Daily salt intake through traditional meat products in Croatia

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Original scientific paper

ABSTRACT

The aim of this study was to determine the proportion of table salt (NaCl) in traditional meat products from the group of dry sausages, dry and semi-dry meat products and bacons, originating from family farms from three Croatian production areas: Istria and Dalmatia, Central Croatia and Eastern Croatia. Mass fraction of salt was determined in 124 samples of traditional meat products and established values by type of product and by production area were correlated with average daily consumption of meat products in Croatia and the recommended daily salt intake. The analysis results showed the highest salt content in dry cured meat products (6.16 ± 0.68%), then in bacons (5.30 ± 0.71%) and lowest in dry sausages (4.20 ± 0.60%). A statistically significant difference in the proportion of salt has not been established ($p > 0.05$) between the homemade sausages and Kulen. In the group of dry and semi-dry cured meat products, there was a statistically significantly higher ($p < 0.05$) salt proportion in the dry ham and prosciutto in comparison to dry rack, dry shoulder, pork serloin and smoked rack In the category of bacons, bettwen a bacon, „špek" and pancetta statistically significant differences ($p > 0.05$) were not determined. Proportions of salt in the same types of meat products in dependence of the Croatia production area, were not significantly different, as a result of the similarities in recipes and production technologies. The research results confirm that traditional meat products are an important source of salt and therefore, in order to protect public health, it should be moderately represented in the human diet.

Keywords: *mass fraction of salt, traditional meat products, sausages, cured meat products, bacons, daily intake, eating habits*

INTRODUCTION

Table salt (NaCl, salt) is necessarily required ingredient in the human diet, because it allows the normal functioning of the body, primarily through control of blood pressure, the transmission of nerve and muscle stimulation and absorption of nutrients in the gastrointestinal tract. At the same time, in view of the harmful effects of excessive intake of salt for human health and the disruption of the body functioning, the World Health Organization (WHO) recommends as lower daily salt intake through food, in an amount no greater than 5.0 g (WHO, 2012). In Croatia, adults on average per day enter 11.6 g of salt, which is 6.6 g more of the recommended daily intake. At the same time, a significant amount of salt that humans enter in organism (77%) is derived from food that is semi-finished and finished for consumption and food from the restaurants. The remaining salt content refers to food additives during the preparation of meals, for instance during cooking and eating, while the lowest share, but at the same time sufficient for the functioning of the human organism, is naturally occurred in food. Among food products, bakery products are the main source of excessive salt intake because of the significant input of this kind of products, as well as the amount of salt they contain, followed by meat products, cheeses and other dairy products (CFA, 2014).

It is known that due to intake of excessive amounts of salt, there is an increase in blood pressure, which consequently causes hypertension, blood vessel damage, heart muscle and kidney damages, and results in the increased sympathetic activity of the autonomic nervous system. High blood pressure causes a higher risk

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for heart, brain and kidney disease. Meals with a higher salt content causes irritation of the stomach lining and leads to inflammation, and if already present ulcers in the stomach lining, the greater is possibility of infection with the bacterium *Helicobacter pylori*, which is a risk factor for the initiation of malignant alteration in the stomach. Correlation between excessive salt intake and gastric cancer and throat was confirmed. Excessive salt intake is associated with bronchial asthma and refractoriness to treatment (Antonios and McGregor, 1995). It is also verified that the excessive consumption of salt drugs have limited efficacy. When the kidneys secrete excessive sodium levels, that leads to a loss of calcium, resulting in a risk of kidney stones and osteoporosis (Asaria et al., 2007; Brown et al., 2009; He et al., 2010).

Salting and curing present chemical methods of preserving meat used in the production of various meat products, such as sausages, bacon, smoked meat and other meat products (Heinz and Hautzinger, 2007). Preservation exclusively with salt is called salting and with salts consisting of a mixture of table salt (mandatory components of the salamura), nitrate, nitrite, carbohydrates, polyphosphates, ascorbate and other regulations authorized ingredients - brining. Besides the preservative effects, salting and brining play a role to improve the organoleptic properties of meat products (flavor, color, texture, etc.). Salting of meat increases the extracellular concentration of salt whereas the proportion and activity of water intracellularly decreases, thereby inhibiting the development of pathogenic bacteria and bacteria of spoilage. It is known that such spoilage bacteria do not grow at water activity (aw) values of less than 0.91, and mould do not grow below water activity of 0.80 (Heinz and Hautzinger, 2007; Garcia-Gonzalez et al., 2008). *Staphylococcus aureus, Listeria monocytogenes, Salmonella sp.* and *E. coli* O157:H7 can survive in conditions of a^w = 0.96 - 0.97, which is equivalent to the mass fraction of salt in the final product of w (NaCl) = 2 - 2.6%.

