



HELLENIC REPUBLIC  
MINISTRY OF RURAL  
DEVELOPMENT & FOOD



# **EVALUATION OF SALT CONTENT OF CRAFT BREADS IN GREECE: IMPLICATIONS FOR PUBLIC HEALTH NUTRITION**



**Nutrition Policy and Research Directorate  
Hellenic Food Authority**

**Athens, November 2016**

**AUTHORS** (in alphabetical order)

**Boukouvalas Georgios, Marakis Georgios, Tsigarida Eirini**

**This project was carried out in accordance with the Decision of the Management Board of the Hellenic Food Authority no: 207/22-03-2012 and the Memorandum of Collaboration (ΑΠ 6169/05-04-2012) between the Hellenic Food Authority and the General Chemical State Laboratory of Greece.**

### **Acknowledgments**

Special thanks to the inspectors of the Hellenic Food Authority for collecting the samples and to the chemists of the General State Chemical Laboratory (particularly Dr Ioannis Gardikis) for carrying out the chemical analyses of sodium in bread samples. The authors would also like to thank Dr Duncan Campbell for his assistance with the methodology regarding the analytical procedure and Prof Panagiotis Skandamis and Dr Marios Mataragas from the Agricultural University of Athens for carrying out the statistical analyses.

## CONTENTS

SUMMARY .....	4
1. Introduction .....	5
2. Materials and Methods .....	5
<i>2.1 Sampling</i> .....	5
<i>2.2 Analytical method for the determination of sodium concentration in bread</i> .....	6
<i>2.3 Questionnaire for bakers regarding bread preparation method</i> .....	7
<i>2.4 Statistics</i> .....	7
3. Results and Discussion .....	7
<i>3.1. Implications for public health and actions</i> .....	11
4. Conclusions .....	11
5. References .....	12

## **SUMMARY**

Bread has been the leading focus in most salt reduction strategies worldwide. The sodium content of 220 craft bread samples in Greece was determined by flame photometry. Basic information about bread preparation method, as declared by the bakers, was also recorded. The average salt content was 1.32g/100g of bread as sold (range: 0.13g-2.22g/100g). "White" bread contained more salt compared to "brown" bread (i.e. bread made with flour having a higher amount of bran) (1.37 vs. 1.25g/100g respectively,  $p < 0.005$ ). Moreover, the types of flour used, as well as the use of baker's yeast vs. starter dough were associated with significant differences in salt concentration. 68.2% of the samples exceed the voluntary targets of max salt content of 1.2% in bread as sold. These data can provide useful baseline data for monitoring and evaluating the progress and success of the actions regarding the decreased use of salt in bread making.

## **1. Introduction**

The necessity to reduce population salt intake to improve public health, is beyond any dispute, on account of the overwhelming body of evidence showing that high salt intake is related to hypertension and greater risk of cardiovascular diseases (ABURTO et al., 2013; POGGIO et al., 2015). Reducing population salt intake to WHO guidelines (WHO, 2012) is therefore expected to result in substantial cost savings (NGHIEM et al., 2016). Salt, on the other hand, is used extensively in food processing, mainly for microbiological, technological as well as sensory reasons. In developed countries, the majority of salt in the diet comes from the consumption of processed foods (BROWN et al., 2009). While the contribution of various foods to total dietary intake may differ in individual countries, bread, cereals and bakery products appear to be the most important sources of salt in most national diets in the EU, contributing to around 20% or more of the total salt intake (EC, 2012).

Despite the lack of published data from national dietary surveys in Greece, there is evidence from studies both in children (MAGRIPLIS et al., 2011) and in adults (PSALTOPOULOU et al., 2004) of the importance of bread contribution to total dietary salt intake in Greece. Hence, bread is regarded as a good starting point in the Greek salt reduction strategy. Yet, published quantitative data on Na content of craft breads, albeit essential, are lacking. Wheat craft breads containing varying amounts of durum wheat flour are popular in Greece, since durum accounts for 80% of the wheat produced in Greece (SABANIS & TZIA, 2007). Unwrapped craft breads, as opposed to prepackaged breads produced by plant bakeries, constitute 95.5% of the Greek market share of bread (AIBI, 2015). The aim of this study was to evaluate the range of salt content and investigate potential factors contributing to differences in salt content of unwrapped craft bread in Greece.

