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Salt reduction in meat products – challenge for meat industry*

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Abstract: History of salt is ancient as the history of human population. Discovery and use of salt have made the food sustainable for longer period, available regardless of the season of the year and enabled its transport over long distances. For several millions of years, the prehistoric men consumed less than 0.5 g of salt daily. But today, daily salt intake is very high. Due to negative effect of salt (sodium) on the human health, modern nutrition trend is to decrease salt content in processed food. Because of that the meat products are one of the main source of sodium, role of the meat industry in the reduction of salt content in the contribution to the human health will be great. But it is not so common problem, because salt has important contribution to technological and sensory properties as well as to the microbial stability of meat products. Eleven EU countries have entered to the program of salt reduction, 16% in the next 4 years. In the goal to human health protection it is very important for food industry of each country to make decision to permanently decrease salt/sodium content.

***Key words**: salt, sodium, meat products.*

History

History of salt is ancient as the history of human population. Discovery and use of salt have made the food sustainable for longer period, available regardless of the season of the year and enabled its transport over long distances. It was produced from sea water or mined in mines. The oldest mines in the world were located in hills where the salt was mined, packed into leather bags and transported by animals, to be traded for amber, gold and copper. It was one of the first categories of trade exchange; also it has been subject of fees, taxes, caused wares and brought colonial power, created and crushed empires.

It was equally important for Jews, Egyptians, Chinese, Greeks and other ancient peoples. The Roman Empire controlled the price of salt, corrected its price, from the highest price when the earnings were used to conduct wars, to the lowest when the poor could afford it. One part of the pay of Roman soldiers was paid in salt, explaining the name for pay, wages in certain languages, e.g. English „salary“ corresponding to Latin word „salarium“. Even soldiers in the American civil war were sometimes paid in salt. With the development of Rome, salt roads were built to enable easier transportation of salt from the Adriatic Sea, known for very high salinity. At that time, famous salt roads were created, such as „Via salaria“ in Italy, „Salzstraβe“ from Lűneburg to Lűbeck, and „Golden road“ from Passau to Bőhmen.

Salt was transported over long distances to German tribes or North Africa, to the central part and south of the continent, when 40 thousand camels transported salt on a 400 mile road to central African states where it was traded for the same amount of gold or for slaves.

Salt is even mentioned in the bible. It was used in burnt offerings, and also in metaphoric sense. Jesus said to his apostles „You are the salt of the

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earth“ (*Matthew* 5:13), and sometimes he instructed them „to have salt within them“.

Salt also played important part in determining the power and location of great cities. So, Liverpool, in the 19th century, developed from small English port into primary export port and became warehouse for salt produced in Cheshire mines.

Salt mines in Poland led to a flourishing kingdom in 16th century, which was lost when Germans brought sea salt, at a better price. Venice was at war with Genoa because of salt. Salt pits were source of income for Columbus travels. Christopher Columbus and Giovanni Caboto, who were citizens of Genoa, later destroyed the Mediterranean by introducing the New World into the salt trade. States, cities and duchies imposed heavy taxes and fees on salt roads, and in 1158 the city of Munich was founded, when the Duke of Bavaria, Henry the Lion, decided that the bishop of the city of Freising could not benefit any more from the salt profits. The French had the hated tax „la gabelle“, which was in effect from 1286 to 1790, when the value of salt was high that it caused the exodus, attracted conquerors and caused wars. The abolition of this fee was main goal of the revolution in year 1789, although Napoleon immediately reintroduced the fee to finance his wars.

The oldest data on application of salt in the medicine date from 3000 b.c. and are associated with Egyptian builder and physician Imothepa, who stated that salt dried infected wound and can slow down inflammatory process, and implementation of salt in the human medicine is continued by Hypocrates in ancient Greece. Paracelsus introduces the salt as the third element, in addition to sulphur and mercury, and interrupts the dualist concept of alchemy and states than only well salted food can be digested properly. He is one of the first people to use salt baths in treatment of skin diseases.

The highest consumption of salt was reached in 1870. With the advent of refrigeration and freezing, salt was no longer necessary in food preservation. And this lasted until 20th century when it was realized that higher income can be generated in production of salty food products. Also, salt became the first functional food stuff by adding of iodine in prevention of goiter.

