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# MEAT PRODUCTS WITH REDUCED SODIUM CONTENT - HOW TO ACHIEVE CONSUMER FAVOR?

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**Abstract:** This review paper presents the experiences of a number of countries in the European Union (EU) and around the world that have accepted and managed to reduce sodium intake in meat products and food in general. Different procedures or their combination are in use, noting that in the strategy for the reduction of NaCl content in food, the goals can be achieved only with multi-year, systematically planned and focused activities. Close cooperation of all stakeholders is necessary, with continuous consumer education. The imperative for the success of the aforementioned strategy is to raise the awareness of the widest population at the national level, primarily consumers, as well as the scientific and professional public who transfer their desires and the results of their research and advanced technologies to the food industry.

**Key words**: reduction of Na content, meat products, consumer habits, review

## Introduction

### *What is table salt and where is it located?*

Sodium chloride (NaCl), better known in the human diet as table salt, is one of its basic ingredients. NaCl is one of the most commonly used additives in the food industry, due to its low cost and numerous (different) desirable activities in foods (Albarracín et al., 2011). Kitchen salt contains at least 97% NaCl. They were obtained by evaporating salt water (boiled salt) or sea water (sea salt) and processing salt ore (rock salt). Iodized table salt is added to meat products, which promotes it as the first functional component of food.

Sodium and chlorine are essential for life and health, because they stabilize internal fluids, electrolytes and blood pressure in the human body. They provide adequate function of muscles and nerves. Sodium allows the absorption of nutrients (glucose - sugar and amino acids). Excessive sodium intake (above the acceptable limit) is harmful, because it leads to the development of hypertension, which causes a heart attack, heart and kidney failure.

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***Influence of table salt on technological, sensory and microbiological properties of meat products***

NaCl performs the following functions:

- dissolves meat proteins, which in processing participate in the connection of meat, water and fat in the desired formation - the structure of the gel;
- activates proteins, increasing their hydration and water binding capacity (WBC);
- increases the viscosity of meat, facilitating the binding of fats, stabilizing the structure;
- increases the pH value of meat or meat products;
- formation of desirable taste;
- preserves meat or meat products by lowering the value of water activity ($a_w$), „extracting" water from tissues;
- increases fluid loss in heat-treated vacuum products.

NaCl is an indispensable addition in the production of meat products, due to the impact on their texture, aroma and sustainability. Reducing the salt content in meat products can have negative effects on WBC and fat emulsification, damage the overall texture, increase cooking losses, impair sensory quality, and especially taste. However, experience has shown that a 25% reduction in NaCl content in meat products does not lead to a significant change in sensory properties (Ruusunen et al., 2005).

NaCl has a significant effect on the aroma (smell and taste) of meat. In addition to salty, NaCl can cause other taste sensations: at low concentrations it is perceived as sweet, and at high concentrations it is a carrier of bitter taste. The intensity of the salty taste depends on the amount of salt, water content and the presence of other substances that affect the taste. More salt in the product leads to a saltier taste. Meat products with an identical salt content have a more pronounced salty taste if they have a higher water content. In these products, NaCl is dissociated to a greater extent, so chloride anions, from which the salty taste originates, have a stronger effect on taste receptors. NaCl also enhances the aromatic properties of other meat ingredients. The aroma of salted meat is one-sided with NaCl and is not stable enough, due to the relatively rapid oxidation of unsaturated fatty acids lipoids. Inguglia et al. (2017) and Ruusunen et al. (2005) in their review papers described that lower NaCl concentration in meat products can affect product quality parameters and shelf life, and the response to NaCl content reduction is product-specific. The main limitation for this reduction in NaCl content is the acceptance of „healthier" products by consumers.

If 33% NaCl was replaced with KCl in the brine treating the dried ham, the salty taste was equivalent to the salinity of the taste of the control sample, but slightly bitter. Calcium gluconate, calcium glycerophosphate and calcium lactate had lower salinity and bitter taste than when calcium chloride was used as a substitute for NaCl (Petit et al., 2019). The taste of sodium monoglutamate, applied at a concentration ten times lower than the NaCl content, is similar to the salty taste of NaCl (Sugita, 1990) and acts synergistically with NaCl in forming the salty taste of meat products (Halpern, 2000).

### *Concerns about excessive daily intake of salt and harmful effects on human health*

Vandendriessche (2008) characterized today's meat processing as a period of improving quality, food safety and nutrition/health.

Currently, there is great concern among consumers around the world due to excessive intake of NaCl in meals. However, despite the development of modern preserving procedures, NaCl is still necessary in meat products. Despite its long history, the use of high levels of NaCl in food is now seriously controversial, due to health problems associated with high blood pressure and cardiovascular risks. Changes in meat processing procedures have reduced potential risks, but differing perceptions continue to shape the way consumers and society view the use of NaCl in meat products. Current consumer demand for food without additives, such as the clean-label movement, has renewed consumers' willingness to consume food products without synthetic additives (Petit et al., 2019).

