhancers of aromas. Sodium ions selectively reduce the bitter taste by increasing the intensity of sweetness (Petit et al. 2019). Salt also affects other important quality parameters of dry-fermented sausages, such as texture, color, pH value, water activity, microbiological stability and sustainability of these products (Bae, Cho, Hong, & Jeong 2018; Doyle & Glass 2010; Lilić, Borović, & Vranić 2014). In the recommended daily amounts, sodium and chlorine are necessary for the normal functioning of the body; they maintain the potential of the cell membranes, blood pressure and distribution of osmotic pressure in body fluids and regulates the volume of extracellular fluid (Campo, Rosato, & Giagnacovo 2020). However, excessive sodium intake, mostly derived from edible salt (NaCl) added to food, leads to hypertension or high blood pressure and the development of cardiovascular diseases Kameník, Saláková, Vyskočilová, Pechová, and Haruštiaková (2017); Lilić, Borović, and Vranić (2013). Nowadays, there is a lot of significant evidence that indicates that food consumption is closely related to health, and all nutrition trends lead to a reduction of fat, sugar and salt content in food (Lilić et al. 2014).

According to the World Health Organization, sodium intake should be a maximum 2 g per day and 5 g of NaCl per day, respectively WHO (2012). Sodium chloride is an important parameter of the quality of dry-fermented sausages; however, excessive consumption of salt negatively affects the health of consumers. To meet consumer demands, the food industry is trying to reduce the salt content of dry-fermented sausages, which is a great challenge (Ganić & Begić 2018). The aim of this study was to evaluate the quality of dry-fermented pork sausages – "čajna" type from the market, with similar composition and different salt content. To achieve this goal, physicochemical parameters of selected samples were determined and sensory quality parameters were evaluated.

2. MATERIALS AND METHODS

2.1. Samples

Samples of dry fermented sausages – "čajna" type, commercial products industrially produced from pork meat and fatty tissue and with different salt content, were procured (purchased) from the market in the area of the city of Banja Luka. The samples were marked with codes: M, T, D and L. The samples were stored at +4°C in industrial packaging until the sensory analysis and physical parameters determination. For the basic chemical composition determination, the samples were chopped, homogenized and stored at -23°C in closed glass jars until the analysis.

2.2. Determination of chemical composition and physical characteristics

Chemical composition and physical characteristics of the samples were determined in the laboratory for instrumental methods of analysis and laboratory for food analysis (Faculty of Technology, University of Banja Luka). The moisture content of each sample was measured by drying the weighed samples in an oven at 105 ± 2°C until a constant weight was obtained, according to the referent method (ISO-1442 1997). The NaCl content in the samples was determined by the Volhard method (ISO-1841-1 1996). Fat content was determined by the Soxhlet method (?). Nitrogen content was determined by the Kjeldahl method and protein content was estimated by multiplying the nitrogen content by a factor of 6.25 (ISO-937 1992). Ash content was calculated from the weight of the sample after burning in a muffle furnace at 550±25°C until a constant weight was obtained, according to the referent method (ISO-936 1998). The obtained results are expressed as the mean of three measurements ± standard deviation (SD). The pH was determined using a pH meter HANNA HI 99161, which was calibrated using standard buffers (pH = 4.00±0.05 and pH = 7.00±0.01 at 20±2°C) before the measurements. Water activity (aw) was determined using a hygrometer (LabMaster - aw Novasina Switzerland) at a constant temperature of 25°C. The obtained results are expressed as the mean of three measurements ± standard deviation (SD). Color measurements (CIE-Lab tristimulus values, lightness: L^*, redness: a^* and yellowness: b^*) were carried out using a Spectrophotometer CM 2600d (Konica Minolta Sensing INC Osaka Japan) with 8 mm port size, illuminant D65 and a 10° standard observer, after standardization of the instrument with respect to the white calibration plate. The obtained results are expressed as the mean of 12 measurements ± standard deviation (SD). The texture of the samples was determined by the instrumental method of analysis using a texture meter device - Texture Meter TA.XT plus Texture Analyzer Stable Micro Systems Godalming. This device measures the breaking force (kg) required for cutting the sample. The obtained results are expressed as the mean of 9 measurements ± standard deviation (SD).