## **2. Materials and Methods**

### *2.1 Sampling*

Two hundred and twenty samples of unwrapped bread loaves were collected from craft bakeries in Attica (110 samples) and Epirus (110 samples)

prefectures in Greece. Bread sampling was random and was based on data owned by Hellenic Statistical Authority (EL.STAT.) regarding the consumption patterns of craft bread. Two thirds of the samples were "white" and the rest were "brown" bread. "White" bread includes those made with refined wheat flour as well as refined durum wheat flour which give a yellow-rustic colour to bread. Breads made with whole-wheat flour or mixtures of whole-wheat and refined wheat or other types of cereal flours (such as rye flour) are referred to as "brown" bread. Sampling begun in May 2012 and was completed in November 2012.

All samples were collected fresh, at room temperature, within 12 hours of supply by the bakeries. All samples were sealed in plastic bags in order to preserve the loaves' moisture and stored in a refrigerator at 4°C until analyzed. Analyses of samples were carried out in two accredited laboratories of the General Chemical State Laboratory (GCSL) of Greece, using exactly the same methodology and the same Food Analysis Performance Assessment Scheme (FAPAS) test material.

### *2.2 Analytical method for the determination of sodium concentration in bread*

Prior to this study, analyses were carried out to confirm that craft bread loaves are homogenous with regard to their salt distribution. In this study, two slices of 2-3mm thickness were cut from different parts of each loaf and were used for Na content determination. The slices were weighed by using an analytical balance with a precision of 0.1mg (Precisa 205A) immediately after cut, dried at 60°C for 8 hours in an oven (Mettler UNE400) reaching a fixed weight and allowed to cool down to room temperature using a desiccator. The slices were weighed again and the percentage of their moisture content was calculated in order to convert the Na concentration measured in the dried samples to concentration in the bread as sold. The dried slices were triturated and homogenized using a household grinder. A quantity of 0.15-0.20g from the homogenized samples was weighed in 20mL glass vials with 0.1 mg accuracy and 3mL of ultra clean nitric acid (Fisher Chemicals TraceMetal Grade, 67-69% HNO<sub>3</sub>) was added. The procedure was performed in duplicate

for each sample. The vials were left overnight at a temperature of 40-50°C, until full digestion of the bread matrix was achieved. Sodium concentration in the solution was determined by flame photometry (Flame photometer Jenway PFP7) and converted to Na concentration in the sample as sold (CASTANHEIRA et al., 2009). FAPAS test material 1864 was used as a quality control sample with each batch of samples analyzed.

### *2.3 Questionnaire for bakers regarding bread preparation method*

For each loaf, self-reported data were collected from bakers regarding: a) the name of bread as sold, b) the types of flour used and their ratio, c) the use of either dry yeast or starter dough and d) the addition of other ingredients such as raising agents, sugar, fats/oils.

