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SALT AND BREAD: LATVIA'S EXPERIENCE

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Much research has shown that reduction in salt intake can have a very positive impact on human health, as salt intake plays a critical role in regulating blood pressure. According to the World Health Organization, populations with low salt intake, all other factors being equal, usually have lower blood pressure level, in that way decreasing the risk of cardiovascular disease. The main source of salt in the diet is ready-made food, and only about 11% of overall salt intake is the salt people add to their food themselves. A common EU framework for salt reduction has been developed, which describes a common vision for a general European approach towards salt reduction. Bread has been identified as an important contributor to the daily salt intake in many countries. On the other hand, salt has important technological functions in bakery products. It improves the qualities of dough, fermentation, and flavour of bread. The aim of this paper was to evaluate the amount of salt in Latvian bread and to assess the need for decreasing the amount of salt in bread. The majority of Latvian bread contains 1.1 to 1.2% salt in flour, but in some other kinds of bread it is even less.

Key words: *salt, bread, sodium chloride.*

INTRODUCTION

Common salt or sodium chloride is a chemical compound NaCl. Salt is a natural mineral halite, which exists as deposits in many world countries, and is the compound of sea water and salt lakes (Kurlansky, 2003). Salt is a significant element in the diet not only for humans, but also for animals and many plants. Salt is one of the most effective and popular food preservatives. Sodium is a mineral, an inorganic compound, and it performs a biological function in the human organism. Ions of sodium are located mainly outside cells, maintaining the amount of water outside cells in balance. Salt takes part in maintaining the balance of liquids and transmitting nervous impulses, and it affects the contraction and relaxation of muscles (Baltess, 1998). Salt participates in regulating the amount of water in the human organism. A strong desire for salt may be related to a lack of minerals, particularly sodium chloride, in the organism. Ions of sodium and chloride act in the function of kidneys. Sodium "seizes" water and together with chloride "holds" water in tissues. Water is absorbed from intestines by means of NaCl. Salt is the central regulator of water exchange in this system. Ions of sodium and chloride are important components of digestive juices. Both ions maintain the tonus of tissues. The sodium-potassium exchange pump is required to maintain cell pressure (Denton, 1983).

The human organism contains approximately 70 g of Na, and its amount has to be regularly replenished in small quantities. We ingest the necessary amount of sodium in the form of salt. Salt is the main source of sodium in the diet and is used as a seasoning that nowadays is usually consumed too much. A too large intake of salt affects the human organism very negatively, as it burdens physiological functions. For example, excessive salt will need to be exceted via kidneys. Too large intake of salt increases the amount of salt in the organism, which promotes hypertension, increases the risk of heart diseases or cerebral thrombosis, as well as promotes kidney diseases (Lejins and Kalvelis, 2011). Studies have shown that individuals consume on average 10–15 g of salt daily, which is much more than the 5 g recommended by dietary doctors. Salt is added to food bought in almost all supermarkets, not only to canned food and sausages, but also to bread, spaghetti, cheese, and even yogurt. The content of salt is so high in food products that the amount injested in one day would suffice for many days. Consumption of products with a high content of salt can result in dropping/swollen eyelids. If salt is regularly consumed too much, more serious health problems might arise. Regarding salt, women have to be very careful during menopause, as its excessive consumption causes greater excretion of potassium into urine, which may make bones fragile to a dangerous extent. There is a view that excessive intake of sodium chloride can promote asthma, stomach ulcer, duodenal ulcer, and cancer (Großklaus *et al*., 2009).

The mechanism by means of which salt causes hypertension is not completely known, but doctors consider that the kid-

neys of patients suffering with hypertension are not able to excrete sodium as much as necessary. Blood pressure affects fluctuations of the Na level in blood plasma. With a decrease in the amount of Na in blood plasma, blood pressure also falls. Serum Na also determines the volume of extracellular fluid, which also affects blood pressure; yet, changes in blood pressure are determined by the sodium level, not changes in the volume (Valtnera, 1995).