2.3. Sensory analysis

Sensory analysis of the samples was performed in the Laboratory for sensory analysis of foods, designed according to the (ISO-8589 2007). The panel for descriptive analysis consisted of 13 selected and trained assessors, and they worked individually in the booths. Water and white bread were served to the assessors for cleaning the mouth between sample evaluations. Quality descriptive sensory analysis (scoring method) was used for the evaluation of samples. The assessors analyzed and evaluated the selected sensory parameters (indicators of sensory quality) using points (scores) from 5 (appropriate, expected quality) to 1 (inappropriate, unacceptable quality) with the possibility of using semi-points (Grujić 2015). Each selected sensory parameter had the appropriate coefficient of significance (CS). External appearance and/or condition of the packaging (CS=2); cross section appearance (CS=5); cross section color (CS=3); odor, aroma and taste (CS=7); and consistency (CS=3) of samples were evaluated. The sum of all the coefficients of significance is 20. After the sensory analysis of the sample, an appropriate coefficient of significance is multiplied by the score of the selected sensory parameter to obtain a corrected score. The sum of all corrected scores (points) is expressed as a percentage of the maximum possible product quality (% MPPQ), or 100% for the best quality (Grujić 2015).

2.4. Statistic analysis

All results were subjected to one-factor analysis of variance (ANOVA) and when Duncan's test was performed to

Table 1. Results of basic chemical composition of commercial dry-fermented sausage samples.

Parameters	Sample codes and mean parameter values ± SD* (n=3)			
	M	T	D	L
Moisture content (%)	32.61 ± 0.07[b]	30.35 ± 0.09[c]	34.29 ± 0.07[a]	33.60 ± 0.10[a]
Total fat content (%)	35.35 ± 0.11[b]	37.55 ± 0.09[a]	30.04 ± 0.07[c]	36.97 ± 0.04[ab]
Protein content (%)	24.12 ± 0.12[b]	23.88 ± 0.16[b]	25.51 ± 0.08[a]	24.30 ± 0.11[b]
NaCl content (%)	4.93 ± 0.02[a]	4.11 ± 0.04[b]	5.04 ± 0.07[a]	4.06 ± 0.12[b]
Total ash content (%)	5.34 ± 0.07[b]	4.08 ± 0.08[d]	5.96 ± 0.07[a]	4.51 ± 0.05[c]

Mean values with different letters in the same row are significantly different according to Duncan test ($P \leq 0.05$).

estimate the signifi cance of diff erences between mean values at P < 0.05, using Statistica 12.0 software (StatSoft, Inc., Tulsa, OK, USA).

3. RESULTS AND DISCUSSION

Moisture content in all the samples of dry-fermented sausages (Table 1) was in line with the requirements defined by the Regulation of fragmented/minced meat, semi-finished products and meat products (Official Gazette of BH No. 82/13 2013), according to which the moisture content can be up to 40%.

