Sodium intake associated with meat product consumption in Serbia

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Abstract. Meat and meat products are an important part of the human diet in Serbia. They are important because of their desirable taste, high nutritional value, variety of the products, traditional considerations etc. Our study addresses sodium levels in some of the most commonly consumed meat products from the Serbian market (cooked sausages, dry fermented sausages, smoked meat products, canned meats and pates). Sodium content was determined using ICP-MS. The highest sodium level was established in dry fermented sausages, and the lowest content was measured in pate. No significant differences were seen in sodium levels between cooked sausages, smoked meat products and canned meats. The mean sodium level of all analysed meat products was 11.8 g/kg. According to average intake of meat products in Serbia (54.7 g/day) and the measured sodium levels, consuming these meat products could contribute up to 26.9\% of sodium daily requirements. This could pose a risk to human health considering the already high sodium intake through adding salt to food and consumption of various processed foods. Generally, the results obtained suggest reducing salt levels in meat products and as well as in diet in general.

1. Introduction
Meat products are manufactured predominantly with sodium chloride as it provides salinity, flavor and increases shelf life. Therefore, these products are significant sources of sodium in human diets [1]. Sodium is also one of the essential nutrients that has an important role in maintaining some biochemical and physiological functions in the body [2]. However, excessive sodium intake has been correlated to risk of increased blood pressure and it could directly lead to heart attack [3-5]. Beside cardiovascular diseases, increased sodium intake has been linked with other health problems, including sodium retention in extracellular fluid [6], bone density disorders [7], risk of gastric cancer [8], proteinuria and a risk of kidney calculosis [9].

Considering the relationship between sodium intake and various chronic diseases, the National Institute of Health [10] established dietary reference intakes (DRIs) for sodium: recommended dietary allowances and adequate intakes (1.5 g per day for adults), and tolerable upper intake levels (2.3 g per day for adults). Some studies are already investigating the possibility of reducing and substituting sodium chloride, as well as the effects of such procedures on sensory quality parameters of different food types [11-15].

The aim of this study was to determine the sodium daily intake through consumption of the most popular meat products (cooked sausages, dry fermented sausages, smoked meat products, canned meats and pates) available on the Serbian market. Also estimation of the potential health risk delivered
from consumption of these products could suggest the necessity for partial reduction of sodium addition and/or substitution of sodium with other salt types.

2. Materials and Methods

A total of 163 meat products were collected from the Serbian market (n=53, cooked sausages; n=33, dry fermented sausages; n=44, smoked meat products; n=27, canned meats; and n=6, pates). An amount (0.5 g) of previously homogenized meat was transferred into a microwave digestion teflon vessel along with 5 mL of nitric acid (67% Trace Metal Grade, Fisher Scientific, Bishop, UK) and 1.5 mL of hydrogen peroxide (30% analytical grade, Sigma-Aldrich, St. Louis, MA, USA). The microwave oven (Start D, Milestone, Sorisole, Italy) was set to the following temperature program: 5 min from room temperature to 180°C, 10 min hold at 180°C, 20 min ventilation. After cooling to room temperature, the solutions were quantitatively transferred into polypropylene volumetric flasks and diluted to 100 mL with deionized water obtained from a water purification system (Purelab DV35, ELGA, Buckinghamshire, UK).

Analysis of the $^{23}$Na was performed by inductively coupled plasma mass spectrometry (ICP-MS), (iCap Q mass spectrometer, Thermo Scientific, Bremen, Germany). A five-point calibration curve (including zero) was constructed for quantification. Multielemental internal standard ($^6$Li, $^{42}$Sc – 10 ng/mL; $^{71}$Ga, $^{89}$Y, $^{209}$Bi – 2 ng/mL) was introduced along with the sample by an additional line through the peristaltic pump.

The quality of the analytical process was verified by analysis of the certified reference material ERM – BB384 (lyophilized pork muscle; Geel, Belgium). Reference material was prepared in the same manner as regular meat samples. Replicate analyses were in the range of certified values.

Since a total diet study has not been undertaken in Serbia so far, we used the only data available to us, from the Republic Institute for Statistics of Serbia [16], for the purpose of intake assessment. According to this source, estimated average daily consumption of meat product is 54.7 g. The following formula was used for calculation of intake assessment expressed as daily intake (g):

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\text{Daily intake} = \text{Concentration of Na} \times \text{Daily consumption data}
\]

3. Results and Discussion

Levels of sodium in different meat products (cooked sausages, dry fermented sausages, smoked meat products, canned meats and pates) from Serbian market are shown in Table 1. Results are reported as mean ± standard deviation

| Meat product            | Na, g/kg |
|-------------------------|----------|
| Cooked sausages         | 10.4 ± 2.20b |
| Dry fermented sausages  | 16.9 ± 2.90a |
| Smoked meat products    | 11.6 ± 4.50b |
| Canned meats            | 10.8 ± 2.40b |
| Pate                    | 4.7 ± 0.50c |

" Different superscripts indicate significant differences of means according to Tukey’s HSD test (p < 0.05)

Statistically significantly higher levels of sodium were established in dry fermented sausages and lower levels in pate compared with other meat products. Statistical analysis showed there were no significant differences in sodium content between cooked sausages, smoked meat products and canned meats.