Research has confirmed that nowadays salt is consumed through food too much, and that its consumption has to be reduced. A decrease of salt in the diet positively affects human health. It reduces blood pressure and improves the condition of heart and blood vessels. A decrease in the blood pressure of individuals, which is caused by a reduction in salt consumption, depends on age — in older individuals, blood pressure can decrease to a greater extent. Given the fact that older people more often have cerebral thrombosis and heart failure, they benefit more from a decrease in their blood pressure. Limiting salt in the diet of this group of people is of great importance (Lejins and Kalvelis, 2011).

Bread is one of the products that is consumed almost every day. To bake bread, the following raw materials are needed: flour, yeast, water, and salt. Salt is a very important seasoning in bread. Salt affects biochemical, colloidal, and microbiological processes in bread dough (Fig. 1). In water, salt splits into ions and a dissociated solution forms — sodium ions are positively charged, while chlorine ions are negatively charged. This affects the properties of gluten, i.e. gluten strengthens, the activity of ferments is hindered and the life processes of yeast are affected (Kunkulberga and Seglins, 2010). Salt obstructs the growth of undesired microorganisms and the structure of bread is more porous; it assists in keeping the shape of bread loaf and stabilises starch. The most significant property of salt is the improvement of taste, as bread without salt is tasteless and insipid.

Salt is added to dough in small quantities — from 1 to 2% of the total amount of flour. Without salt, dough is sticky and flabby, it rises fast during fermentation and does not maintain its form, and the bread is insipid and has a pale and hard crust. However, an excessive amount of salt — more than 2% relative to the weight of flour — delays fermentation processes or dough does not rise at all, it is wet and hard to processed, and the bread has an unpleasant salty taste.

According to the recommendations of the European Commission, the amount of salt in producing bakery products

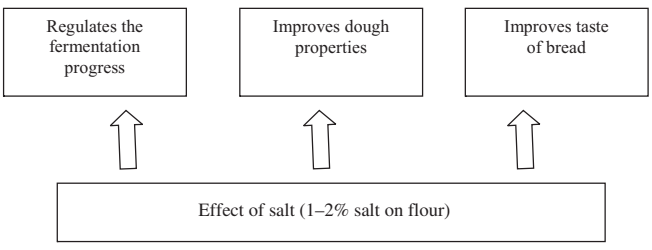

Fig.1. Technological role of salt in breadmaking.

should be reduced at least to 1.5%, and for some products to 1.8% per 100 g of flour. For instance, it is planned to reduce the amount of salt in dough from 2.2% to 1.8% per 100 g of flour in Ireland, Italy, Spain, and Great Britain during the coming years, while bread producers in Germany do not plan to take any special salt reduction measures (Galeone, 2009; Kleinert *et al*., 2009).

Scientists and practitioners of many countries have investigated the effects of salt on dough and bread baking processes. One disadvantage appears in dough with a low salt content if the dough is processed and formed at a higher temperature or during an extended period of fermentation. It is hard to precisely determine the critical amount of salt that negatively affects technological processes, as different equipment is exploited in industrial bread production. It is easier to adapt to the production of bread with a lower salt content in the sector of small and medium bakeries where dough is processed manually. According to Finnish specialists, it is necessary to convince bread producers to reduce the amount of salt in this sector, as processing dough with a low salt content may cause problems to industrial bread producers (Salovaara, 1982a; Salovaara *et al*., 1982).

A governmental system for proposals for voluntary salt consumption reduction has been introduced in the European Union, which is supported by action plans, to meet the recommendations of the member states and the World Health Organisation. The approaches of the EU member states need to be adapted to all socio-economic societal groups for salt consumption reduction in foods of all price groups. Also, the international aspect of changing salt content in food products and the role that might be played by the existing forums of interested individuals, for instance, the EU Action Platform on Diet, Physical Activity and Health, have to be considered. A significant role is played by food marking that provides visible, clear, and easy-to-understand information to consumers, thus enabling them to choose products with a lower salt content. The working group has decided to use the term “salt”, instead of “sodium”, as salt is the basic substance targeted by the mentioned recommendation, the term “salt” is easier to understand, and it is the main way of how to add sodium to food (Großklaus *et al*., 2009).