Higher fat content affects the reduced water content in meat products. Sample T had a significantly lower ($P \leq 0.05$) moisture content than other samples, and also this sample had a higher fat content compared to other samples (Table 1). The protein content in all sausage samples was above 20%, which is in accordance with the requirements of Regulation 11. Higher fat content may indicate a lower ratio of meat in dry-fermented sausages, and thus lower protein content. Sample D with the highest ($P \leq 0.05$) protein content also had the lowest ($P \leq 0.05$) fat content, while sample T with the lowest protein content had the highest fat content among the examined sausages (Table 1). Samples M and D had a significantly higher ($P \leq 0.05$) total ash content and sodium chloride content compared to samples T and L. It can be assumed that the sodium chloride content affects the total ash content formed during sample burning. The obtained mean values for the measured color parameters (L^*, a^*, b^*) of the fermented sausage samples are presented graphically (Figure 1). Samples T, D, L had a higher, but not statistically significant ($P \geq 0.05$) share of yellow color (b^*), and significantly higher ($P \leq 0.05$) values for lightness (L^*) compared to sample M. Meat products with a lower salt content are evaluated as products with a paler color, lighter than expected, compared to products with a higher salt content (Petit et al. 2019). The stable red color of dried meat products can be maintained by using only salt (NaCl), because the product retains a low redox potential during ripening, which is why myoglobin does not oxidize. NaCl affects the stability of the red color by preventing the oxidation of myoglobin, which can lead to darkening of the product (Bae et al. 2018). Corral, Salvador, and Flores (2013) found that salt reduction in dry-fermented pork sausages did not lead to significant differences in L^*, a^* and b^* values. Variations in meat texture derive from the composition in muscle, fat and connective tissues and other ingredients from the recipe. Samples with a lower salt content T and L had a lower ($P \geq 0.05$) value for breaking force compared to samples M and D (Figure 2). These results are in line with the claims of other authors that products with lower salt concentration have improved softer structure (Doyle & Glass 2010). Analyzing the texture of dry-fermented pork sausages, Laranjo et al. (2015) observed higher values for hardness and chewiness of the samples with higher salt content (5%), compared to the samples with lower salt content (3%). Similar results were obtained by other authors (Corral et al. 2013). Higher salt content leads to higher levels of extraction of soluble protein, which contributes to better binding of meat.

The obtained mean pH values of the samples are presented in Figure 3. Lowering the pH value is the basic physicochemical change and one of the most important changes during the ripening of fermented sausages. The sustainability, color stability, consistency and aroma of sausages depend on the pH value (Bae et al. 2018). Samples T and L, with a higher salt content, had approximately the same pH values, significantly higher than the pH values of samples M and D. Laranjo et al. (2015) found that the pH value increases with increasing salt content in fermented pork sausages. A higher salt content leads to a higher level of extraction of soluble proteins in the extracellular medium, to a higher buffering effect and thus to higher pH values.

The obtained results of water activity (Figure 4) are in line with the literature data (Laranjo et al. 2015) and they are low enough to provide microbiological and biochemical stability conditions. Salt reduces the free water content, and thus the products with higher NaCl content have lower aw values (Laranjo et al. 2015). Accord-

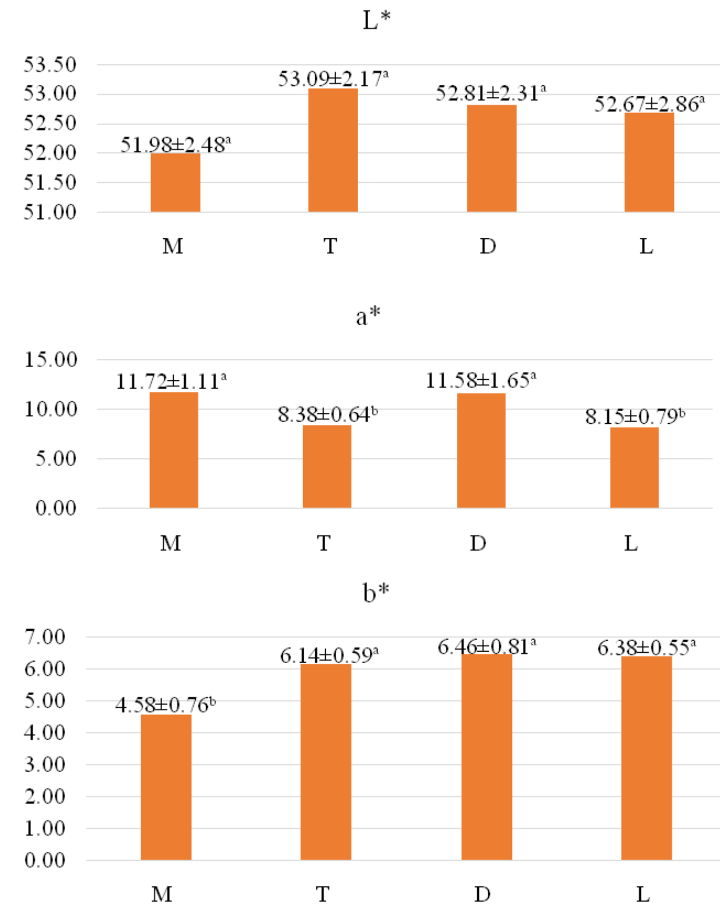

Figure 1. Color parameters L*, a*, b* of commercial dry-fermented sausage samples. Mean values presented by columns with same letters are not significantly different according to Duncan test ($P \geq 0.05$).

