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EVALUATION OF SENSORY CHARACTERISTICS AND HEALTH SAFETY OF CHICKEN MEAT PRODUCTS

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Abstract: *Chicken meat has been used for decades as a basic raw material and as a substitute for part of beef and pork in the production of boiled sausages. However, the production of smoked and dried chicken meat products is not present in most countries in the world. In recent years, the industry's interest in making these products has been growing. During the development of new chicken meat products, it is very useful to use existing or traditional procedures for the production of beef and pork products. The transfer of knowledge and experience gained during traditional procedures to production in industrial conditions provides numerous opportunities for safe production products with standardized characteristics. The aim of this work is to examine the sensory properties of dried and boiled chicken meat products during the production of which eight different treatments were used. Sensory evaluation was performed in the sensory evaluation laboratory by 6 trained evaluators (professors and faculty assistants). During the assessment, a descriptive analysis test with a scale of five values was used. The non-parametric Kruskal-Wallis test/two-tailed test was used during the statistical processing of the sensory analysis results. Statistical significance of differences between pairs was tested using Dunn's procedure. Testing was performed in Excel using the statistical program XLSTAT (XLSTAT Version 2014, 5.03). Among the boiled products, the evaluators gave the highest rating to product samples from group EG I (95.3%). Of the dried products, samples from group EG VIII obtained the highest percentage of maximum possible quality (88.8%). The obtained results showed that chicken meat products made in industrial conditions according to traditional technologies have a high sensory quality, which indicates that they will be well accepted by consumers.*

Key words: *chicken meat, traditional products, industrial production, sensory evaluation*

Introduction

Chicken meat occupies an important place in people's diet. It is characterized by finesse, high nutritional value and human body favorable ingredients, low price and simple preparation. The meat quality of young chickens (broilers) depends on a large number of factors, including genotype, age/body weight, pre- and post-slaughter procedures [1].

Zhu et al. [2] determined the existence of a positive influence of consumption of chicken meat on human health. These authors [2] state that in cases of increased consumption of chicken meat in Europe, there was a reduction in the risk of developing esophageal cancer by about 53%.

In recent decades, there has been a noticeable trend of increasing the production and consumption of chicken meat in the world and in Bosnia and Herzegovina. Thus, the amount of poultry and the meat produced have doubled in the last ten years. In the period 2004 - 2013, the number of poultry increased by 140% in the Republic of Srpska and by 207% in the FBiH [3]. The consumption of poultry meat in the whole world continues to grow [4]. Juiciness, taste, color and tenderness are sensory properties that distinguish poultry meat from other types of meat. The sensory properties of chicken meat are mostly influenced by the species, breed, sex and age of the animal, followed by diet, nutrition of the animal, starvation and transport before slaughter and conditions during meat processing [4].

A number of studies have been conducted on the impact of the chicken meatprocessing, that is, the production of products that are more available on the market and are consumed more and more often. Chicken meat, especially mechanically deboned meat, has long been used as a substitute for part of other types of meat or as a basic raw material in the production of sausages [5, 6]. Khan et al. [7] studied the quality of chicken meat products on the market. Their study is based on different types of products and differences in the chemical properties of individual meat components [7]. Akhtar and Omre [8] investigated the influence of different heat treatment temperatures (45°C, 55°C, 65°C, 75°C and 85°C) on the hardness of two groups of chicken meat (raw and heat-treated). Drying chicken meat is a very important operation for obtaining good quality products, as well as one of the cheaper methods of processing and preserving chicken meat. Meat drying offers a number of advantages, which are not only related to the method of preservation, but act in the direction of additional reduction of packaging and transport costs [8]. Silva et al.[9] analyzed the influence of different heat treatment methods on lipid oxidation, smell and aroma of salted and dried pieces of chicken meat.

Regardless of the previously mentioned advantages, the production and processing of chicken meat is an area which has a significant impact on the environment, which is why it is necessary to take certain measures in order to reduce this impact [10, 11].

Material and methods

During this research, cold and hot smoked (dried and boiled) chicken meat products made in industrial conditions were used. Eight different treatments were applied in production. The chickens, from which the meat was obtained, were raised on the family farm in conditions of intensive breeding. Intensive breeding took place in two phases with appropriate fodder mixtures (starter and finisher). The main ingredient in the fodder mixtures was cereals, predominantly corn. In addition to corn, toasted soybeans, sunflower seeds, and dehydrated alfalfa are added to chicken mixes. Chickens were slaughtered and bled in the local meat industry, where 12 chickens were bled over a period of 4 weeks. After bleeding, the carcasses were cooled for 24 hours at a temperature of 1°C, and after being separated from the carcasses, the thigh meat was cut into pieces of equal size. After salting, the pieces of meat were (a) thermally processed at the temperature of boiling and smoking or (b) smoked and dried (Table 1). From 12 carcasses of chickens during bleeding of each of the 4

groups, 24 pieces of meat were formed, which were divided into 4 experimental groups. Of those 24 pieces of meat, twelve (12) were heat-treated by boiling (thermo-smoke chamber for drying, smoking, roasting and cooking manufactured by Atmnos Maurer Germany), and twelve (12) were smoked at low temperature and dried in a fermentation chamber (Universal thermo-smoke chamber produced by Doleschal, Austria). Meat samples from pieces of finished products were used for sensory analysis.