Diffusion of salt into the meat during salting raises the osmotic pressure in the envelope (sarcolemma) of the muscle fibers (cells), and pass through the osmosis, or since the water has less particles of salt, for the purpose of equalizing the concentration and pressure of the solution on both sides of the sarcolemma - water from hypotonic solution passing through the muscle cells to the plasma (the internal semipermeable membrane of the cells) and the outer semipermeable membrane basal cells in the extracellular hypertonic aqueous salt solution wherein plasmolysis cells (dehydration) leads to its heat aging, concentration in the cytoplasm (sarcoplasma) dissolved salts, acids, etc. and the reduction of water activity and inhibition of microbial growth. For a taste of salt, or the smell and taste of salted meat products, chlorine ions are responsible. Also, chlorine acts as an oxidizing agent, inhibits lipolytic enzymes, i.e. lipolysis of adipose tissue and during long-term maturation of traditional meat products contributes to the preservation of quality (Kovačević, 2014).

Croatia has a long tradition in production of meat products on family farms, especially dry fermented whose production is characterized by salting with table salt (sea or rock), drying (with or without smoking), and long-term maturation. The production technology of traditional Croatian meat products on family farms, unlike most European countries in which the production of traditional meat products (both in industry and households) include curing salts with nitrates and nitrites, applies only salting process with table salt. Preservative effect of salt enhances the synergistic effect by combining the several methods of preservation at sublethal level, such as smoking, drying, fermentation (ripening) and addition of spices, in order to achieve the optimal effect of the conservation, and at the same time satisfactory product quality.

The aim of this study was to determine and to compare the proportion of salt in products from the group of dry sausages, dry and semi-dry cured meat products and bacons, produced on family farms in three production areas: Istria and Dalmatia, Central Croatia and Eastern Croatia. By comparison of the determined values of salt proportion with the recommended daily salt intake and eating habits of the population, salt intake through traditional meat products in the Croatian population was estimated.

MATERIALS AND METHODS

Samples for analyses

Samples of traditional meat products (n = 124) were collected during 2013 -2014 on family farms from three production areas of Croatia: Istria and Dalmatia (Istrian and Split-Dalmatian Region), Central Croatia (Koprivnica-Križevci, Varaždin and Međimurje Region) and Eastern Croatia (Osijek-Baranja, Brod-Posavina, Vukovar-Srijem and Požega-Slavonia Region). Of the total number, 51 samples were sampled from the category of dry sausages, 45 samples of dry cured meat products and 28 samples of bacon.

Samples were homogenized with Grindomix GM 200, at different speeds and the duration of homogenization, depending on the type of the product. During the homogenization temperature of samples did not exceed 25 °C. Homogenates were stored at a temperature of + 4 °C and analyzed within 48 h.

Determination of salt

Determination of the mass fraction of salt (w, %) was performed by use of validated analytical Mohr method with principe of sedimentation titration. In a mortar,

with clean sand (no chlorine), with the addition of 2-3 mL of water, 2.00 ± 0.01 g of the meat product was chipped. The entire content was transferred into a volumetric flask of 100 mL with the elution of the mortar content. The content was well shaken by hand, and the flasks placed in a water bath at 100 °C for 15 minutes. The content of the flask was cooled, supplemented with water up to the mark and filtered. A volume of 25 mL of the filtrate is pipetted into Erlenmeyer's flask. If the acidic filtrate was reacted (test with indicator paper) neutralization is carried out with 1 M NaOH. A few drops of the indicator K_2CrO_4 was added and titrated with 0.1 N solution of $AgNO_3$ to the appearance of stable reddish color. Each sample was analyzed in duplicate and as final value of the salt content mean of two parallel determinations was taken. Based on the amount of meat product sample taken in the analytical procedure and the volume of $AgNO_3$ solution used for titration, weight of the salt was calculated in the analyzed sample. All used chemicals and sand were of analytical grade (Kemika, Zagreb).