The World Health Organization (WHO) considers non-infectious diseases (heart disease and brain infarct) to be the predominant cause of premature death in the 21st century, and has strongly supported the Governments of many countries to start implementing the „Global Action Plan to Reduce Non-infectious Diseases". One of the nine global goals is to reduce salt intake by about 30% by 2025 (World Heart Day, Geneva, September 25, 2014). Dickinson and Havas (2007) state that the revocation of GRAS (Generally Recognized As Safe) status of table salt has been proposed in order for food manufacturers to confirm the precise amounts of NaCl they add to food. Xiaosong (2007) reports that hypertension in China has tripled since 1958, and that cardiovascular disease has become the number one killer (2.6 million deaths per year). On a global scale, death from gastric cancer is the second most important of the various types of cancer. Some studies suggest a link between salt intake, *Helicobacter pylori* infections, and mortality from gastric cancer (Wong et al., 2004).

Many deaths and chronic diseases are associated with risk factors that can be easily avoided: high blood pressure, hypercholesterolemia, obesity and lack of physical activity. Unbalanced meals, including high salt intake, which have a negative effect on blood pressure, have been identified as the cause of most chronic diseases. The British Medical Research Council has found that a daily reduction in sodium intake from 3800 mg to 2400 mg leads to a 13% drop in cardiovascular disease and a 10% drop in heart disease. The Scientific Advisor Committee on Nutrition (SACN) has published a report on the impact of table salt on human health, which confirmed the link between salt intake and high blood pressure. WHO and Food and Agriculture Organization of the United Nations (FAO) hope that each country will develop its own strategy for reducing the NaCl content in different products, with specific, simple, realistic and concrete instructions for the implementation of activities by the population.

Significant amounts of sodium are ingested through meat and meat products (12 to 20% of total food intake), so these are priority products in which its content should be reduced (Desmond, 2006).

***Strategies for formulating low-sodium meat products and the effects of NaCl substitutes on various quality aspects***

The demand for the development of healthier meat products, with a lower proportion of fat and salt, is growing day by day. Frangopoulos et al. (2020) developed an experimental range of fermented sausages with low fat and salt content. The products were formulated with different fat contents (10 g/100 g – 20 g/100 g), NaCl (0-2 g/100 g) and KCl (0-1 g/100 g). KCl was used as a substitute for NaCl. A significant interaction between the addition of KCl and the fat content in the perception of bitter taste was identified.

Partial replacement of NaCl with KCl and $CaCl_2$ affected lipolysis reactions and lipid profile in salted meat with reduced Na (Nachtigall et al., 2019). Jin et al. (2018) published the results of a study evaluating the effects of partial replacement of NaCl with mixtures of $CaCl_2$, $MgCl_2$ and KCl on changes in the quality of emulsified sausages prepared from pork, with reduced fat content. Mixtures with one or two other substitutions for NaCl ($CaCl_2$, $MgCl_2$ and KCl) are acceptable for partial replacement of NaCl in the production of emulsified sausages with reduced fat content, because their quality remains intact.

During the assessment of Turkish-type Drycured Meat Product „Pastirma" production analysis parameters, whether natural or controlled production conditions, it is possible to replace NaCl with KCl (Hastaoglu and Vural, 2018). Moisture content, fat, $a_w$, pH, color, thiobarbituric acid (TBA) values, textures, salts, Na and K allow limited targeted changes in „Pastirma" production. The sensory properties of „Pastirma" were acceptable when NaCl was replaced by KCl, in a proportion of 15%. Stanley et al. (2017) evaluated the effects of reducing the content and replacing NaCl with KCl or applying a modified salt based on KCl, using weight or molar equivalent, based on the sensory and physicochemical properties of pork sausage patties. Three independently produced samples (triplicate) of pork sausages were used to compare 5 treatments: normal Na content, reduced Na content, modified KCl weight-based substitution, modified KCl molarity substitution, and standard NaCl substitution based on weight-based KCl. The use of modified KCl reduced the Na content and improved the Na: K ratio, while changes in composition or physicochemical properties were minimal.

Kim et al. (2015) examined the effects of reducing fat content from 30% to 20% and salt concentration from 1.5% to 1.0%, on the physicochemical properties of meat emulsion. The mentioned reductions were performed by partial replacement of fat and NaCl by a combination of phosphate and edible algae *Undaria pinnatifida*. The results showed that samples of emulsions with reduced fat/low NaCl content have higher viscosity, and that the inclusion of phosphate and edible algae in the emulsion formulation successfully reduced their fat content and salty taste intensity.

Intriguing research by Carraro et al. (2012) promoted healthier characteristics of Bologna sausage produced with low sodium and high potassium levels. The authors replaced 50% of the NaCl content with KCl. The two combinations of herbs

and tested spices effectively eliminated the sensory deficiencies caused by the addition of KCl. The conclusion is that the use of tested herbs and spices (0.5% coriander, 0.4% onion; 0.1% white pepper, 0.3% onion, 0.5% cardamom and 0.2% Jamaican pepper) in combination with partial replacement of NaCl with KCl can be considered an adequate procedure for the production of Bologna sausages with reduced Na content, without compromising their safety and sensory quality.