Human requirements in salt

For several millions of years, the prehistoric men consumed less than 0.5 g of salt daily (*Feng et al.,* 2010). Intentional adding of salt to food started around 5000-10000 years ago, at the beginning of the agricultural development and daily intake of salt reached average value of 10g, which is in evolutionary sense relatively recent. Intake of common salt is caused not only by physiological needs, but also habits which are acquired in the early childhood, as well as tradition in nutrition (region, i.e. climatic conditions, preparation of food, livestock resources, etc.). Of total daily amount of common salt introduced into organism by common amounts of food (dishes prepared in the household, bread, bakery products, cheese, etc.), approx. 20% derives from meat products (*Wirth*, 1991).

Sodium from salt is mainly located in the extracellular fluid in the organism and it influences the maintaining of the water balance, nerve function, acid-base balance and muscle contractions. Although even unexpected, reduced intake of sodium can lead to muscle contractions, nausea, vomiting, anorection and coma. Because of this important role of sodium in the organism, requirements of humans in salt are often expressed as sodium requirements. According to some data, daily requirement in sodium for adults, to maintain metabolic processes and needs, is below 1500 mg. In case of athletes, requirements are higher, and even exceed 10000 mg per day, when large amount of sodium is lost through intensive sweating. However, daily intake of sodium is often over 5000 mg (*Benardont*, www.healthline.com/hlbook/nut-sodium). American Heart Association recommends for persons with hyper tension daily intake of not more than 1500 mg, and for persons with congestive heart disorders, daily sodium intake of not more than 1000 mg.

Table 1 presents recommended and tolerable intake of sodium and chloride for infants, children, men and women, pregnant and nursing women.

The effects of excessive intake of salt (sodium)

Excessive intake of sodium can lead to:

- Direct risk of heart attack (*Perry and Beevers*, 1992),
- Hypertrophy of the left heart chamber (*Schmieder and Messerli*, 2000),
- Sodium retention in extracellular fluid, i.e. water retention and clinical and idiopathic edema, especially in women (*MacGregor and de Wardener*, 1997),
- Increased hardness, i.e. decrease of elasticity of blood vessels, especially arteries, independent of the blood pressure (*Avolio et al.*, 1986),

Table 1. Recommended and tolerable daily intake of sodium and chloride (*Dietary Reference Intakes for Water, Potassium, Sodium, Chloride and Sulphate,* 2004)

Tabela 1. Preporučeni i tolerišući dnevni unos natrijuma i hlorida (Dietary Reference Intakes for Water, Potassium, Sodium, Chloride and Sulphate, 2004)

	Recommended daily intake/ Preporučeni dnevni unos, g		**Tolerable daily intake/ Tolerišući dnevni unos, g**	
	Sodium/Natrijum	**Chloride/Hloridi**	**Sodium/Natrijum**	**Chloride/Hloridi**
Infants/Bebe				
0-6 months/meseci	0.12	0.18	/	/
7-12 months/meseci	0.37	0.57	/	/
Children/deca				
1-3 years/godine	1.0	1.5	1.5	2.3
4-8 years/godina	1.2	1.9	1.9	2.9
Males/muškarci				
8-13 years/godina	1.5	2.3	2.2	3.4
14-18 years/godina	1.5	2.3	2.3	3.6
19-30 years/godina	1.5	2.3	2.4	3.6
31-50 years/godina	1.5	2.3	2.4	3.6
51-70 years/godina	1.3	2.0	2.4	3.6
>70 years/godina	1.2	1.8	2.3	3.6
Females/žene				
8-13 years/godina	1.5	2.3	2.2	3.4
14-18 years/godina	1.5	2.3	2.3	3.6
19-30 years/godina	1.5	2.3	2.4	3.6
31-50 years/godina	1.5	2.3	2.4	3.6
51-70 years/godina	1.3	2.0	2.4	3.6
>70 years/godina	1.2	1.8	2.3	3.6
Pregnant women/ Trudnice				
14-18 years/godina	1.5	2.3	2.3	3.6
19-30 years/godina	1.5	2.3	2.3	3.6
31-50 years/godina	1.5	2.3	2.3	3.6
Lactating women/dojilje				
14-18 years/godina	1.5	2.3	2.3	3.6
19-30 years/godina	1.5	2.3	2.3	3.6
31-50 years	1.5	2.3	2.3	3.6