Given the statistical data on diseases of heart and blood vessels, the EU Council’s working group on food products has decided to appeal for reducing salt consumption in the EU member states. It is known that excessive salt consumption is the main contributor to hypertension, which, in its turn, causes diseases of heart and blood vessels. These diseases cause 42% of all deaths in Europe, and the treatment of these diseases costs EUR 192 billion. The European Food Safety Agency stated that the majority of Europeans consume 8–11 grams of salt a day, which is much more than the recommended amount. The largest part of salt or up to 75% of its daily portion is consumed by people through ready-made food. Mainly people of industrially developed countries consume approximately 80% of salt through products to which salt has been added during their industrial

production. Natural products contain a small amount of sodium and its salts, and some salt is added by us ourselves when we cook food or add it during eating our meals. According to studies, in natural products the amount of salt accounts for approximately 12% of the total intake of salt a day, ready-made food produced industrially and food from public caterers provides 77%, while salt that is knowingly added by us accounts for only 11% (of which approximately 5% is additionally added to meals and 6% is added during cooking home meals) (Johnston, 2009).

The member states are requested to actively implement their salt consumption reduction programmes. These may include, for example, activities to inform the public and to encourage the food industry to reduce the amount of salt in food and ready-made meals as much as possible. The European Commission permanently supports the efforts of the member states regarding these issues. Together with the member states, the European Commission regularly identifies the lowest salt contents reached in various food categories in the European Union. Such a survey allows to determine the extent to which salt content can be reduced in products that are the main sources of salt in daily diets. The EU stresses the need for controlling the activities related to changes in the content of products, for informing the public on the consumption of salt by individuals to enable them to regularly analyse and review their actions, and for familiarising the general public with the corresponding findings. The EU appeals to the member countries for strengthening their coordinated and sustainable national nutrition policy as well as for elaborating a policy if one has not been yet introduced, which also includes salt consumption reduction programmes aimed at reducing intake to an appropriate level (Galeone, 2009).

Given the fact that the European Commission has established a high-level working group on diets and physical activities, one of the objectives of which is to reduce the salt content in food products, member states have to analyse their national statistics on salt consumption and the present amounts of salt in food. The research data show that bread is one of the key sources of salt in the diet of individuals; therefore, a salt consumption reduction plan has been elaborated in many countries, which envisages a 16% reduction in salt consumption over a period of four years. According to the European Commission recommendations, the member states have to make discussions with their food producers and local federations of food enterprises and hold activities for informing the public on the salt content in food and its reduction; therefore, it is important to ascertain the knowledge of consumers on salt consumption and their salt consumption behaviour.

No salt reduction programme has been elaborated in Latvia, and studies are needed to identify the salt content in bread baked in Latvia. No detailed information is available on the amounts of salt added to bread during its production process. Therefore, the aim of the present paper was to determine the salt content in bread produced in Latvia, to identify the possibilities for reducing the salt content, and to analyse the intake of salt through bread by Latvia's consumers.

MATERIALS AND METHODS

The study analyzes two types of bread, one — baked in the laboratory with different salt contents, other — industrially produced bread. Wheat bread with various salt content was experimentally baked at the Bread Technological Laboratory of the Faculty of Food Technology, Latvia University of Agriculture (LLU). The basic recipes for bread are presented in Table 1. The amounts of salt relative to the weight of flour were selected as follows: 0.5%, 1%, 1.5%, and 2% as well as no salt at all. The dough production technology and the baking of bread complied with the guidelines for experimental baking.

The dough was prepared in a dough mixer *Varimixer bear AR10 2.* The time of dough mixing: 2 minutes at Speed 1 and 4 minutes at Speed 2. After mixing the dough, it was fermented for 10 minutes, then it was divided and into pieces of 220 g, the pieces were shaped and fermented in a post-fermentation camera for 45 minutes at a temperature of 36 ^{o}C and a relative humidity of 75%. The bread was baked in a convection oven Sveba Dahlen S8, steam was supplied for 9 seconds, and the duration of baking was 18 minutes at a temperature of 200 ^{o}C. After a period of 24 hours, the bread was tested for its organoleptic indicators, and the salt content was identified according to a chloride determination method by titrating it with mercury (II) nitrate.