Table 1. The parameters of technological treatments during warm smoking (boiling) and cold smoking (drying) of chicken meat

Treatment		Temperature (°C)	Heat treatment total time	Air circulation (m^3/min)	Humidity (%)
Warm smoking (Boiling)	EG I	70 (65 - 75)	1 hour and 30 minutes	7.1	74 - 76
	EG II	65 (65 - 75)	1 hour and 40 minutes	9.7	78 - 82
	EG III	60 (60 - 75)	1 hour and 30 minutes	9.7	78 - 82
	EG IV	55 (55 - 75)	1 hour and 47 minutes	12.7	82 - 86
Cold smoking (Drying)	EG V	17.5 (17 - 18)	5 hours and 30 minutes	40	85 - 86
	EG VI	14.5 (14 - 15)	9 hours and 15 minutes	40	85 - 86
	EG VII	14.5 (14 - 15)	6 hours and 45 minutes	40	85 - 86
	EG VIII	14.5 (14 - 15)	7 hours and 45 minutes	40	85 - 86

Sensory analysis

A group of 6 trained evaluators performed the sensory analysis of samples of boiled and dried chicken meat products. The assessment was carried out in the premises of the Biotechnical faculty, Laboratory designed for sensory analysis. The samples were prepared, coded and presented to all raters at the same time and under the same conditions. A point system of analytical descriptive tests with a scale of 1 to 5 was used for evaluation, where each rating represents a certain level of quality: 1 – the worst, 5 – the best property [12]. During the sensory analysis, the external appearance, appearance and composition of the cross-section, color and sustainability of color, smell and taste, texture and juiciness were evaluated. After evaluating the individual properties, a corrected rating of the total sensory quality of the product was calculated, by multiplying the rating for each property with the corresponding coefficient of importance and calculating the percentage of the maximum possible quality (% MQ) (Table 2).

Table 2. Description of grades used during sensory analysis of sheep meat products

Sensory caracteristic	Mark	Coefficient of importance	Maximal grade
External appearance	SI	2	10
Appearance and composition of the cross-section	SP	3	15
Texture and juiciness	TS	3	15
Smell and taste	MU	7	35
Color and sustainability of color	BO	5	25
%MQ			100

%MQ – The percentage of maximal quality

Descriptive analysis was applied to describe and evaluate the distribution parameters of the research results. During the statistical processing of the sensory analysis results, the non-parametric Kruskal-Wallis test/Two-tailed test was used. Statistical significance of differences between pairs was tested using Dunn's procedure with Bonferroni correction, so all effects were reported at a significance level of 0.0083. Testing was performed in Excel using the statistical program XLSTAT (XLSTAT Version 2014, 5.03).

Results and discussion

The results presented in this paper are part of wider research [13], one part of which was published in journals [14] or presented at scientific conferences [15, 16]. Research was conducted on the effects of different processing methods (heat treatment and smoking; i.e. cold smoking and drying) of chicken meat, whereby the influence of various factors (method of obtaining smoke, temperature, time, relative humidity, speed of smoke circulation, etc.) was monitored on properties and safety of finished chicken meat products.

Tables 3-6 show descriptive indicators of the sensory evaluation of chicken meat in four experimental groups obtained by the hot smoking (boiling) process and four groups of chicken meat products obtained by the cold smoking (drying) process. Both processes were carried out in industrial conditions, with the application of different technological parameters (temperature, time, relative humidity) (Table 1).

The data presented in Table 3 correspond to the sensory evaluation of chicken meat products obtained by hot smoking (boiling). By applying a non-parametric test (Kruskal-Wallis test/two-tailed test), it was determined that at the significance level of 5% ($p<0.05$) there are no differences in most of the sensory properties of the 4 experimental groups of chicken meat products (SI: $K(3) = 4.0889$; $p=0.2520 > 0.05$; SP: $K(3) = 6.3889$; $p=0.0941 > 0.05$; TS: $K(3) = 6.0621$; $p=0.1096 > 0.05$; MU: $K(3) = 5.1541$; $p=0.1609 > 0.05$). The heat treatment parameters influenced only to the color of the finished products (BO: $K(3) = 8.7678$; $p=0.0325 < 0.05$). Multiple comparisons of pairs using Dunn's procedure/two-tailed test determined the significance of the difference between pairs of treatments. The results are shown in Table 3, where means with different exponents (a-b) differ significantly. Kruskal-Wallis K statistic (K3,30)

= 2.0099) for "overall acceptability" (UP) showed that between meat samples from different groups (p=0.5703 > 0.05).