- Proteinuria, primarily to urinary excretion of albumin, resulting in increased risk of heart and kidney diseases (*Du Cailar et al*., 2002),
- Greater possibility of infection by *Helicobacter pylori* and risk of stomach cancer (*Tsugane et al*., 2004),
- Increase of urinary excretion of calcium and risk of forming of kidney calculi (*Capuccio et al.*, 2000),
- Risk of reduced bone density, resulting in osteoporosis and compressive bone fractures, especially in case of women in menopause (*Devine et al.*, 1995),
- Exacerbations (more intensive and longer) of asthmatic seizures (*Mickleborough et al.*, 2005),
- Increase of HOMA (homeostasis model assessment) insulin resistance in patients with essential hypertension, majority of which

have reduced glucose tolerance (*Kuroda et al.*, 1999), and

- Indirect incidence of obesity due to intensive intake of refreshing, non-alcoholic beverages (*Feng et al*., 2010).

In addition to stated harmful/adverse effects, increased intake of sodium is one of the major causes of hyper tension which represents the greatest risk for development of cardio vascular diseases. This topic is in the focus of attention due to continuous increase in consumption of salty food, bad nutritional habits and poor physical activity of people in the modern society.

The earliest record of the effect of salt from food on blood pressure (*Huang Ti Nei Ching Su Wein,* 2698-2598 BC) is following „If too much salt is used for food, the pulse hardens...“ and „Therefore if large amounts of salt are taken, the pulse will stiffen and harden“.

Of all established hypertension conditions, 95% represent essential hypertension. The most common medical advice is to consume less salty food.

The mechanism leading to increase of blood pressure due to excessive intake of salt is inability of kidneys to excrete the excess sodium amount until the arterial blood pressure is elevated and in this way the excretion of fluids through kidneys is increased (*Wirth and Offermanns,* 2008). Studies show that with the increase of intake of salt the body mass, total sodium content in blood, extracellular volume, plasma and blood volume also increase. At the same time, the levels of renin, angiotensin and norepinephrine decrease (*Haddy*, 2006).

For the first time, in year 2000, in the journal Progress in Cardiovascular Nursing, the salt sensitivity is mentioned, representing the elevation of blood pressure as response to increased intake of sodium. In sodium sensitive persons, fluctuations of blood pressure as response to increased or reduced intake of sodium are more dramatic compared to non-sensitive persons. Sodium sensitivity occurs more often than we think, even around 30% in normotensive persons and more than 50% in hypertensive persons. It is more common in black race, elderly and people with kidney insufficiency and diabetes.

Considering that prehistoric man consumed less than 0.5 g of salt daily, intake of salt exceeding this amount, in the evolutionary sense, is more recent occurrence, and it is clear that people are not genetically programmed to consume higher amounts of salt. Epidemiological studies in the 20th century vary from absence of hypertension in population consuming less than 3 g of salt daily to high incidence of hypertension in populations consuming over 20 g of salt per day.

About 40 indigenous tribes from South America, Africa, Pacific and Arctic consume less than 3 g of salt per day and their pressure is not elevated with the age. In South America, members of the Yanomamo tribe, living on the border between Venezuela and Brazil, consume less than 0.5 g of salt daily and average blood pressure in men is 105/70 mmHg and 95/60 mmHg in women.

There is positive correlation between HOMA insulin resistance and sodium sensibility in patients with essential hypertension, and in many of them also glucose tolerance. Increase insulin level in blood leads to sodium sensibility through increase of sodium absorption in kidney channels (*Kuroda et al*., 1999).

In addition, today, according to modern techniques, also the genetic basis of sodium sensitivity is studied. Over 20 gens are responsible for essential hypertension or for rare Mendelian disease with high or low blood pressure (*Lifton et al*., 2001; *Mein et al*., 2004). Majority of these genes encode proteins which are mediators of sodium excretion through kidneys (*Meneton et al*., 2005). Gene mutations can lead to increased sodium absorption resulting in elevation of blood pressure.