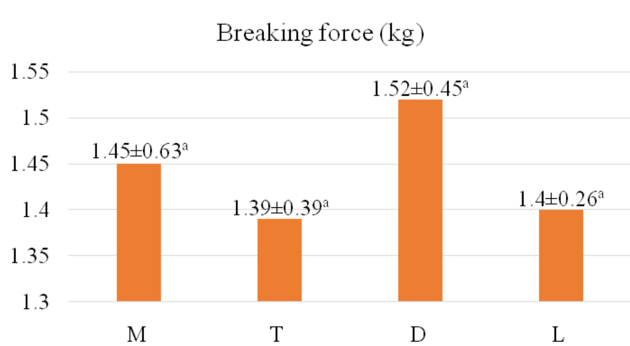

Figure 2. Breaking force of commercial dry-fermented sausage samples. Mean values presented by columns with same letters are not significantly different according to Duncan test ($P \geq 0.05$).

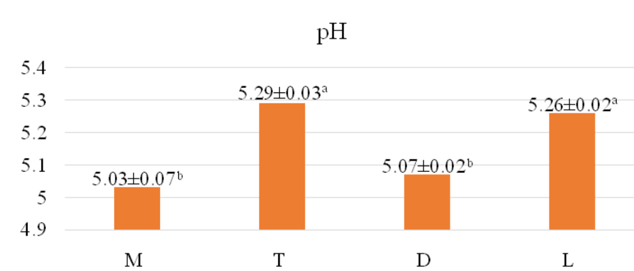

Figure 3. pH value of commercial dry-fermented sausage samples. Mean values presented by columns with same letters are not significantly different according to Duncan test ($P \geq 0.05$).

ing to Lilić et al. (2011), the water activity of dried pork is usually below 0.90, which makes these products very stable during storage even at room temperatures (Vignolo, Fontana, & Fadda n.d.). rained evaluators can assess small differences in the sensory quality of products and their evaluation is extremely important and useful, especially when it comes to products with different ratio of basic ingredients, such as different salt content in meat products (Hoppu et al. 2017). The results of the sensory analysis of commercial dry-fermented pork sausages are shown in Table 2. All samples had certain disadvantages in terms of the state of packaging. Quality of this sensory parameter was the highest ($P \leq 0.05$) for sample L among

Table 2. Results of sensory analysis of commercial dry-fermented sausage samples.

Selected quality parameters	Sample codes and mean values ± SD* (n=13)			
	M	T	D	L
External appearance and/or condition of the packaging	3.00 ± 0.00^{c}	3.50 ± 0.00^{b}	2.50 ± 0.00^{d}	4.00 ± 0.00^{a}
Cross section appearance	4.58 ± 0.49^{a}	4.00 ± 0.61^{b}	4.69 ± 0.48^{a}	4.00 ± 0.68^{b}
Cross section color	4.92 ± 0.27^{a}	3.92 ± 0.28^{b}	4.08 ± 0.93^{b}	3.81 ± 0.48^{b}
Odor, aroma and taste	4.77 ± 0.48^{a}	3.38 ± 0.79^{b}	4.54 ± 0.54^{a}	3.41 ± 0.95^{b}
Consistency	5.00 ± 0.00^{a}	$4.04 \pm 0.72a^{b}$	4.92 ± 0.28^{a}	4.12 ± 0.51^{b}
% MPPQ**	92.05	74.54	87.23	75.66

Mean values with different letters in the same row are significantly different according to Duncan test ($P \le 0.05$ *standard deviation; **ercentage of the maximum possible product quality.