The results are shown in Table 3, where the means with different exponents (a-b) differ significantly. Kruskal-Wallis K statistic (K3,30) = 2.0099) for "overall acceptability" (OA) showed that there is no statistically significant difference between meat samples from different groups (p=0.5703 > 0.05).

Table 3. Sensory assessment of samples of chicken meat products obtained during the hot smoking process (boiling)

	EG I	**EG II**	**EG III**	**EG IV**	K (Observed value)	p-value (Two-tailed)
SI	9.7±0.8^{b}	9.0±1.1$^{a.b}$	8.0±1.8^{a}	9.0±1.1$^{a.b}$	4.0889	0.2520
SP	14.5±1.2^{b}	12.5±1.2^{a}	13.0±1.5$^{a.b}$	14.0±1.6$^{a.b}$	6.3889	0.0941
TS	13.5±1.6$^{a.b}$	12.0±1.9$^{a.b}$	11.5±2.3^{a}	14.0±1.5^{b}	6.0621	0.1096
MU	32.7±3.6^{a}	28.0±4.4^{a}	28.0±4.4^{a}	28.0±4.4^{a}	5.1541	0.1609
BO	25.0±0.00^{b}	20.8±2.0^{a}	21.7±2.6^{a}	20.0±4.5^{a}	8.7678	0.0325
OA	19.1±8.8^{a}	16.5±7.5^{a}	16.4±7.9^{a}	17.0±7.2^{a}	2.0099	0.5703
%MQ	95.3	82.3	82.2	85.0		

All results are expressed as mean ± standard deviation.
OA – overall acceptability
%MQ – percentage of the maximum possible quality (sum of corrected grades expressed in relation to the maximum possible quality - 100%)
K (Critical value) = 7.8147
alfa = 0.05
Means with different superscript letters (a-b) are significantly different

By comparing pairs using Dunn's procedure (Table 4). it can be seen that the highest sum of ranks and the highest average value of ranks have products from EK I (2019.0000 and 67.3000. respectably). This confirms the results obtained by calculating the percentages of the maximum possible sensory quality of products from group EG IV (92.8%). which is higher than the rating of products from EK I (95.3%). EK IV (85.0%). EK II (82.3%) and EK III (82.2%) (Table 3).

Table 4. Multiple pairwise comparisons using Dunn's procedure/two-tailed test for the parameter "Overall acceptability (OA)" of hot smoked (boiled) chicken meat products

Sample	Frequency	Sum of ranks	Mean of ranks	Groups
EG III	30	1688.5000	56.2833	A
EG II	30	1702.5000	56.7500	A
EG IV	30	1850.0000	61.6667	A
EG I	30	2019.0000	67.3000	A

The data shown in Table 5 correspond to the sensory evaluation of chicken meat products obtained by the cold smoking (drying) process. Using a non-parametric test (Kruskal-Wallis test/two-tailed test). it was determined that at the significance level

of 5% (p<0.05) there are differences in all sensory properties of 4 groups of chicken meat products that were processed using different smoking regimes and drying (SI: K(3) = 9.5464; p=0.0228 < 0.05; SP: K(3) = 8.5611; p=0.0357 < 0.05; TS: K(3) = 10.0984; p=0.0177 < 0.05; MU: K(3) = 13.8454; p=0.0031 < 0.05; BO: K(3) = 12.8793; p= 0.0049 < 0.05). Multiple comparison of pairs using Dunn's procedure/two-tailed test was used to check the significance of the difference between pairs of treatments. The results are presented in Table 5. where the means with different exponents (a-b) differ significantly. Kruskal-Wallis K statistic (K3.30) = 6.1247) for "overall acceptability" (OA) showed that there is a statistically significant difference between meat samples from different groups (p=0.0106<0.05). Based on this. it can be concluded that there is a statistically significant difference between the evaluation of overall acceptability (OA) of finished products from different experimental groups.