Analyses of genomes in human population showed that in persons with hypertension, very important is the role of the renin-angiotensin system. Angiotensin II regulates the blood pressure and salt retention in the organism. In case of hypertensive persons, angiotensin molecules are different from those in healthy persons (substrate for the action of renin) are determined. These mutated angiotensin variants are directly responsible for incidence of essential hypertension. By analysis of the genome of diseased persons the functional mutation of gene in charge of angiotensinogen synthesis (AGT) was detected, which is manifested in substitution of adenine for guanidine in the AGT promoter region. Translation of mutated gene causes the acceleration of the AGT gene transcription and consequently the increase of the angiotensinogen concentration in the systemic circulation, i.e. to increase of blood pressure (*Charles et al*., 2005).

In addition to the effect on elevation of blood pressure, AGT gene also has impact on salt sensibility. Namely, persons with homozygous allele AA and heterozygous allele AG show statistically significant variations in blood pressure depending on the concentration of sodium chloride in food and represent risk group for incidence of essential hypertension, whereas persons with homozygous mutated allele GG (and constantly elevated blood pressure) had no reaction to the change of sodium chloride concentration (*Melo et al*., 1998; *Watkins et al*., 2010).

Physiological regulation of blood pressure takes place through several protein complexes, including atrial natriuretic peptide (ANP). This protein consists of 28 amino acids, and it is synthesized in heart atriums. When ANP is applied in physiological doses to the organism, blood pressure drops and excretion of salt is increased. Certain researchers have studied if the changes in the gene for ANP synthesis influence changes of blood pressure. It was established that in mice which by genetic manipulation had their ANP gene promoter extracted (homozygous mutants), significant increase of blood pressure occurred in consumption of standard diet (0.5% NaCl) and intermediary diet (5% NaCl), whereas in heterozygous mutants the hypertension occurred in diet with high content of NaCl (8%). It was established that the polymorphism of ANP promoters exists in humans (*Unger et al*., 1990).

Third known mutation of gene responsible for changes in blood pressure depending on the intake of salt is mutation of gene for synthesis of adducin. Hypertensive persons which have the mutation (Gly 460) of adducin, in nutrition poor on sodium, show drop in arterial blood pressure (*Steaessen and Bianchi*, 2005; *Manunta et al.,* 2007).

Functional properties of salt in meat products

Salt in meat products causes the salinity (*Rusunen and Puolanne*, 2005) and together with fats contributes to numerous sensory properties. Increase of saltiness is more distinct in products with increased amount of fat, and in products with higher protein content, the sense of saltiness is lower. One of the major functions of salt in meat products is solubilisation of functional myofibril proteins, which activates the proteins to increase the hydration and water holding capacity (WHC) and, accordingly, improve the texture of product. Increase of WHC in meat reduces cooking loss and increases the tenderness and softness of meat products. There are two hypotheses on role of salt in meat WHC. According to *Hamm* (1986), chlorine ions have the tendency to penetrate myofilaments causing their dissolution, whereas *Offer and Trinick* (1983) claim that sodium ions form ion "clod" around filaments. They base hypothesis on selective bonding of chlorine ions to myofibrillar proteins. Dissolved myofibrillar proteins form sticky exudate on the surface of meat pieces which are subsequently connecting in this way during the heat treatment of the product. Matrix of proteins coagulated by heat tie in "trap" the free water. In emulsified meat products such as cooked sausages, dissolved proteins in form of continuous phase, represent the film around fat and water drops.

Salt has antimicrobial effects. Inhibitory effect of salt on bacteria is based on lowering of the activity of water. At a certain concentration of kitchen salt, water exits the cells through osmosis, and this can slow down or completely stop the microbial development/growth. Relatively high concentrations of salt are necessary to inhibit microorganisms. Limit concentrations of sodium chloride for microbial growth are: 5% for *Clostridium botulinum* type E and *Pseudomonas fluorescens*, 6% for *Shigelae* and *Klebsiellae*, 8% for *Escherichia coli*, *Salmonellae*, *Bacillus cereus*, *C. botulinum* type A and *C. perfringens*, 10% for *C. botulinum* type B and *Vibrio parahaemolyticus*, 15% for *Bacillus subtilis* and *Streptococcaceae*, 18% for *Staphylococcus aureus*, 25% for *Penicillium* and *Aspregillus* species and 26% for *Halobacterium halobium*, *Bacterium prodigiosum* and *Spirillium* species (*Prändl, 1988*).