The bread moisture content was determined according to ISO 6496:1999 method.

The salt content of some samples was determined at the Food and Environmental Test Laboratory of company BIOR Ltd according to the GOST 5698_51 method. At the Scientific Laboratory of Agronomic Research of LLU, the sodium content was determined by Atomic Absorption Spectrophotometry AACC Method 40-71.

In the present study, 103 wheat bread, rye bread, seed bread and toast samples produced in various Latvian bakeries, with different package labels, as well as information on the contents of salt and sodium available on the labels were analysed.

Table 1

WHEAT BREAD FORMULA WITHOUT SALT

Raw materials	Amount, kg
Wheat flour, Type 550	0.500
Yeast	0.015
Sugar	0.010
Water	0.300
Dough total	0.825

Standard deviations and errors were calculated for the data by using the Microsoft Office package, Microsoft Excel (XLS), and SPSS.

RESULTS

To verify the effect of salt on the quality of bread and to determine the content of salt in the bread samples having a known amount of salt added to the dough, wheat bread was experimentally baked. The samples of bread were tested for organoleptic, physical, and chemical indicators. The acidity of the bread samples titrated ranged within a pH range of 1.8–2.0 and the moisture was 36–38%, which corresponded to usual parameters of wheat bread. The dough prepared without salt was sticky and flabby and rose fast, and the bread was pale with a hard crust and tasteless and insipid. Salt content affected colour of the crust by becoming darker. According to the scientific literature, salt not only regulates the fermentation process, but it also improves the properties of proteins, which enhances the porosity and elasticity of the soft part of bread, the size of bread and what is the most important — its taste (Salovaara, 1982b).

Most often, salt is added to dough at an amount from 1.2 to 2% relative to the weight of flour. It is important to consumers to know the percentage of salt per 100 g of bread as well as the weight of sodium, in mg, per 100 g of bread; therefore, an experiment was carried out to calculate correlation between the salt content, as percentage of the weight of flour, and the salt content as percentage in bread. The salt content in the bread samples was determined by the titration method, and the results obtained are presented in Table 2. A linear correlation existed between the percentage of salt content in bread and salt content calculated in flour (r = 0.9984). The regression equation derived from the results (Fig. 2) was:

Table 2

SALT AND SODIUM (%) IN BREAD SAMPLES

Bread sample	NaCl of flour, %	NaCl in bread, %
1.	0	0.1 ± 0.03
2.	0.5	0.48 ± 0.04
3.	1	0.74 ± 0.02
4.	1.5	1.08 ± 0.02
5.	2.0	1.36 ± 0.04

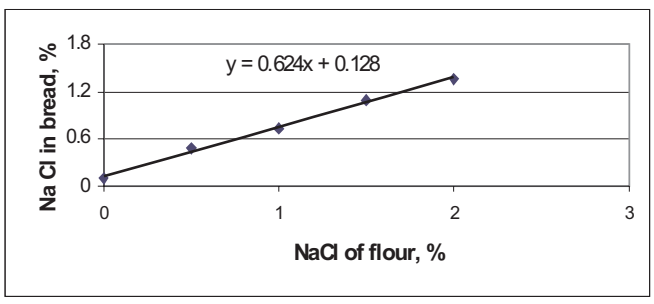

Fig. 2. Linear regression between the percentage of salt content in bread and in flour.

NaCl % in bread = NaCl % relative to the weight of flour x 0.6 + 0.1.

However, this equation is precise only for bread baked according to the given recipes and the mentioned technological parameters of baking bread at the given output of dough; therefore, in relation to other kinds of bread, this equation can produce approximate values. Even if the same recipes are used, but the duration or temperature of baking is changed, the loss of bread weight is greater and the result is not precise; in this case, a correction has to be made. By using such equations, it is possible to easily and quickly calculate a salt content in bread if the amount of salt added to dough relative to the weight of flour is known.