The measured sodium level in cooked sausages (10.4 g/kg) was higher than established data in a Finnish study (6.0-9.0 g/kg, [5]) but lower compared with data reported by DTU (18.7 g/kg, [17
Smoked meat products and dry fermented sausages had lower sodium contents than those reported by DTU (13.2-23.0 and 15.0 g/kg, respectively [17]). The determined mean sodium level in canned meats was higher compared with data reported by DTU (7.2 g/kg) [17] and Dietitians of Canada (9.15 g/kg) [18]. Sodium levels obtained in pate (4.70 g/kg) were comparable with data reported by Dietitians of Canada (4.45 g/kg) [18] and lower than the reported level from USDA (6.97 g/kg) [19].

The mean sodium level of all five types of meat products was 11.8 g/kg. According to the average intake of meat products in Serbia (54.7 g/day, [16]) and the measured Na levels, consuming these meat products could contribute up to 26.9% of Na daily requirements (6 g NaCl, i.e. 2.4 g Na, based on national legislation [20]).

4. Conclusion

Having in mind that intake of meat products comprise only 2.76% of total daily food intake, 26.9% of the recommended daily intake of sodium could pose a risk to human health due to the likely significant intake of high levels of sodium through food with a high salt levels, e.g. packaged and processed foods (breads, cereals, cheese, some canned foods, sauces, etc.). Also, humans habitually add salt to food because it improves the positive sensory properties of food, which is perceived as better tasting food. Considering all these facts and taking into account the negative health effects of high levels of sodium, it is necessary to reduce salt levels in meat products and as well as in diets. This could be achieved through partial substitution of sodium salt with other salt types (potassium or ammonium), which is an important topic in scientific literature.

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References

[1] Muguerza E, Gimeno O, Ansorena D and Astriasaran I 2004 Trends Food Sci. Technol. 15 452
[2] Goyer R A 1997 Annu. Rev. Nutr. 17 37
[3] Perry I J and Beevers D G 1992 J. Hum. Hypertens. 6 23
[4] McCarty M F 2004 Med. Hypotheses 63 138
[5] Ruusunen M and Puolanne E 2005 Meat Sci. 70 531
[6] MacGregor G A and de Wardener H E 1997 Idiopathic edema Diseases of the Kidney ed R W Schrier and C W Gottschalk (Boston MA: Little Brown and Company) pp 2343–52
[7] Devine A, Criddle R A, Dick I M, Kerr D A and Prince R L 1995 Am. J. Clin. Nutr. 62 740
[8] Tsugane S, Sasazuki S, Kobayashi M and Sasaki S 2004 Br. J. Cancer 90 128
[9] Cappuccio F P, Kalaitzidis R, Duneciflt S and Eastwood J B 2000 J. Nephrol. 13 169
[10] NIH 2019 National Institutes of Health https://ods.od.nih.gov/Health_Information/Dietary_Reference_Intakes.aspx
[11] Lilić S, Matekalo-Sverak V, Vranić D, Karan D, Rašeta M, Nikolić D and Lukić M 2014 2nd Int. Cong. Food Technology, Quality and Safety, October 28-30, Novi Sad, Serbia, Proc. p 55
[12] Branković Lazić I, Raseta M, Nikolić D, Lukić M, Karan D and Lilić S 2015 58th Int. Meat Industry Conf. “Meat Safety and Quality: Where it goes?”, October 4-7, Zlatibor, Serbia, Proc 5 p 22
[13] Lilić S, Branković Lazić I, Vranić D, Korićanac V, Nikolić D, Borović B and Velebit B 2016a Meat Technol. 57 110
[14] Lilić S, Branković Lazić I, Karan D, Babić J, Lukić M, Nikolić D and Rašeta M 2016b Meat Technol. 57 22
[15] Lilić S, Nikolić D, Pejkovski Z, Velebit B, Lukićević B, Korićanac V and Vranić D 2017 59th Int. Meat Industry Conf. MEATCON2017, October 1-4, Zlatibor, Serbia. IOP Conf. Series: Earth Environ Sci 85 012053
[16] Household Budget Survey 2016 Republic Institute for Statistics of Serbia Bilten 627
[17] DTU 2019 Technical University of Denmark https://frida.fooddata.dk
[18] Dietitians of Canada 2016 https://www.dietitians.ca/getattachment/ff62244f-1300-4ba5-bebd-208c3db61adc/FACTSHEET-Food-Sources-of-Sodium.pdf.aspx
[19] USDA 2019 Food Composition Databases https://ndb.nal.usda.gov/ndb/search/list
[20] Pravilnik o deklaraciji, oznacavanju i reklamiranju hrane, Official Gazette RS 19/17 and 16/18