



**“NUTRIBUN” – AN IODINE-FORTIFIED FUNCTIONAL BUN FOR
CHILDREN: SCIENTIFIC RATIONALE**

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Abstract: This article examines the scientific rationale for developing “NutriBun”, an iodine-fortified functional bun intended for children aged 3–10 years. We reviewed epidemiological studies on iodine deficiency disorders in Uzbekistan, physiological iodine requirements, and international experience in fortifying bakery products. The evidence indicates that universal salt iodization has markedly reduced endemic goitre, yet iodine deficiency persists among children in some regions, supporting the use of a complementary daily food vehicle. We describe the production scheme, the principles for calculating the iodine dose while accounting for baking losses (15–20%), safety limits, and preliminary economic indicators. The work is theoretical and design-oriented: the final recipe, iodine



retention, and sensory properties must be confirmed at the subsequent laboratory stage.

Keywords: *iodine; iodine deficiency; functional food; bread fortification; child nutrition; Uzbekistan.*

1. Introduction

Iodine is a trace element required by the body in very small amounts, but it cannot be replaced by any other substance. It is a component of thyroid hormones, which regulate cellular metabolism, children's physical growth, and the development of the central nervous system [5, 9]. The consequences of iodine deficiency are not limited to goitre, or enlargement of the thyroid gland. According to UNICEF, when iodine requirements are not met, children's physical and cognitive development may be impaired [16].

For many years, Uzbekistan was among the areas with a high prevalence of iodine deficiency. Studies conducted in 1998 and 2004 reported endemic goitre prevalence among children of 64.5% and 51.6%, respectively [1]. In May 2007, the Law "On the Prevention of Iodine Deficiency Disorders" was adopted [17]. Salt producers were equipped with iodization systems, and iodine levels in urine and salt began to be monitored regularly [1]. These measures produced positive results, but recent studies indicate that the problem has not been fully resolved: in 2025, iodine deficiency was identified in 57.2% of urine samples collected from children aged 4–6 and 11–15 years in Karakalpakstan [3].

Why bread? Salt iodization is the most widely used approach worldwide, but it has one limitation: the amount of iodine a child receives depends heavily on the quality of the household salt and the quantity consumed. At the same time, the World Health Organization (WHO) recommends keeping salt intake below 5 g per day for adults and children [15], meaning that increasing salt consumption is not an appropriate way to increase iodine intake. Therefore, other foods in the daily diet—particularly bread—are being considered as complementary vehicles for iodine. Since 2009, the use of iodized salt in breadmaking has been mandatory in Australia,



and recent studies have reported improved iodine status among school-aged children [10, 11].

In addition, the growing share of packaged snacks, rusks, and sugar-rich confectionery in children's diets conflicts with healthy-eating principles and may reduce the nutritional quality of their diets [18]. In this context, developing a micronutrient-fortified product designed for children and easily incorporated into everyday meals has become a relevant objective.

The aim of this study is to systematize the scientific, technological, safety, and economic rationale for developing "NutriBun", an iodine-fortified bun for children aged 3–10 years. Four objectives were established: (1) to assess iodine deficiency among children in Uzbekistan using available epidemiological data; (2) to identify physiological iodine requirements and safe intake limits; (3) to examine international experience in iodine fortification of bakery products and the technological stability of iodine; and (4) to calculate the production scheme, iodine dose, and preliminary economic efficiency of the product.

The scientific novelty of this work lies in combining physiological iodine requirements for children, baking losses, safety limits, and economic calculations into a single framework adapted to local production conditions. Its practical significance is that the calculations provide a foundation for laboratory testing and a subsequent pilot phase.

2. Literature Review

Iodine requirements and safety limits

According to recommendations from WHO, UNICEF, and ICCIDD, the daily iodine requirement is 90 μg for children aged 0–5 years, 120 μg for those aged 6–12 years, and 150 μg for people over 12 years of age [5]. The recommended values used in the United States are grouped somewhat differently: 90 μg for ages 1–8 and 120 μg for ages 9–13 [7, 8]. The tolerable upper intake levels (ULs) are 200 μg for ages 1–3, 300 μg for ages 4–8, and 600 μg for ages 9–13 [7, 8]. The difference between the recommended intake and the upper limit is relatively small in young



children—approximately 2.2–3.3 times—so iodine should not be added according to the principle that “more is better.” Population iodine status is generally assessed using the median urinary iodine concentration; among school-aged children, a range of 100–199 $\mu\text{g/L}$ indicates adequate intake [6, 9].

