

UDC 614 (479.25)

DOI:10.54503/0514-7484-2024-64.3-112

Iodized Salt Use in Bread Baking and Iodine Intake through Bread Commonly Consumed in Armenia

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Keywords: processed foods (PF), bread, salt; iodine, standard, universal salt iodization (USI), coverage, regulatory monitoring, Iodine Global Network (IGN).

Introduction

There is growing international recognition that most of the total salt intake comes from processed foods (PF)¹; therefore, such commercially manufactured foods with iodized salt in their recipes are the main source of dietary iodine among consumers [3-6, 12, 14, 16, 17, 23, 25-27]. Given this evidence, the use of iodized salt in food processing should be an important part of regulatory monitoring of a country USI² programme implementation [9, 14, 22, 23].

Bread is staple food in many parts of the world: it is considered to be the foodstuff that provides the most dietary salt [1, 7, 8, 10, 18, 20]. Using the example of 15 countries from different parts of Europe, it is shown that the residents of the region consume on average 59 kg of bread per year (that is 162 g/day) [11]. The daily consumption of bread is quite high in Turkey – 285

¹ The term 'processed foods' refers to large-scale commercially produced and manufactured foods including bread, instant noodles, bouillon cubes and other salty condiments.

² The concept of universal salt iodization (USI) entails the iodization of all food-grade salt (i.e. salt used in both households and during food processing) [27].

g/day, followed by Bulgaria and Ukraine with figures of 260 and 244 g/day, respectively. Relatively little bread is consumed in the United Kingdom, Spain, Slovenia, Finland and Denmark – 88, 101, 115, 115, 125 g/day. In many European countries, bread provides the highest proportion of salt compared to other PFs – 20-25% [7, 8, 20, 24]. Of the total salt consumption by the population, bread accounts for: in Ireland – 25.9%; Turkey – 25.5%; Belgium – 24.8%; France - 24.2% and Spain -19.1% [20]. Bread is also the leading source of salt in the diet in countries such as New Zealand (26%) and Australia (≈20%) [8]. Among the other processed foods, use of iodized salt in bread baking has long been considered the most feasible delivery strategy for iodine [12].

About 61% of edible salt consumed in Armenia comes from processed foods. Bread is the basic component of the diet and a key source of dietary salt. In 2017, the consumption of bread was at the level of **295 g/day** [21], exceeding significantly the consumption levels of this product in most European countries and almost identical to this indicator (about 300 g/day) in the countries of the East Mediterranean region [1]. The average per capita salt intake from bread was estimated at 3.75 g/day, comprising 38.3% of salt obtained from PFs and discretionary household salt [4]. Furthermore, as a major source of iodine in the diet, bread provided approximately 40% of the recommended daily intake (RDI) of iodine, being equal to the share of iodine provided through consumption of household iodized salt. Overall, about 3/4 of daily iodine intake was attributed to iodized household salt and bread containing iodized salt [3] considering average iodine content in salt of 40 mg/kg.

While the WHO recommends to conduct national iodine surveys every 3-5 years, the high cost and complicated logistics of such surveys are significant barriers to their implementation. Recognizing the need for less complex and costly data collection approaches, the IGN developed an on-going programme monitoring and surveillance methodology (called USI FORTIMAS), using sentinel site³ data collection, that could allow for reliable analysis and interpretation of data on coverage of iodized salt and iodine nutrition status among target population groups at a much lower cost, than “statistically representative” cross-sectional surveys [18, 19]. IGN recommended piloting the FORTIMAS methodology adapted to tracking “effective coverage” of iodized salt in Armenia.

The primary objective of piloting the overall FORTIMAS is to assess the feasibility and acceptability of the IGN new “USI FORTIMAS” methodology for monitoring the national iodization programme, using sentinel site data collection approach. This part of the overall study is designed to assess the

³ “Sentinel site” refers to a community - a large town or a district, within a defined region, where population level data on household coverage of dietary iodized salt & urinary iodine could be collected to feasibly confirm sustained high coverage of quality dietary iodized salt & adequate population iodine status in the area over time.

coverage of iodized salt in bakeries and measure iodine intake through bread commonly consumed in Armenia.