Content of salt in meat products

Content of salt in meat products depends, primarily, on technologically justified amounts, and, of course, on the influence of salt on the saltiness. There are numerous studies on content of salt in different meat products (*Vranic et al*., 2009). The lowest salt content is in the cooked sausages and meat cans. In cooked sausages, content of salt ranges from 1.28 to 2.03 g/100 g, in average 1.66 g/100 g, whereas in meat cans it ranges from 1.35 to 1.84 g/100 g, in average 1.67 g/100 g. In smoked meat products the salt content is slightly higher and it ranges from 1.66 to 3.11 g/100 g, i.e. in average 2.19 g/100 g. In dry fermented sausages, technologically justified amount of salt is considerably higher and therefore 2.5–3.0% is added, since these products are not subject to heat treatment, and salt serves for maintaining of the microbiological stability of the products. Salt content in these sausages is 2.08–3.98 g/100 g, i.e. in average 2.61 g/100 g. The dry meat products have the highest salt content. Due to long production process, i.e. curing, these products are salted or cured using 5–10% of salt or curing salt, in order to reduce, by action of the salt, the water activity in order to prevent growth of undesirable microorganisms. Salt content in dry meat ranges from 3.78 to 7.35 g/100 g, in average 5.09 g/100 g.

Possibilities for reduction of salt in meat products

Present trends in nutrition to reduce the content of sodium in meat products, as reported by *Ruusunen and Puolanne* (2005) and *Desmond* (2006), can be achieved in the following way: (1) by reducing the amount of sodium chloride added (*Sofos*, 1983; *Lilić*, 2000); (2) by substituting part of NaCl with other salts (*Sofos*, 1983; *Terell*, 1983; *Guàrdia et al.,* 2006; *Lilić et al.*, 2008).; (3) by using flavour/aroma enhancers and masking agents (*Desmond*, 2006); (4) combination of mentioned procedures (*Sofos*, 1983; *Terell*, 1983); (5) adding of spice herbs and spice extracts to meat products (*Lilić and Matekalo-Sverak*, 2007; *Matekalo-Sverak et al.*, 2007); (6) optimisation of the physical form of salt (*Angus et al.*, 2005); and (7) alternative process techniques (*Claus and Sørheim*, 2006).

Potassium chloride is most common salt replacer, however, complete substitution of salt is not possible since, already in case of 50% substitution the bitter flavour is intensified and saltiness is reduced. Use of potassium salts has often been disputed because of potential sensitivity of one part of human population, such as persons suffering from diabetes type I, chronic renal insufficiency, last stage of kidney diseases, persons with heart and adrenal insufficiency (*FSAI*, 2005). US Dietary Guidelines (2005) indicate that diet rich in potassium weakens the effects of salt on blood pressure and daily potassium intake of 4.7 g is recommended.

Various diet salts as mixtures of sodium chloride and potassium chloride which improve the excretion of sodium from the organism are already on the market.

In cooked hams, sodium chloride can be substituted with potassium chloride and 50% without any effect on sensory properties (*Frye et al.*, 1986). In hams, the use of 70% of NaCl and 30% of KCl, i.e. 70% NaCl and 30% $MgCl_2$, has no effect on flavour, tenderness and overall impression compared to hams produced only using NaCl (*Collins*, 1997).

In fermented sausages (*Gou et al.*, 1996), researchers have established absence of any difference in texture in substitution, but bitter flavour can be sensed already when 30% of KCl has been added. They also report that substitution of 40% with KCl and potassium lactate in dry meat does not lead to undesirable flavour characteristics.

According to *Ruusunen and Puolanne* (2005), reduction of salt in fermented sausages is not possible below 2% due to inability to reach sufficiently low water activity which provides microbiological stability of these products.

Recent production processes are developed in a way that brine is injected into meat, and it contains KCl in combination with calcium citrate, calcium lactate, lactose, dextrose, potassium phosphate, ascorbic acid and sodium nitrite (*Riera et al.*, 1996).