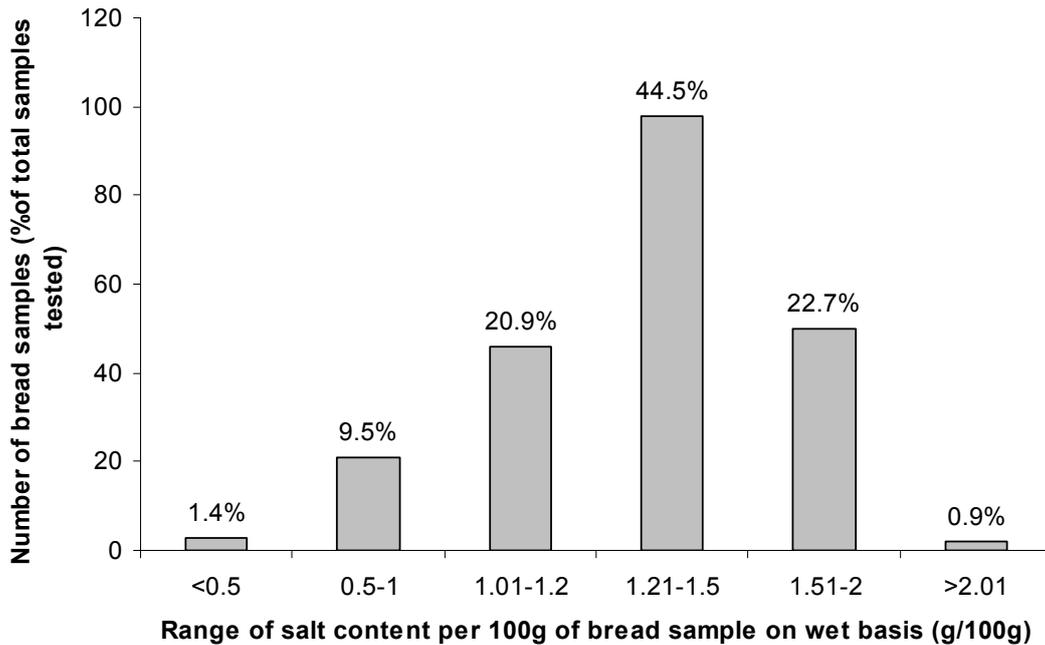
### *2.4 Statistics*

The descriptive statistics were computed using Excel 2003. Based on the research question different statistical techniques were used. ANCOVA was used to test the differences in salt content between “white” and “brown” bread, between different more descriptive bread categories and between the samples taken from different regions. The differences in salt content which could be attributed to the addition of sugar, fat or improving agents, were analysed using multiple regression analyses. Point-biserial correlation was employed to investigate the differences in salt content between those samples containing only wheat flour and those containing varying amounts of other than wheat, flours. All statistical analyses were carried out with SPSS (version 15.1, Chicago, USA).  $p$ -values lower than 0.05 were considered as significant.

## **3. Results and Discussion**

Bread has no intrinsic Na content; its salt load is entirely due to the salt added during preparation for sensory reasons, control of yeast growth and fermentation rate, improvement of product texture and reduction of spoilage (BELZ et al., 2012). The average salt content of bread in our study was 1.32g

per 100g of bread, ranging from 0.13g/100g to 2.22g/100g of bread (Figure 1.). Significant variability in the salt content of bread has been observed in other studies too (e.g. CASTANHEIRA et al., 2009; ABU HUSSAIN et al., 2016). Generally, wider ranges of salt concentration are observed for craft types of bread, as opposed to those produced in plant bakeries.



**Figure 1.** Number (and percentage) of samples within specific salt content ranges.

Due to the great variability in the types of flour used for bread making, bread classification was complex. In addition, the names of the unwrapped baked bread loaves on the bakery shelves were not always indicative of their composition. Thus, according to the information collected from the bakers on the types of flour used, the samples were initially classified into eight specific categories. Table 1 shows the proposed bread categories, the number of samples within each category as well as their mean salt content.

It was observed that moisture as a covariate has a significant influence on the salt content of every bread category ( $p=0.022$ ). Based on a covariate bread moisture content of 28.72%, statistically significant differences in salt content were observed between different bread categories ( $p=0.003$ ). In

general, breads containing durum wheat (more traditional ones) had higher salt content compared to the other types of bread. Durum wheat flour, due to its weak gluten network formation during bread making (SABANIS & TZIA, 2007), may require more salt which is known to promote the development of gluten-structures in the mixing of dough (CAUVAIN, 2007).

Bread samples were grouped into two broader categories: "White bread" which included categories 1-3 (Table 1) and "brown bread" which included the rest of the categories. "White bread" ( $n=140$ ) contained statistically significant more salt compared to "brown" bread ( $n=80$ ) ( $1.37\pm 0.02\text{g}$  and  $1.25\pm 0.04\text{g}$  respectively;  $p=0.005$ ). This difference was independent of the moisture content of bread samples ( $p=0.273$ ). Analyses were based on a covariate moisture content of 28.72%.