Material and Methods

Selection of sentinel sites for the overall study. Population level data on iodine status and iodized salt coverage were collected within 7 sentinel sites: 3 districts within the capital of Yerevan (Nor-Nork, Erebuni, Malatia-Sebastia) and 4 marzes (provinces) across the country. The sites were selected on the premise that adequate iodine status (measured by mUIC level) among the population of the sentinel territories will reflect the iodine status of the people in other regions of the country with a similar high coverage of iodized salt, assuming a relatively homogeneous market distribution of iodized salt among the communities of the marz.

Salt collection in sentinel bakeries. Two typical⁴ bakeries producing “ordinary” (European style) bread and lavash (Armenian flat bread) were selected at each of the 7 sentinel sites (14 bakeries in total) located in the catchment area of the selected secondary schools. One sample of food-grade salt was collected from each of 14 bakeries and transported to the designated Laboratory Services Center (LSC) of the FSIB for subsequent iodine analysis, using a validated quantitative assessment tool - iodometric titration (GOST R 51575).

Salt content in bread. Salt content in bread (finished product) was calculated from the baker’s recipe (BR) dividing salt concentration in dough to commonly applied index 1.25 [1, 20]. Based on the average concentration of salt in bread, the average daily intake of salt from the product is calculated using the percent product weight as salt multiplied by the estimated average daily consumption of the product.

Using information on daily per capita consumption of bread, salt content in bread (in per cents) and iodine content of iodized salt, the average daily iodine intake from iodized salt used in bread baking was estimated.

Results and Discussion

According to data from National Statistics Agency (ARMSTAT), in 2022 people in Armenia consumed a total of 8,09 kg bread per month or **266 g per day** [21]. The consumption of two categories of bread: **I**) a large group of “ordinary” breads, including popular premium wheat breads (>80%), such as “matnakash”, “naan”, white or brown loafs, baguettes, etc. and **II**) lavash (Armenian flat bread) amounted to 6.99 and 1.10 kg/month, respectively. The

⁴ “Typical” refers to bakeries where most of the families within the catchment area of each sentinel school purchase bread and bread products (relatively large ones).

ratio of consumption of these two main categories of bread (86,4% and 13,6%) is obtained in order to calculate the weighted average of iodized salt consumption from “average” bread (daily salt intake) taking into account the expected difference in the amounts of salt mixed with the flour (in dough).

Data presented in Table 1 show that salt content in ordinary wheat breads and traditional flat bread “lavash” is 1.37 and 1.57 g per 100 g of the product, respectively.

Table 1
Average salt levels in bread calculated from “baker’s recipe”, 24-27 November 2023

Bread category	Consumption, kg/month	% of the total	Samples, n	Salt content, Mean \pm SD, g/100 g	95% CI	CV, %
I. Ordinary bread	6.99	86,4%	10	1.37 \pm 0.18	1.25 \div 1.49	8,97%
II. Lavash	1.10	13,6%	10	1.57 \pm 0.27	1.39 \div 1.75	16.9%
Abbreviations: CI – confidence interval, CV – coefficient of variation, SD – standard deviation						

The weighted average for salt content in bread is: $(1.37 \times 86.4\% + 1.57 \times 13.6\%) \div 100\% = \mathbf{1.397 \text{ g/100 g}}$ (approx. 1.4%); this integral figure is close to the average value of salt content in ordinary breads, since the share of ordinary breads in the total consumption of bread products is much larger. In our earlier study of 2019-2021 [3, 4], the results from computational and experimental analyses were approximated as $1.45 + 1.33 = 2.78 \div 2 = 1.39 \text{ g/100 g}$. Thus, our current estimate confirms almost the same value of dietary salt content in 100 g of “averaged” bread.

Based on daily consumption of bread in Armenia (266 g/day) and the average concentration of salt in bread ($\approx 1.4\%$), the average daily salt intake from bread is calculated: $0.014 \times 266 = 3.72 \text{ g}$ of salt, which makes **up to**⁵ 37.2% of the total average daily consumption of salt by the population of the country.