Phosphates are also very successful in reduction of salt in products, although they act in synergy with sodium chloride. They increase the WHC by increasing the ion strenght when free groups of negative charge enable that proteins tie more water (*Trout and Schmidt*, 1984). However, phosphates are also sodium carriers. So, sodium polyphosphate contains 31.24% of sodium, compared to 39.34% in sodium chloride, however its use is limited to approx. 0.5% in the product.

Ruusunen et al. (2002) established that the production of Bologna sausage and cooked ham with less salt (1.0–1.4%) is possible and that reduction of sodium content can be achieved by using potassium salts. It can be claimed that the use of phosphates in relation to sodium chloride is in the equivalent of 0.2% NaCl.

There is another possibility to compensate for technologically desirable properties of NaCl, and that is the use of ingredients such as fibres, hydrocolloids and starches which enable forming of the gel and protein coagulates (*Collins*, 1997).

One of the possibilities for reduction of salt in meat products is the use of flavour enhancers and masking agents. There are many different commercial mixtures which usually contain yeast extracts, lactates, monosodium glutamate and nucleotides. Flavour enhancers activate the receptors in the mouth/oral cavity and they compensate for the reduction of salt in the product (*Brandsma*, 2006).

Certain authors (*Pasin et al.*, 1989) have established that it is possible to reduce NaCl to 75% in cooked sausages, by combining KCl, preparation containing ribotide (commercial mixture of 5'–ribonucleotides IMP and GMP). Any addition of monosodium glutaminate leads to drop in the acceptability of the flavour of the product even by 50% due to incidence of bitter flavour caused by potassium salts. Linguagen, company from USA has patented a blocker of the bitter flavour, adenosine 5'-monophosphate, which blocks the activation of the gustducine in flavour receptor cells and accordingly, prevents stimulation of the nerve which is responsible for taste receptors (*McGregor*, 2004). This blocker can be used to improve the flavour when combinations of KCl and NaCl are used.

There are several preparations on the market such as NeutralFres which removes the metallic, bitter flavour of KCl and gives the flavour similar to sodium salt, Magifique Salt-Away and Mimic, which mask the bitter and metallic character of KCl as well as SaltTrim.

Other combinations such as lysine and succinic acid are used as substitutes (*Turk*, 1993). These substances have salty flavour and some antimicrobial and antioxidative properties and can be used as salt substitutes up to 75%. In regard to technological properties, i.e. WHC, phosphates can be used, as well as starches and rubber.

Gou et al. (1996) studied the effect of glycine and potassium lactate as salt substituent and established that substitution of 40% of NaCl is possible using some of these compounds, which if used in larger amounts give unacceptably sweat flavour. In dry meat, substitution of up to 40% with potassium chloride and potassium lactate is possible without any significant difference in flavour, whereas 30% is maximum allowed amount if glycine is used as substituent.

There are also derivatives of mycoproteins (Mycoscent) which offer possibility to reduce the amount of sodium chloride by 50% in biscuits and snack foods and by 25% in hot, spicy dishes. Mycoscent 400 is natural source of ribonucleotide and glutamic acid, and it has flavour resembling broth and can be used to achieve the flavour of cooked meat in meat applications (*Mycoscent*, 2005). Yeast autolysates are also known to suppress the bitter flavour of KCl, such as Provesta preparations, Aromild and Maxaromeselect. A problem with autolysates is their distinct broth flavour, which is not desirable in some products, and some of them have typical original umami flavour. By using certain technological procedures it is achieved that these preparations are optimized for meat products with neutral flavour and optimal umami effect.

Level of saltiness depends also on physical form of salt. Salt flakes are proven to be functional in terms of binding, increasing pH, increasing protein solubility in emulsion model systems (*Campbell*, 1979). Salt flakes are better and faster soluble compared to granules, and this can be problem when in formulas no water is used, therefore flakes can be used for products where no water is added, for instance dry meat. Leatherhead Food International studied the optimization of the physical form of salt and monitored changes in the physical form of salt which is becoming more available and hence could be used in smaller amounts. This includes increase of its efficiency, change of the structure and modification of the perception of salt (*Angus et al*., 2005).