**Table 1.** Salt content (g/100g) of bread types according to flour used

	<b>Bread types</b>	<b>N</b>	<b>Mean salt content g/100g (<math>\pm</math>SEM)</b>	<b>Moisture (Mean<math>\pm</math>SEM)</b>
1	White bread (without Durum wheat flour) <sup>1</sup>	61	1.30 $\pm$ 0.04	26.8 $\pm$ 0.04
2	White - rustic bread (with 1-50% Durum wheat flour) <sup>1</sup>	19	1.41 $\pm$ 0.07	29.0 $\pm$ 0.05
3	White - rustic bread (with 51-100% Durum wheat flour) <sup>1</sup>	60	1.40 $\pm$ 0.04	29.9 $\pm$ 0.05
4	Whole-wheat bread <sup>2</sup>	33	1.23 $\pm$ 0.05	29.4 $\pm$ 0.06
5	Mixed whole-wheat bread <sup>3</sup>	24	1.35 $\pm$ 0.06	29.9 $\pm$ 0.08
6	Rye bread <sup>4</sup>	10	1.35 $\pm$ 0.09	29.9 $\pm$ 0.08
7	Mixed rye bread <sup>5</sup>	10	1.12 $\pm$ 0.09	28.2 $\pm$ 0.10
8	Multi-cereal bread	3	0.92 $\pm$ 0.17	23.8 $\pm$ 0.17

<sup>1</sup> each of the categories 1-3 may contain max 10% of other types of flour such as corn flour, whole-wheat flour or rye flour

<sup>2</sup> made using at least 70% non-refined whole-grain wheat flour. Up to 29% can be other types of flour such as white flour or flour representing 85% of the whole wheat (excluding rye flour)

<sup>3</sup> made using 20-69% non-refined whole-grain wheat flour (the endosperm, bran and germ is ground to make whole-wheat flour). The rest can be other types of wheat flour such as white flour or flour representing 85% of the whole wheat (excluding rye flour)

<sup>4</sup> made with a mixture of "rye flour" and "wheat flour" and has at least 51% rye flour

<sup>5</sup> made with a mixture of "rye flour" and "wheat flour" and has between 10-50% rye flour. The rest can be a mixture of refined and un-refined wheat flour

Generally, whole-wheat, rye or multi-cereal breads have more intense flavour which could accommodate better the more “yeasty” or “sour” flavour that may result from the addition of less salt (LYNCH et al., 2009).

In addition, bread samples were classified as to whether they were made from 100% wheat flour or from a mixture of wheat and any other type of grain flour. Bread made from 100% wheat flour ( $n=187$ ) had statistically significant more salt compared to bread made from a mixture of grain flours ( $n=33$ ) ( $1.35\pm 0.02\text{g}$  and  $1.17\pm 0.06\text{g}$  respectively,  $p=0.0008$ ). This difference in salt content was independent of the use of improving agents in bread making. Substitutions of wheat flour with other types of flours (e.g. corn flour) may lead to differentiated rheological properties of the dough, possibly due to the fact that other types of flour such as corn flour act as strengthening filler in the gluten network (NAVICKIS, 1987; SABANIS & TZIA, 2007). Taken into account that salt can enhance cross-linkages of wheat flour proteins leading to increased net gluten content (TOYOSAKI & SAKANE, 2013), substitution of wheat flour with other types of flour may result in less salt requirements.

Table 2 shows the mean salt content of bread samples with or without the addition of sugar and/or fat.