The results of the measurement of iodine content in salt samples collected in 14 bakeries of the selected seven sentinel sites are presented in the below Table 2. These data demonstrate a rather high coverage of bakeries of quality iodized salt: only one out of 14 sentinel bakeries has been using non-iodized

⁵ Approximation “**up to**” is used, as 39.6 is the percentage from the lowest daily salt intake derived from the STEPS Survey of 2016 [2], which found a mean salt intake at **9.8 g/day** among 18-69 aged people. In a parallel study [15], sodium content was measured in urine of reproductive age women: UNaC/UCr ratios approximated an average sodium intake of 5.5 g/day, equivalent to a salt intake of **13.9 g/day**. Our **dietary assessment** of the contribution of PFs to salt intake of 2020 [3] yielded an average intake of **10.6 g** salt from household salt and key salt-containing foods. Finally, the Global Fortification Data Exchange [13] provides an estimate of salt intake for the country at **12.5 g/capita/day**.

salt; the other 13 have been baking breads using adequately iodized salt with iodine content within the range of the national standard (25 - 55 mg/kg)⁶. Mean and median of iodine content in salt sampled in the 13 sentinel bakeries were **38.0 ± 6.86** and **37.0** mg/kg, respectively (the salt sample “6b” without iodine was excluded from this calculation). The 95% CI 33.82 ÷ 42.18 show the range of likely values of the parameter; the coefficient of variation CV – 18.1% is intermediate.

Table 2

Iodine levels in salt used for bread baking in sentinel bakeries

Sentinel site (administrative territory – district or marz)	Code of sentinel school	Code of Sentinel bakery	Bakery salt iodine content, mg/kg
1. Yerevan, community Nor Nork	1.	1a.	39.1
		1b.	37.0
2. Yerevan, community Erebuni	2.	2a.	31.7
		2b.	31.7
3. Yerevan, community Malatia-Sebastia	3.	3a.	43.3
		3b.	37.0
4. Armavir marz, city of Echmiadzin	4.	4a.	29.6
		4b.	45.4
5. Kotayk marz, city of Abovyan	5.	5a.	34.9
		5b.	34.9
6. Shirak marz, city of Gyumri	6.	6a.	43.3
		6b.	0 (No iodine)
7. Ararat marz, city of Ararat	7.	7a.	32.7
		7b.	53.9

Mean 38.0 ± 6.86; Median - 37.0 mg/kg

Earlier [3], we provided an estimate of relative contribution of household salt and salt-containing processed foods (including bread products) to population iodine intake. Then, the study was based on interviews of artisan bakers for collecting information on the extent to which iodized salt was used in bread baking. It was also assumed, that the iodized salt was at the average level of the national salt iodine standard, i.e. 40 mg/kg. In this study, the iodized salt coverage of sentinel bakeries is assessed through direct personal sampling of salt used in common bread baking facilities, and the iodine content in salt from bakeries is defined through direct measurement of iodine in the FSIB laboratory.

All available information and data, including results of measurement of iodine content in iodized salt from sentinel bakeries, are consolidated in the

⁶ High proportion (>81%) of iodized salt used for production of bread commonly consumed in Armenia was revealed in a small sample-size survey in 2018, through interviewing a small group (n=34) of artisan bakers [3, 6].

table 3 and the average daily iodine intake from salt in the staple of the country diets is estimated. In addition, the percent of the daily Recommended Nutrient Intake (RNI) for iodine in adult (non-pregnant) population, being currently met by the use of iodized salt in bread baking, is calculated.

Table 3
Average daily iodine intake (mcg) from salt in bread products and percentage daily RNI iodine from iodized salt from estimated per capita consumption of bread products

Daily per capita bread consumption (g)	Salt content, (% product weight)	Daily salt intake from the product (g)	Percent of total salt used in the product that is iodized	Current iodine intake (mcg) from daily intake of the product* (g)	Percent of RNI for iodine in adult population, i.e. 150 mcg/day
266	1.4	3.72	92.8	91.83	61,22

* **based on % iodized salt for bread baking with 30% iodine loss** (when mean 38 mg/kg iodine in salt is reduced by 30%, we get 26.6 mg/kg, which is multiplied by 3.72 g daily salt intake; the resulting value of 98.95 is multiplied by 92.8%, resulting current iodine intake (mcg) from daily intake of the product at 91.83 which constitutes 61,22% of iodine RNI).