Iodine deficiency in Uzbekistan

Local studies show positive changes over time. A survey in Khorezm Region reported that endemic goitre prevalence had fallen to 38.7% by 2012, while the proportions of samples with adequate iodine levels in salt and urine were 75% and 60.6%, respectively. Nevertheless, the authors emphasized that iodine deficiency remained a serious issue [1]. In a survey of 19,212 schoolchildren aged 6–15 years across six regions (Namangan, Syrdarya, Jizzakh, Surkhandarya, Andijan, and Karakalpakstan), endemic goitre was identified in 47.63%. Adequate household consumption of iodized salt was reported for 52.0% of the children; intake was insufficient for 42.0%, and salt was not iodized at all in 6.0% of households [4]. A 2025 study in Karakalpakstan found diffuse goitre in 19.4% of children, while historical data showed that severe iodine deficiency had declined from 94.5% to 4.4% between 1998 and 2014 [3]. A 2026 literature review by specialists from the Endocrinology Centre also emphasized that the existence of a salt-iodization programme does not, by itself, always guarantee adequate iodine status [2].

It should be noted that these studies were conducted in different regions, among different age groups, and using different methods; therefore, their figures cannot be directly compared. The overall picture, however, is clear: the situation has improved substantially compared with the 1990s, but iodine deficiency among children remains a relevant concern.

Experience with iodine fortification through bread

In Australia, Tasmania became the first jurisdiction to introduce the voluntary use of iodized salt in breadmaking in 2001. In October 2009, the use of iodized salt became mandatory nationwide for yeast-leavened bread, with organic bread exempted [10]. Subsequent studies showed improved iodine status among school-



aged children, and iodine intake among children in Victoria was assessed as adequate [11]. An analysis of Australia's national nutrition survey found that children consuming at least 100 g of bread made with iodized salt per day were significantly more likely to have adequate iodine intake (OR 12.34). However, the confidence interval was very wide (1.71–89.26), so this figure should be interpreted cautiously [12].

Technological stability of iodine

Some iodine is lost during baking. Pasha and colleagues studied bread fortified with iodized salt and potassium iodide and found that 15–20% of the iodine was lost in the finished product, meaning that most of it was retained [13]. A technical review by New Zealand's Ministry for Primary Industries emphasizes the importance of the chemical form of the iodine source: iodate is a strong oxidizing agent, while ascorbic acid converts iodate into iodide. Studies using iodized salt found no significant effects on dough preparation or bread quality, although the amount of iodine lost varies according to the iodine form and the processing system [14]. Thus, iodine losses must be measured separately for each recipe.

In summary, the sources reviewed indicate that iodine-fortified bread can be an effective vehicle. However, systematic justification remains limited for a bun specifically intended for children, with a defined serving size and adapted to local conditions. This article aims to address that gap.

3. Research Methods

The work was carried out in three stages. First, open scientific sources on iodine deficiency, physiological iodine requirements, and the fortification of bakery products were reviewed, including documents from international organizations, scientific journals, and publications by specialists from the Y.H. Turakulov Endocrinology Centre. Second, the product's production scheme and quality-control points were systematized on the basis of project documents, and the iodine dose was calculated using a mass-balance approach:

$$D = M / (1 - k)$$



where D is the amount of iodine added to the dough ($\mu\text{g/serving}$), M is the target amount in the finished product ($\mu\text{g/serving}$), and k is the proportion lost during baking and storage.

Third, using the project assumptions (production cost of UZS 3,000 per bun and selling price of UZS 5,000), costs, revenue, and gross profit were calculated for production volumes ranging from 1,000 to 500,000 buns. No experimental measurements were conducted at this stage; therefore, the calculated values in the article are based on assumptions and require confirmation through laboratory testing.