Table 5. Sensory evaluation of chicken meat product samples obtained by the cold smoking (drying) process

	EG V	EG VI	EG VII	EG VIII	K (Observed value)	p-value (Two-tailed)
SI	6.7±1.0^{a}	8.0±1.3$^{a.b}$	7.3±1.0^{a}	9.0±1.1^{b}	9.5464	0.0228
SP	10.0±1.5^{a}	11.0±1.5^{a}	13.5±1.6$^{a.b}$	11.5±2.3^{a}	8.5611	0.0357
TS	9.5±1.2^{b}	11.0±2.4^{b}	10.5±1.6^{b}	13.50±1.6^{a}	10.0984	0.0177
MU	19.8±2.9^{b}	23.3±5.7^{b}	21.0±4.4^{b}	31.5±3.8^{a}	13.8454	0.0031
BO	15.3±2.0^{c}	20.0±3.2$^{a.b}$	18.3±2.6$^{b.c}$	23.3±2.6^{a}	12.8793	0.0049
OA	12.4±5.2^{b}	14.7±6.7$^{a.b}$	14.1±5.6$^{a.b}$	17.8±8.8^{a}	6.1247	0.0106
% MQ	61.8	73.3	70.7	88.8		

All results are expressed as mean ± standard deviation.
OA – overall acceptability
%MQ – percentage of the maximum possible quality (sum of corrected grades expressed in relation to the maximum possible quality - 100%)
K (Critical value) = 7.8147
alfa = 0.05
Means with different superscript letters (a-b) are significantly different

Based on the comparison of pairs using Dunn's procedure (Table 6). it can be seen that the highest sum of ranks and the highest average value of ranks have products from group EG VIII (2163.5000 and 72.1167. respectably). This confirms the results obtained by calculating the percentage of the maximum possible sensory quality of products from group EG VIII (90.0%) (Table 5). According to the sensory assessment. the products were ranked as follows (from the most acceptable to the least acceptable): EG VIII (88.8). EG VI (73.3). EG VII (70.7) and EG V (61.8).

Table 6. Multiple pairwise comparisons using Dunn's procedure /Two-tailed test for the parameter "Overall acceptability (OA)" of cold smoked (dried) chicken meat products

Sample	Frequency	Sum of ranks	Mean of ranks	Groups
EG V	30	1504.5000	50.1500	A
EG VII	30	1784.5000	59.4833	A, B
EG VI	30	1807.5000	60.2500	A, B
EG VIII	30	2163.5000	72.1167	B

Conclusion

Based on the sensory analysis of hot and cold smoked (boiled and dried) chicken meat products. it can be concluded that both types of products were given a high rating by the evaluators. which can be seen from the data for the overall ratings of the products sensory quality (hot smoked - boiled products: 95.3% to 82.2%. i.e. cold smoked - dried products: 88.8% to 61.8%).

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OCJENJIVANJE SENZORNIH KARAKTERISTIKA I ZDRAVSTVENE BEZBJEDNOSTI PROIZVODA OD MESA KOKOŠAKA

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Sažetak: *Meso kokošaka je više decenija koristi kao osnovna sirovina i zamjena dijela mesa goveda i svinja u izradi barenih kobsica. Međutim, izrada dimljenih i sušenih proizvoda od mesa kokošaka u komadu nije prisutna u većini država u svijetu. Poslednjih godina raste interes industrije za izradu ovih proizvoda. Tokom razvoja novih proizvoda od mesa kokošaka, veoma je korisno koristiti postojeće ili tradicionalne postupke koji se koriste za izradu proizvoda od mesa goveda i svinja. Prenos znanja i iskustva stečenih tokom tradicionalnih postupaka u proizvodnju u industijskim uslovima daje brojne mogućnosti za izradu bezbjednih proizvoda standardizovanih karakteristika. Cilj ovog rada je da se ispitaju senzorna svojstva sušenih i barenih proizvoda od mesa kokošaka tokom čije proizvodnje je korišteno osam različitih tretmana. Senzorno ocjenjivanje je provedeno u laboratoriji za senzorno ocjenjivanje od strane 6 obučenih ocjenjivača (profesora i asistenata fakulteta). Tokom ocjenjivanja korišten je test deskriptivne analize sa skalom od pet vrijednosti. Tokom statističke obrade rezultata senzorne analize korišten je neparametarski Kruskal-Wallis test/two-tailed test. Statistička značajnost razlika između parova ispitana je pomoću Dunn's procedure. Testiranje je provedeno u Excelu pomoću statističkog programa XLSTAT (XLSTAT Version 2014, 5.03). Među barenim proizvodima najveću*

ocjenu ocjenjivači su dali uzorcima proizvoda iz grupe EG I (95,3%). Od sušenih proizvoda, uzorci iz grupe EG VIII dobili su najveću vrijednost procenat od maksimalno mogućeg kvaliteta (88,8%). Rezultati do kojih se došlo tokom provedenih istraživanja, pokazali su da proizvodi od mesa kokošaka izrađeni u industrijskim uslovima prema tradicionalnim tehnologijama imaju visok senzorni kvalitet, što ukazuje da će biti dobro prihvaćeni od strane potrošača.

***Ključne riječi**: meso kokošaka, tradicionalni proizvodi, industrijska proizvodanja, senzorna ocjena*