Restrepo-Molina et al. (2019) designed mixtures with reduced sodium content that are used in the production of hot dogs. The mixtures were made up of a combination of four salts: sodium chloride, sodium tripolyphosphate, potassium chloride and tetrapotassium pyrophosphate (TPPNa), with ten formulations. The experimental group T2 (mixture of 78% NaCl and 22% TPPNa) showed the best results (the lowest cooking losses and the most desirable texture). The smallest cooking losses were found when reducing the NaCl content by applying the highest levels of TPPNa (T2, T4, T6 and T9).

Peulić et al. (2019) determined the content of Na, ie NaCl, in eleven samples of chicken meat sausage and 10 samples of pork sausage, purchased in the retail network on the Serbian market. The sodium content in the tested samples ranged between 6278 and 9131 mg/kg, which is very similar to the results of other authors who tested related meat products on the EU market. The presented results indicate the possibility of reducing the NaCl content in meat products and adjusting to the recommendations of EU regulatory bodies.

de Almeida et al. (2016) concluded that the production of low-fat salami using salt substitutes (KCl and $CaCl_2$) can be carried out efficiently, without compromising the main sensory attributes.

Kurćubić et al. (2014; 2015) and Okanović et al. (2015) comprehensively examined the quality of finely chopped boiled sausages - hot dogs, packed in vacuum, after replacing the nitrite sodium salt with combined sodium-potassium salt, without the addition of nitrite. The following experimental groups were formed: K-1 (control): produced according to the original recipe of the manufacturer, with the addition of nitrite salt, in the amount of 2% (200 g/10 kg of stuffing); PP-1: 25% nitrite salt replaced with sodium-potassium salt mixture, without nitrite admixture (50 g/10 kg of filling); PP-2: 50% nitrite salt replaced with sodium-potassium salt mixture, without nitrite admixture (100 g/10 kg of filling); PP-3: 75% nitrite salt replaced with sodium-potassium salt mixture, without nitrite admixture (150 g/10 kg of filling); PP-4: 100% nitrite salt replaced with sodium-potassium salt mixture, without nitrite admixture (200 g/10 kg of filling). The results of the examination of sensory properties indicate that the properties of the tested sausages were poorly evaluated after the cooking test. The fragrant note is more pronounced, the color is more intense, and the consistency shows poor connection of the components. Experimental groups PP-1, PP-2, PP-3 were rated higher than PP-4 and the control group (K-1). The samples with PP-3 were evaluated with the best average sensory score (3,757), and the PP-4 experimental group with the weakest (2,748), in which 100% of the nitrite salt was replaced by a mixture of sodium-potassium salt without nitrite admixture. Sodium

content is in descending order: 0.495 g/100 g, 0.487 g/100 g, 0.422 g/100 g, 0.390 g/100 g and 0.342 g/100 g, respectively. Control recipe represents the sodium content considered common for cooked emulsified sausages. Replacement of 25%, 50%, 75% and 100% of the nitrite salt with mixed sodium-potassium salt resulted in a decrease in Na content by approximately 1.59%, 14.70%, 21.25% and 30.87%, respectively, in relation to the content in the control group samples. Food producers are faced with the dilemma: „How to reduce the sodium content in food without over-modifying its taste?". Trends indicate that consumers are increasingly opting for „healthy" food, so taste remains the most critical factor for its purchase. Toldrá et al. (2009) published a review of innovative patents for reducing salt in food.

## Conclusion

Meat and meat products contain 12 to 20% sodium in relation to its total food intake, so sodium content must be reduced in them as a matter of priority. Reducing the sodium content makes modified products more attractive and healthier for consumers, because reducing sodium intake in the human diet is considered a way to reduce risk factors for hypertension and, consequently, from the development of heart disease.

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## PROIZVODI OD MESA SA SMANJENIM SADRŽAJEM NATRIJUMA - KAKO POSTIĆI NAKLONOST POTROŠAČA?

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### Sažetak

U ovom preglednom radu su prikazana iskustva većeg broja zemalja u Evropskoj uniji (EU) i širom sveta koje su prihvatile i uspele da smanje unos natrijuma u proizvodima od mesa i generalno u hrani. U primeni su različiti postupci ili njihova kombinacija, uz napomenu da u Strategiji redukcije sadržaja NaCl u hrani ciljevi mogu postići samo uz višegodišnje, sistemski planirane i usmerene aktivnosti. Neophodna je tesna saradnja svih zainteresovanih strana, uz kontinuirano obrazovanje potrošača. Imperativ za uspeh je podizanje svesti najšire populacije na nacionalnom nivou, prioritetno potrošača, kao i naučne i stručne javnosti koja svoje želje kao i rezultate svojih istraživanja i unapređenih tehnologija transferišu u sektor prehrambene industrije.

**Ključne reči**: smanjenje sadržaja Na, proizvodi od mesa, navike potrošača, pregled