Statistical data analysis

Statistical analysis was performed using the software SPSS 20.0 (SPSS Inc., USA). The results are presented as the mean ± standard deviation. The level of statistical significance was 5% ($p < 0.05$). Comparison of salt mass fractions by categories and types of products, and by production areas, was carried out using non-parametric Mann-Whitney test.

RESULTS AND DISCUSSION

Table salt is an essential ingredient of meat products, as helping to boost the capability of binding water and fat, the formation of color, taste and texture, and ensuring microbiological safety of the finished product (Kovačević et al., 2011). Salinity depends on the amount of added salt and on the duration of drying and ripening phase (Wirth, 1986), and has a significant impact on the hardness, elasticity and resistance to chewing of the meat product (Kovačević et al., 2010). Although salt is necessary for normal functioning of the organism, increased salt intake is harmful to the body, and because of bad eating habits daily are taken and double of the amount of salt than recommended (CFA, 2014). Excessive use and the ignorance of consumers about the harmful effects of excessive salt intake causes numerous adverse effects in the human body. Therefore, the consumption of foods rich in salt, and certainly traditional meat products, which represent one of the major source of salt, should be moderate.

In this paper, the mass fraction of salt in different categories and groups of meat products, including sausages, dry and semi-dry cured meats and bacons (systematization according to the Regulations on meat products from Official Gazette 131/2012) was investigated. In total, 124 traditional meat products, produced on family farms from three production areas of the Croatia (Istria and Dalmatia, Central Croatia and Eastern Croatia) were analysed. Determined salt content by type of meat product, and with respect to the origin or the production area of Croatia, are shown in Table 1 and Table 2.

Table 1 The mass fraction of salt (%) in different types of traditional meat product

Category of product [a]	Group of products [a]	Type of product [a]	N	Mass fraction of salt (%)				
				Mean	SD	CV	Min	Max
Sausages	Dry sausages	Homemade sausage	38	4.14	0.57	13.7	3.02	5.32
		Kulen	13	4.37	0.68	15.6	3.34	5.48
Cured meat products	Dry cured meat products	Prosciutto	11	6.34	0.34	5.36	5.93	7.18
		Dry ham	22	6.52	0.54	8.28	5.62	7.64
		Dry rack	2	5.46	0.14	2.56	5.36	5.56
		Dry shoulder	6	5.45	0.45	8.26	4.86	6.13
	Semi-dry cured meat products	Smoked sirloin	2	5.34	0.25	4.68	5.16	5.51
		Smoked rack	2	4.92	0.33	6.71	4.68	5.15
Bacons	Semi-dry bacons	Bacon	15	5.09	0.52	10.22	4.36	6.21
		„Špek"	9	5.52	0.91	16.48	4.56	6.79
	Dry bacons	Pancetta	4	5.57	0.82	14.72	4.48	6.22

[a] Systematization according to the Regulations on meat products from Official Gazette 131/2012; Mean – mean value; SD - standard deviation; CV – coefficient of variation; Min – minimal value; Max – maximal value

In the group of dry sausages average salt content in certain homemade sausages was 4.14 ± 0.57%. Comparing the proportion of salt by the region of production, the highest proportion of salt was determined in sausages originating from Central Croatia (4.39 ± 0.47%), although by regions values were not significantly different. Mean concentration of salt determined in Kulen (4.37 ± 0.68%) was slightly higher than in homemade sausages, but this difference was not statistically significant, which can be explained by similar preparation or addition of salt in products from the group of dry sausages in the most family farms.

In previous Croatian studies, determined salt content in the homemade sausages was 3.57 ± 0.13%, while in

Table 2 Mass fraction of salt (%) in the traditional meat products according to production area of Croatia