Alternative process techniques include use of prerigor meat in manufacturing of meat products or use of high pressure technology (*Claus and Sørheim*, 2006, *Dederer*, 2009).

Economical justification of the salt reduction

Several studies have shown that reduced slat intake in population is economically justified (*Asaria et al*., 2007). So, *Murray et al*. (2003) have shown that health interventions, including government actions to stimulate the reduction of salt content in food products were economically justified in sense of decrease of the incidence of cardiovascular diseases. One of the studies showed that reduced intake of salt to 6 g per day in Norwegian population had lead to drop in systolic blood pressure by 2 mm Hg and reduced cost by 4.7 million dollars annually (*Selmer et al*., 2000). Study carried out in Canada showed that reduction of salt intake to 4.6 g daily can save approximately 430 million dollars annually in treatment costs, visits to doctors and laboratory testing of the causes of hypertension (*Joffres et al*., 2007).

In their study, *Asaria et al*. (2007) have evaluated the effects and costs of the strategy to reduce the salt intake and tobacco control for 23 less developed and developing countries, and have proven that with the reduction of salt by 15% in the period 2006 to 2015, the death of 8.5 million people suffering from cardiovascular diseases could be prevented, and by reduction of smoking by 20% death of 3.1 million people. Moderate salt reduction could be achieved by reduction of salt content in food by producers, as well as through continuous media campaign. Cost of implementation of such programs of salt reduction is estimated at the amount of 0.09 dollars *per capita* annually. Cost of tobacco control including free measures and cost amount to 0.26 dollars *per capita* annually. These data clearly indicate that the reduction in salt intake is more or at least to the same extent economically justified compared to tobacco control in reduction of prevalence of cardio vascular diseases.

Role of food industry in salt reduction

Many countries have developed their own guidelines for the programs of salt intake reduction. In developed countries, approx. 80% of salt is added to food through different production stages.

Because of the importance of this topic, many producers initiate salt reduction programs in their production and starting with reformulation of their products. But there are many producers who are not supporters of these programs because of commercial reasons. If very salty food is consumed consistently, receptors become used to saltiness and demand for salty food increases. Salt is main determinant in sense of thrust and reduction in salt intake would definitely have impact on sale and consumption of refreshing non-alcoholic beverages and mineral water (*He et al*., 2008). However, some of the snacks producing companies in the world are also part of companies manufacturing such beverages; therefore it is understandable that they do not want to participate in programs for reduction of salt in food. World health organisation (WHO) initiated the reduction strategy through regional directorates. Eleven EU countries have agreed to and signed the program of salt content reduction of 16% in the next 4 years. Food industry in Serbia also can be included in this program and meat industry could have one of the main role in this reduction program, contributing to the human health.

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Redukcija soli u proizvodima od mesa – izazov za industriju mesa

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R e z i m e: Istorija soli stara je koliko i istorija ljudskog roda. Otkriće i upotreba soli učinili su hranu dostupnijom u dužem vremenskom periodu, nezavisno od sezone i omogućilo njen transport na veće udaljenosti. Tokom miliona godina, praistorijski čovek unosio je manje od 0,5 g soli dnevno. Ali danas, unos soli je veoma veliki. Usled negativnih efekata soli (natrijuma) po ljudsko zdravlje, moderni nutricionistički trend je da se smanji sadržaj soli u proizvedenoj hrani. Zbog toga što su proizvodi od mesa jedan od osnovnih izvora natrijuma, uloga industrije mesa u redukciji sadržaja soli kao doprinos ljudskom zdravlju, biće velika. Ali to nije tako jednostavan problem zato što so značajno doprinosi tehnološkim i senzorskim karakteristikama, kao i mikrobiološkoj stabilnosti proizvoda od mesa. Jedanaest zemalja Evropske Unije ušle su u program redukcije soli za 16% u naredne četiri godine. U cilju zaštite ljudskog zdravlja, veoma je važno da industrija hrane iz svake zemlje donese odluku da počne sa permanentnim smanjenjem sadržaja soli/natrijuma.

***Ključne reči**: so, natrijum, proizvodi od mesa.*

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