To summarize, the results of this study confirm that bread products commonly consumed in Armenia remain the major source of food-grade salt in diets of the population of the country. Being adequately iodized (at normal levels) and used by the most typical bakeries countrywide (by 13 out of 14 sentinel bakeries, i.e. > 90%), quality iodized salt used in bread recipes continues to provide rather large share of RNI (61,2%), which is almost identical to the value of the same indicator (66,4%) from the “National Assessment of the actual or potential contribution of industrially processed food salt to population iodine intake, 2020” [3]. Our findings can be used along with other indicators of USI FORTIMAS, such as “Expected coverage of the population with quality iodized salt supplies”, “Household coverage of iodized salt”, “Median urinary iodine concentration (mUIC) in the pregnant women population” and “Thyroid stimulating hormone (TSH) in neonates” to assess the feasibility and acceptability of the IGN new methodology for monitoring of the national iodization programme. Regulatory monitoring can be reoriented to concentrate focus on major source of iodine, such as iodized salt in bread recipe, to ensure effectiveness of the national salt iodization program.

Accepted 27.05.24

Использование йодированной соли в хлебопечении и потребление йода с обычным хлебом в Армении

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Исследование проводилось в рамках международного проекта Глобальной сети по йоду по оценке осуществимости и приемлемости новой методологии «USI FORTIMAS» для мониторинга программы йодирования соли с применением метода сбора данных на дозорных участках. В настоящей публикации представлены данные по охвату дозорных пекарен йодированной солью с определением уровней потребления йода с наиболее широко используемыми в Армении сортами хлеба.

Установлено, что широко потребляемые в Армении хлебные изделия являются основным источником соли в рационе питания населения страны. При этом, адекватно йодированная соль (38 мг йода/кг соли), используемая 13 из 14 дозорных пекарен, обеспечивает довольно большую долю рекомендованной нормы потребления (РНП) йода – 61,2% от суточной потребности. Этот результат практически совпадает с аналогичным показателем (66,4%), выявленным в 2020 году при оценке фактического или потенциального вклада йодированной соли, используемой в производстве промышленно-обработанных пищевых продуктов, в потребление йода населением Армении. Представленные данные будут использованы вместе с другими показателями, такими как «Ожидаемый охват населения качественной йодированной солью», «Охват домохозяйств йодированной солью» и др. при определении возможности использования методологии «USI FORTIMAS» для мониторинга национальной программы йодирования соли. Нормативный мониторинг необходимо переориентировать, сосредоточив внимание на основных источниках йода, таких как йодированная соль в рецептах хлеба.

Յոդացված աղի օգտագործումը հացաթխման մեջ և յոդի սպառումը սովորական հացի միջոցով Հայաստանում

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Ուսումնասիրությունն իրականացվել է Յոդի գլոբալ ցանցի միջազգային նախագծի շրջանակներում, որը նպատակ ունի գնահատելու USI FORTIMAS նոր մեթոդաբանության իրագործելիությունը աղի յոդացման ծրագրի մոնիթորինգի համար՝ օգտագործելով դետքային կետերում տվյալների հավաքագրման մոտեցումը: Այս հրապարակման մեջ ներկայացված են յոդացված աղով դետքային փոերի ընդգրկվածությունը, և միաժամանակ գնահատվել է Հայաստանում առավել հաճախ օգտագործվող հացատեսակների միջոցով յոդի սպառման մակարդակը:

Հաստատվել է, որ Հայաստանում լայն սպառում ունեցող հացամթերքը շարունակում է մնալ երկրի բնակչության սննդակարգում կերակրի աղի հիմնական աղբյուրը: Ըստ այդմ, պատշաճ յոդացված աղը (38 մգ/կգ), որն

օգտագործվում է առավել տիպիկ փոքրիկ կողմից (14 դետքային փոքրիկ 13-ը), ապահովում է յոդի RNI-ի բավականին մեծ բաժինը (61,2%): Վերջինս գրեթե նույնական է 2020 թվականին «Բնակչության կողմից սպառվող յոդի քանակում պատրաստի սննդամթերքի արտադրության մեջ օգտագործվող աղի ներդրման որոշմանը» նվիրված հետազոտության ընթացքում արձանագրված նույն ցուցանիշի արժեքին (66,4%) USI FORTIMAS-ի մյուս ցուցանիշների հետ միասին, այս աշխատանքի արդյունքները կօգտագործվեն աղի յոդացման ազգային ծրագրի շրջանակներում՝ IGN նոր մեթոդաբանության կիրառման իրագործելիությունը որոշելու համար:

Առաջարկվում է մոնիթորինգի համակարգը վերակողմնորոշել, որպեսզի ծրագրի կանոնակարգման աշխատանքները կենտրոնանան յոդի հիմնական աղբյուրների վրա, ինչպիսին է հացի բաղադրատոմսերում կիրառվող յոդացված աղը:

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