Analysis of the information on the package labels of 103 bread samples regarding contents of salt and sodium in various kinds of bread showed that the salt contents in wheat, rye, seed, and toaster breads do not differ significantly, and per 100 g of bread, and according to package labels, varied from 1.1 to 1.2%. The content of sodium is within the range from 0.4 to 0.5% per 100 g of bread.

According to the present study, Latvian bread producers show correct information on package labels, in accordance with Cabinet Regulation No. 964 of 23 November 2004 "Regulations regarding the Marking of Food Products". Although showing the energy and nutritional values on any package label of food products is mandatory only if a special note on the energy or nutritional value or the impact on health has to be made, it has to be noted that bread producers provide such information in 99% cases. On package labels, more and more often information is provided on the recommended daily portion of nutrients present in a product, as no occurs in 60.4% cases. One can conclude that bread producers understand that salt is a significant mineral, and they try to inform consumers about salt content in a product. It has to be noted that such information is not available on the package labels of other products, such as cheese, sausage, and salty meat snacks.

Six ryc bread samples (R1–R6) were tested for salt content at the Food and Environmental Test Laboratory of BIOR Ltd and at the Scientific Laboratory of Agronomic Research of LLU, which confirmed that the salt amount shown on the package label provided sufficiently precise information on its content (Table 3).

Table 3

SALT AND SODIUM CONTENT OF BREAD, %

Bread sample designation	Indicated on packaging, %		Salt content, %	Na content, %	Salt content by calculation from the Na, %
	Salt	Na			
R1	0.9	0.3	0.9 ± 0.1	0.31 ± 0.02	0.78
R2	1.2	0.48	0.9 ± 0.1	0.37 ± 0.01	0.94
R3	1.0	0.4	-	0.34 ± 0.03	0.86
R4	2	-	1.2 ± 0.1	0.43 ± 0.04	1.09
R5	1.0	0.4	-	0.37 ± 0.02	0.94
R6	-	0.8	-	0.41 ± 0.01	1.04

The daily intake of salt through bread at a daily bread consumption of 100, 200, and 300 g is shown in Table 4. On average, 1 slice of "Live-Seed Bread" produced by Fazer Bakeries Ltd weighs 15 g, meaning that 100 g of the bread corresponds to approximately 6.5 slices of bread, and 1 slice of "Latvian Rye Bread" weighs on average 35 g, thus 100 g of the bread comprises three slices. On average, 1 slice of "Special Rye Bread" from Liepkalni Ltd weighs 40 g, thus 100 g of this bread comprises about two slices. If an adult consumes on average 250 g of bread a day, the salt content of which is 1.2%, the salt intake is 3 g, which accounts for 50% of the recommended daily salt portion. Yet, if bread contains only 0.9% salt, the daily intake of salt is 2.25 g by consuming the same amount of bread, which accounts for 26.6% of the recommended daily salt portion. If bread contains 1.6% salt, the salt intake is 4 g by consuming 250 g of bread, which accounts for 80% of the recommended daily salt portion.

DISCUSSION

Salt plays a very important role in the human organism. It takes part in regulating the amount of water and in kidney function; Na and Cl as ions are the main electrolytes of blood. People are not able to live without salt, whereas an excessive intake of salt negatively affects their health.

Adding salt to products is partially determined by technological needs, but salt is mainly used for improving the taste of products. Therefore, there is a real possibility to reduce the amount of salt in products added during their production. This can also apply to bread production. In Latvia, it is important to conduct studies on the lowest possible salt content in food products, which would include information on consumption of food products and would allow to elaborate legal acts regarding an optimal use of salt in food production, including bread baking.

The majority of bread producers show the content of both salt and sodium in bread on the package label. Some producers showed salt content (R4) relative to the weight of flour on their package label, which provides imprecise information and misinforms consumers, as the salt content in bread is lower. In accordance with European Council Regulation No. 1924/2006 (20 December 2006) regarding information on nutritional values and health that has to be shown on package labels of food products, the amounts of components have to be shown for the final product.