**Table 2.** Salt content of bread (g/100g) with or without added sugar and/or fat (with or without improving agents)

<b>Self-reported (by bakers) use of additional ingredients</b>	<b>N</b>	<b>Mean salt content g/100g (<math>\pm</math> SEM)</b>
Without addition of sugar or fat	128	$1.33\pm 0.03$
Addition of sugar	32	$1.37\pm 0.04$
Addition of fat	17	$1.24\pm 0.10$
Addition of both sugar and fat	43	$1.33\pm 0.04$

Statistical analyses in all bread categories showed that the addition of sugar or fat did not appear to be a significant factor for the amount of salt

added. However, bread loaves made with starter dough had less salt compared to those made with yeast ( $1.20\pm 0.98\text{g}$  and  $1.34\pm 0.27\text{g}$  respectively,  $p=0.029$ ). Starter dough has a more complex microbiological makeup than baker's yeast (*Saccharomyces cerevisiae*) and includes other micro-organisms such as lactic acid bacteria (DE VUYST et al., 2002). As a consequence, starter dough, due to the presence of these bacteria, could improve dough properties and bread texture, improve flavour, retard the staling process and protect bread from mould and bacterial spoilage (CORSETTI et al., 1998), thus leading to less salt requirement.

### *3.1. Implications for public health and actions*

According to AIBI Bread Market Report 2013 (AIBI, 2015), the average daily consumption of craft bread in Greece is approximately 178g per person. Hence, depending on the type of craft bread consumed, the daily intake of salt from bread alone can vary from 0.23g/day to 3.95g/day per person. This represents approximately 4.6% to 79% of the 5g of salt recommended for adults by WHO.

In March 2016, a memorandum of understanding was signed between the Hellenic Food Authority and the Hellenic Federation of Bakers for voluntary reduction of salt in all types of bread. The target for bakeries is to reduce salt in all types of bread to a max level of 1.2% in the product as sold. The fact that about 3 out of 10 bread samples have already less than 1.2% salt demonstrates that salt reduction does not appear to be a major technical issue related to bread manufacture. It confirms previous findings that salt reduction is feasible in terms of both technology as well as sensory acceptance (QUILEZ & SALAS-SALVADO, 2012), and without adversely affecting sales (QUILEZ & SALAS-SALVADO, 2016).

## **4. Conclusions**

A wide range of salt content in bread was observed in this study. The great variability in bread making recipes indicates potential challenges in salt reduction and highlights the importance of accelerating and intensifying

efforts towards reducing salt in all types of bread by all bakers. The outcome of this project provides baseline information for monitoring the progress and evaluating the success of any efforts made by the bakery sector regarding salt reduction. These types of data can be used by different countries for comparison purposes, since bread is a staple food in many nations worldwide.

## 5. References

- ABU HUSSAIN, F.M. & TAKRURI H.R.(2016): A study of salt content of different bread types marketed in Amman. *Jordan J. Agric. Sci.*, *8*, 169-178.
- ABURTO, N.J., ZIOLKOVSKA, A., HOOPER, L., ELLIOTT, P., CAPPUCCIO F.P. & MEERPOHL, J.J. (2013): Effect of lower sodium intake on health: systematic review and meta-analyses. *BMJ*. *346*: f1326.
- AIBI Bread Market Report 2013. (2015): Available at: <http://www.aibi.eu/wp-content/uploads/draft-AIBI-Bread-Market-report-2013.pdf>. (last accessed 15 June 2016)
- BELZ, M.C., RYAN, L.A. & ARENDT, E.K. (2012): The impact of salt reduction in bread: a review. *Crit. Rev. Food Sci. Nutr.*, *52*, 514-524.
- BROWN, I.J., TZOULAKI, I., CANDEIAS, V. & ELLIOTT, P. (2009): Salt intakes around the world: implications for public health. *Int. J. Epidemiol.*, *38*, 791–813.
- CASTANHEIRA, I., FIGUEIREDO, C., ANDRE, C., COELHO, I., SILVA, A.T., SANTIAGO, S., FONTES, T., MOTA C. & CALHAU M.A. (2009): Sampling of bread for added sodium as determined by flame photometry. *Food Chem.*, *113*, 621-628.
- CAUVAIN, S.P. (2007): Reduced salt in bread and other baked products. In: Kilcast D and Agnus F (Eds.) *Reducing salt in foods*, Woodhead Publishing Ltd. Cambridge, UK. pp. 283-295.
- CORSETTI, A., GOBBETTI, M., BALESTRIERI, F., PAOLETTI, F., RUSSI, L.& ROSSI, J. (1998): Sourdough lactic acid bacterial effects on bread firmness and staling. *J. Food Sci.*, *63*, 347-351.