Type of product	Istria and Dalmacia		Central Croatia		Eastern Croatia	
	Mean ± SD	Range (min-max)	Mean ± SD	Range (min-max)	Mean ± SD	Range (min-max)
Homemade sausage	3.83±0.51	3.12-4.67	4.39±0.47	3.73-5.72	4.14±0.57	3.02-5.19
Kulen	-	-	-	-	4.37±0.68	3.34-5.48
Prosciutto	6.31±0.34	5.93-7.18	-	-	-	-
Dry ham	-	-	6.33±0.50	5.62-7.12	6.24±0.86	5.93-7.64
Dry rack	-	-	5.56	5.56	5.36	5.36
Dry shoulder	-	-	6.13	6.13	5.31±0.33	5.08-5.68
Smoked sirloin	-	-	-	-	5.34±0.25	5.16-5.51
Smoked rack	4.92±0.33	4.68-5.15	-	-	-	-
Bacon	-	-	5.07±0.45	4.48-5.56	5.12±0.60	4.36-6.21
„Špek"	-	-	6.02±0.67	5.55-6.79	5.26±0.95	4.56-6.78
Pancetta	5.57±0.82	4.48-6.22	-	-	-	-

Mean – mean value; SD - standard deviation; Min – minimal value; Max – maximal value

the same product from the another production household was 2.68 ± 0.46%, pointing to possibly significant differences in applied recipe and production method for these products between different households (Pleadin et al., 2013). In a study conducted at the Istrian homemade sausage, average salt content was 2.92% (Bartulić et al., 2011), in Slavonian homemade sausage 4.07% (Kovačević et al., 2011), and in Kulen in the range of 4.10% to 6.32% depending on the addition of salt and the duration of the drying process (Kovačević et al., 2010). Literature data also show that the average salt content in the stuffing of sausages ranges from 2.0% to 2.6%, and that during the drying process growing to about 3.3% to 4.3% in the finished product (Ockerman and Basu 2007; Stahnke and Tjener, 2007). Results of this study indicate that the proportion of salt in the homemade sausages is moving around higher values than the values established in mentioned earlier studies.

In the category of dry and semi-dry cured meat products, prosciutto and dry ham contained the highest proportions of salt. The average salt content in dry ham was 6.52 ± 0.54% and in prosciutto 6.34 ± 0.34%, and the lowest proportion of salt contained dry rack (4.92 ± 0.33%). Comparing by the production areas, the proportion of the salt among the products in this category were not statistically significantly different ($p < 0.05$), but still slightly higher salt content contained the products originating from the Central Croatia, then from Istria and Dalmatia, and the lowest from Eastern Croatia.

In earlier studies, conducted on samples of the Istrian prosciutto, determined salt content was 6.45 ± 0.81% (Karolyi, 2006). In the study by Marušić et al. (2011), the higher values of salt content in the Istrian prosciutto of two different manufacturers (9.18 ± 0.00% and 8.93 ± 0.06%) were determined. In the Istrian prosciutto produced in 2010, determined salt proportion was 7.4 ± 1.2%, and in prosciutto produced in 2012 of 6.3 ± 1.3% (Marušić et al., 2014). Slavonian ham had salt content of 8.37 ± 2.06% (Senčić et al., 2010). Salt content in certain traditional European hams was 8.70% in Serrano (Toldrá et al., 1997), 6.00% in Parma (Baldini et al., 1992), 6.50% in Iberian ham (León-Crespo et al., 1986), 6.20% in Bayonne (Toldrá et al., 1997) and 6.50% in San Daniele (Baldini et al., 1992). This study determined the similar values of salt content in ham and prosciutto in comparison to other types of ham from the European market, and was also comparable with the results of earlier researches performed in Croatia (Karloyi, 2006; Krvavica and Đugum, 2006). All of these data reveals a similarity of the results on the proportion of salt in the prosciutto and ham originating from different European countries.

In the category of bacons, salt content in „špek" (5.52 ± 0.91%) and bacon (5.09 ± 0.52%), as a semi-dry bacons, was not statistically significantly different ($p > 0.05$) from salt content in pancetta (5.57 ± 0.82%) as dry bacon. Previous studies, carried out on two different samples of pancetta, showed a significantly higher salt proportion of 8.56 ± 1.41% and 9.08 ± 0.97% (Pleadin et al., 2013) in relation to the results of this study. In samples of bacon from the European market, the average salt content was 5.07 ± 0.60% (Guofeng et al., 2010). The results of this study do not exceed the mentioned values from the literature.

In general, the highest salt content of traditional meat products was determined in dry and semi-dry cured meat products. Literature data show that the salt is added as a preservative in large quantities in the process of curing or preservation of these products (Toldrá, 2010; Krvavica et al., 2012). Lower proportions of the salt were determined in the products from the category of the bacons, and the lowest in dry sausages. In general, salt content in the meat product is dependent on the applied recipe and production weight loss, and with the loss of water, and the weight of the product, proportionally increases the proportion of salt. In the products that contain a higher proportion of salt, water disso-

ciates better, causing thereby higher concentration of chloride ions that contribute to the taste of the product, and the addition of salt in a product with a higher water content resulting in its higher salinity.