Every day people eat different food products, including bread, and every product contains some salt. Bread is a valuable food product, yet, according to statistical data, the consumption of bread declined in Latvia from 70 to 48 kg per capita in the period 2004–2009. This trend may be explained not only by the economic situation, but also by a change in food consumption behaviour (Noort *et al*., 2010).

Many dietary specialists recommend increasing the consumption of bread up to 250 g a day, including the World Health Organisation. On average 27% of dietary fibres are provided by consuming the recommended amount of wheat bread, while rye bread provides 54%.

In most cases, Latvian bread producers add salt to dough at an amount of 1.2–2% relative to the weight of flour. Yet it is important to consumers to know the percentage of salt in 100 g or in 1 slice of bread as well as the amount of sodium in mg in 100 g or in 1 slice of bread. The result of research shows that correlation between salt content as a percentage relative to the weight of flour and the salt content as a percentage in bread was r = 0.9984.

In 99% cases, bread producers provide information on the special energy value of bread, showing the contents of salt and sodium in bread on their package labels, and 60.4% of bread producers provide information on their package labels about the recommended daily portion of nutrients present in their product.

If an adult consumes on average 250 g of bread a day, the salt content of which is 1.2%, the salt intake is 3 g, which accounts for 50% of the recommended daily salt portion. Yet, if bread contains only 0.9% salt, the daily intake of salt is 2.25 g by consuming the same amount of bread, which accounts for 26.6% of the recommended daily salt portion.

Analysis of the salt amounts in bread baked in Latvia indicates that it was in the range of 0.8–1.2%, which did not exceed the amount (1.0–1.2%) recommended by the European Commission. Given the fact that nowadays food is oversaturated with salt, it is necessary to regularly hold informative campaigns for the public and discussions with food producers about reduction of salt content in food.

Table 4

INTAKE OF SALT THROUGH BREAD CONSUMPTION, g

Type of bread and salt content, %	100 g bread	200 g bread	300 g bread
Live-Seed Bread 0,9%	0.9	1.8	2.7
Latvian Rye Bread 1,2%	1.2	2.4	3.6
Special Rye Bread 1,6%	1.6	3.2	4.8

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SĀLS UN MAIZE: LATVIJAS PIEREDZE

Pēc Eiropas Komisijas ieteikumiem, dalībvalstīm ir jāanalizē nacionālie dati par sāls patēriņu un pašreizējo sāls daudzumu pārtikā. Maize ir viens no galvenajiem uztura produktiem Eiropā, un ar to tiek uzņemta 20–25% no ikdienas sāls devas. Cilvēka organismam sāls ir nepieciešams, jo tas veic svarīgas bioloģiskas funkcijas, savukārt pārmērīga tā lietošana ir riska faktors dažāda veida slimībām — hipertensijai, nieru slimībām. Pētījumā ar dažādām metodēm maizes paraugos noteikts sāls un nātrija saturs un secināts, ka Latvijā ražotā kviešu, rudzu, sēklu un tostermaize pēc sāls satura būtiski neatšķiras un tas ir robežās no 1,1 līdz 1,2%. Veikta maizes iepakojuma informācijas analīze un aprēķini par uzņemto sāls saturu, apēdot noteiktu maizes daudzumu. Šāds aprēķins ļauj novērtēt uzņemto sāls daudzumu pēc patērētā maizes apjoma, ko noderīgi zināt katram patērētājam. Pēc iedzīvotāju domām, Latvijā ražotajai maizei nav nepieciešams samazināt sāls daudzumu, arī pēc iepakojumā norādītās informācijas un veiktajiem pētījumiem sāls saturs maizē ir ieteicamās normas (1,0–1,2%) robežās. Tomēr jāatzīmē, ka nepieciešams plašāk organizēt sabiedrības un pārtikas produktu ražotāju informēšanas pasākumus par sāls saturu un tā samazināšanas nepieciešamību pārtikas produktos.