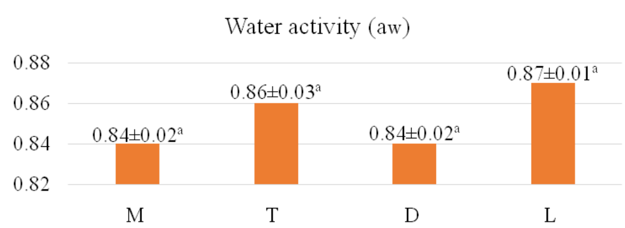

Figure 4. Water activity (a_w) of commercial dry-fermented sausage samples. Mean values presented by columns with same letters are not significantly different according to Duncan test ($P \ge 0.05$).

the tested samples. No deformations were observed on the sample, and the product had only minimal defects in the form of small folds on individual parts of the wrapper (artificial casing).

Samples M and D had a significantly better ($P \le 0.05$) cross section appearance compared to samples T and L. The meat and fat tissue particles were not completely evenly chopped, but the fat tissue pieces did not smear and fall off during cutting. Barely noticeable connective tissue particles were observed in the cross section. No damage was visible inside samples M and D. The cross section color of sample M was evaluated as the most acceptable compared to the color of the other samples. The sample had a uniform red color of muscle tissue and whitish color of fat tissue particles, which is in accordance with the results of color measurement. Sample M had a higher proportion of red color compared to other samples, with the lowest value for yellow color (Figure 1). The assessors noticed that the pieces of meat in sample L had an uneven color. The decrease in the intensity of the red color can be caused by the denaturation of myoglobin and hemoglobin during the heat treatment of meat (Bae et al. 2018). The instrumental determination of color showed that sample L had the lowest value of red color (Figure 1). Samples M and D had a significantly higher ($P \le 0.05$) quality of odor, aroma and taste compared to samples T and L. Samples M and D, with a higher salt content (Table 1), had a pronounced pleasant aroma and odor characteristics for dry-fermented meat products, and were without foreign odors. The salinity, which was evaluated as pleasant in the sample M, was responsible for the harmony of taste, aroma and smell. Sample D with the highest salt content (Table 1) was evaluated as a sample with slightly more pronounced salty taste than expected. Samples M and D were evaluated with higher points for consistency compared to samples T and L, which had lower values for breaking force (Figure 2). The consistency of the samples M and D was stable and firmly elastic and compact during cutting. These samples were neither too hard nor too soft during chewing. The firm elastic consistency is in accordance with the results of determining the texture of the samples by the instrumental method of analysis. Samples L and T, with lower salt content, were evaluated with lower points for appearance and color of cross section, odor, aroma, taste and consistency, compared to samples M and D. Salt (NaCl) has an impact on the sensory perception of taste, but also on other sensory parameters, which affects the overall sensory quality of the product (Ganić & Begić 2018).

4. CONCLUSIONS

Based on the results of chemical analysis, it can be concluded that commercial dry-fermented pork sausage samples T and L with lower salt content have more acceptable nutritive value compared to samples M and D. Sample D has the highest protein content and the lowest fat content. However, this sample also has the highest sodium chloride content, which is not in line with the expected nutritive quality. By analyzing and comparing the overall sensory quality of the samples, it can be concluded that samples M and D (with higher salt content and total ash content, and lower fat content) had higher sensory quality, especially odor, aroma, taste, consistency and cross-section. These samples were evaluated as samples with a pronounced pleasant aroma, taste, and odor characteristics for dry-fermented products, without foreign odors. The salinity of these samples was rated as pleasant and appropriate for the product. It can also be concluded that the sausage samples with a lower salt content had a less pronounced odor, aroma and salty taste than expected. The results of this study can be used as guidelines for the food industry in order to achieve a nutritionally higher quality product with a lower salt content, and with expected, optimal sensory quality. Since the lower NaCl content affects the sensory quality of the tested meat products, manufacturers should consider using a substitute for sodium chloride. This would reduce the sodium content in the products and ensure the quality that consumers expect.

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