Statistical analysis shows a statistically significant difference ($p < 0.05$) in the proportion of salt in dry sausages in relation to dry and semi-dry cured meat products. As the salt content was not significantly different ($p > 0.05$), depending on the region of production of meat products (Table 2), it can be considered that the technological processes of production within selected regions of the Croatia means the application of similar recipes and ways of processing of these traditional meat products.

In the period from 2011 to 2012, the Croatian Food Agency conducted a "National survey on eating habits" of the population in Croatia. Of a total of 2,002 respondents, 325 consumed meat products. Table 3 shows the average consumption of meat products by the type of product (CFA, 2011-2012) and the daily intake of salt due to the average consumption of the products from this research.

Table 3 The average daily intake of salt due to the average daily consumption by the type of meat product

Type of product	Average daily intake[a] (g/day)	Daily salt intake[b] (g/day)
Homemade sausage	42.55	1.76
Kulen	58.33	2.55
Ham	44.25	2.88
Prosciutto	29.79	1.87
Rack	14.70	0.76
Pancetta	51.29	2.85
Bacon	41.48	2.11
„Špek"	34.56	1.91

[a] "A national survey on eating habits", unpublished data of the Croatian Food Agency (HAH, 2011-2012); [b] Daily salt intake through traditional meat products, determined based on the results of the salt content of the products from this research and their average daily consumption by the Croatian regions (CFA 2011-2012)

The average daily intake of salt in the human body should not be higher than 5.0 g/day (WHO, 2012). By the average consumption of 42.55 g/day of the homemade sausages, 58.33 g/day of the Kulen, 44.25 g/day of the dry ham and 51.29 g/day of the pancetta (CFA 2011-2012), and putting into relationship with the results of this research in which it was found that the salt content in homemade sausage is 4.14%, in Kulen 4.37%, in dry ham 6.52% and in bacon 5.57%, through daily consumption of homemade sausages entered 1.76 g of salt, 2.55 g by Kulen, 2.88 g by dry ham and 2.85 g by bacon. Compared with medical recommendations (WHO, 2012), it is notable that the average consumption of specific types of traditional meat products enter one third to half of the value of the highest recommended daily intake of the salt.

Table 4 shows the average daily intake of salt due to the average daily consumption of meat products by Croatian production regions of this research.

Table 4 Average daily salt intake due to the average daily consumption per consumer of the meat product from the various regions in Croatia

Croatian region	Average daily intake[a] (g/day)	Daily salt intake[b] (g/day)
Istria and Dalmacia	41.80	2.16
Central Croatia	53.09	2.96
Eastern Croatia	58.60	3.01

[a] "A national survey on eating habits", unpublished data of the Croatian Food Agency (HAH, 2011-2012); [b] Daily salt intake through traditional meat products, determined based on the results of the salt content of the products from this research and their average daily consumption by the Croatian regions (CFA 2011-2012)

Taking into account the average daily intake of meat products (CFA 2011-2012) by Croatian production regions discussed in this study, as well as determined salt content of meat products of this research, the highest salt intake through the consumption of these types of meat products was determined in Eastern and Central Croatia, while the lowest was determined in Istria and Dalmatia. Consumers in Eastern and Central Croatia entered via these products approximately 60%, and in Istria and Dalmatia approximately 40% of the recommended daily intake of salt.

CONCLUSION

The highest share of salt was found in the category of dry and semi-dry cured meat products, followed by the bacons, and the lowest in the dry sausages. Comparing by Croatian production regions, there was no statistically significant difference in the proportion of salt among the analyzed products, which shows similarities in the technology of the same type of the product. Putting into relationship the data of the average meat products consumption with the data of the salt proportion obtained in this study, it could be seen that by the average consumption of these products recommended daily intake of salt is not exceed, but also that for certain products it represents even about half of the recommended daily salt intake. As traditional dry meat products contain significant amounts of salt (average of 4 - 8%), their use in human nutrition should be moderate.

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Dostavljeno 18.11.2015. **Prihvaćeno: 27.11.2015.**