- DE VUYST, L., SCHRIJVERS, V., PARAMITHIOTIS, S., HOSTE, B., VANCANNEYT, M., SWINGS, J., KALANTZOPOULOS, G., TSAKALIDOU, E. & MESSENS, W. (2002): The biodiversity of lactic acid bacteria in Greek traditional wheat sourdoughs is reflected in both composition and metabolite formation. *Appl. Environ. Microb.*, *68*, 6059-6069.
- EUROPEAN COMMISSION (2012): Implementation of the EU Salt Reduction Framework - Results of Member States survey. Available at: [http://ec.europa.eu/health/nutrition\\_physical\\_activity/docs/salt\\_report\\_en.pdf](http://ec.europa.eu/health/nutrition_physical_activity/docs/salt_report_en.pdf). (last accessed 15 June 2016)
- LYNCH, E.J., DAL BELLO, F., SHEEHAN, E.M., CASHMAN, K.D. & ARENDT, E.K. (2009): Fundamental studies on the reduction of salt on dough and bread characteristics. *Food Res. Int.*, *42*, 885-891.
- MAGRIPLIS, E., FARAJIAN, P., POUNIS, G.D., RISVAS, G., PANAGIOTAKOS, D.B. & ZAMPELAS A. (2011): High sodium intake of children through 'hidden' food sources and its association with the Mediterranean diet: the GRECO study. *J. Hypertens.*, *29*, 1069-1076.
- NAVICKIS, L.L. (1987): Corn flour addition to wheat flour doughs - Effect on rheological properties. *Cereal Chem.*, *64*, 307-310.
- NGHIEM, N, BLAKELY, T., COBIAC, L.J., CLEGHORN, C.L. & WILSON, N. (2016): The health gains and cost savings of dietary salt reduction interventions, with equity and age distributional aspects. *BMC Public Health.*, *16*, 423. doi: 10.1186/s12889-016-3102-1.
- POGGIO, R., GUTIERREZ, L., MATTA M.G., ELORRIAGA N., IRAZOLA, V. & RUBINSTEIN, A. (2015): Daily sodium consumption and CVD mortality in the general population: systematic review and meta-analysis of prospective studies. *Public Health Nutr.*, *18*, 695–704.
- PSALTOPOULOU, T., NASKA, A., ORFANOS, P., TRICHOPOULOS, D., MOUNTOKALAKIS, T. & TRICHOPOULOU, A. (2004): Olive oil, the Mediterranean diet, and arterial blood pressure: the Greek European Prospective Investigation

- into Cancer and Nutrition (EPIC) study. *Am. J. Clin. Nutr.*, *80*, 1012-1018.
- QUILEZ, J. & SALAS-SALVADO, J. (2012): Salt in bread in Europe: potential benefits of reduction. *Nutr. Rev.*, *70*, 666-678.
- QUILEZ, J. & SALAS-SALVADO, J. (2016): The feasibility and acceptability of reducing salt in partially baked bread: a Spanish case study. *Public Health Nutr.*, *19*, 983-987.
- SABANIS, D. & TZIA, C. (2007): Effect of Rice, Corn and Soy Flour Addition on Characteristics of Bread Produced from Different Wheat Cultivars. *Food Bioprocess Tech.*, *2*, 68-79.
- TOYOSAKI, T. & SAKANE, Y. (2013): Effects of Salt on Wheat Flour Dough Fermentation. *Adv. J. Food Sci. Technol.*, *5*, 84-89.
- WORLD HEALTH ORGANIZATION. (2012): Guideline: Sodium intake for adults and children. Geneva: World Health Organization.