4. Main Section: Results and Discussion

Production scheme and control points

“NutriBun” is intended to be produced at specialized facilities that meet sanitary and hygienic, food-safety, and technological requirements. The process consists of the following stages:

1. Receipt of raw materials and incoming inspection.
2. Weighing ingredients according to the recipe (the iodine source is added at this stage).
3. Dough mixing.
4. Shaping.
5. Baking.
6. Cooling.
7. Packaging.
8. Quality control of the finished product (microbiological, physicochemical, and sensory characteristics).

In our view, the most sensitive point is ensuring an even distribution of iodine throughout the dough. Because each serving contains only tens of micrograms of iodine, it may be preferable to add it as a premix first blended with flour rather than adding it directly. This is a technological proposal that must be tested. Other important control points include baking temperature and duration, as well as storage conditions (temperature, humidity, and packaging type), since these may affect



iodine retention. Iodine content can be determined using the spectrophotometric approach applied in [13] or a standardized titrimetric method; the final choice should be agreed upon with an accredited laboratory.

Calculation of the iodine dose

We propose a target iodine content of 40 μg per serving of “NutriBun”. This would provide approximately 44% of the recommended daily intake for children aged 1–8 years (90 μg) and 33% for those aged 9–13 years (120 μg). In other words, the product would not meet the entire daily requirement on its own, but would complement other dietary sources, such as iodized salt, milk, and seafood. This is intentional: excessive iodine, like iodine deficiency, can disrupt thyroid function [9].

Table 1. Contribution of one serving (40 μg iodine) by age group and safety margin

Age group	Recommended daily intake (μg)	Tolerable upper intake level (UL, μg)	One serving (% of daily intake)
1–3 years	90	200	≈ 44
4–8 years	90	300	≈ 44
9–13 years	120	600	≈ 33

Source: Authors’ calculations based on [7, 8].

Because iodine is lost during baking, more iodine must be added to the dough than the target amount in the finished product. Applying the formula above and accounting for the 15–20% loss reported in [13]—with a conservative allowance of up to 25%—gives the following values:

Table 2. Amount of iodine to be added to the dough according to estimated losses (target: 40 μg /serving)

Estimated loss (%)	Iodine in dough (μg /serving)
15	≈ 47
20	50
25	≈ 53



Source: Authors' calculations using $D = M / (1 - k)$.

If, for example, a serving weighs 80 g, then 40 µg of iodine corresponds to 50 µg per 100 g of finished product. This is only an example: the serving weight will be determined during recipe development, and two sizes may be considered to reflect the needs of a 3-year-old child versus a 10-year-old child.

Safety considerations

Given that the upper intake level for the youngest consumers is 200 µg (ages 1–3), iodine from two servings per day (80 µg) would still leave a margin for iodine from other sources. Nevertheless, it is advisable to limit daily consumption to 1–2 servings and provide clear instructions to parents on the package. Adding iodine through a separate premix rather than through salt has another advantage: it does not increase the salt content of the bread and is consistent with WHO recommendations to limit salt intake [15]. Children with thyroid disorders may have altered sensitivity to iodine; therefore, consultation with a physician is recommended before introducing the product into their diet. In addition, the iodine content and chemical form must comply with applicable technical regulations and food standards, and every production batch must undergo laboratory quality control.

Preliminary economic efficiency

According to the project assumptions, the production cost of one bun is UZS 3,000 and the selling price is UZS 5,000, giving a gross profit of UZS 2,000 per bun. This corresponds to a gross margin of 40% of revenue and a markup of 66.7% relative to cost. Estimates for different production volumes are shown below:

Table 3. Estimated costs, revenue, and gross profit by production volume (UZS)

Volume (units)	Production cost	Sales revenue	Gross profit
1,000	3,000,000	5,000,000	2,000,000
10,000	30,000,000	50,000,000	20,000,000
50,000	150,000,000	250,000,000	100,000,000
100,000	300,000,000	500,000,000	200,000,000



500,000	1,500,000,000	2,500,000,000	1,000,000,000
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Source: Authors' calculations based on project data [18].

These figures should be treated cautiously. The profit shown in the table is gross profit and excludes taxes, marketing, logistics, rent, and other fixed costs. In addition, prices for supplying schools and kindergartens may depend on public procurement conditions. Therefore, actual economic efficiency should be recalculated in a business plan using real costs.

Implementation and monitoring

The main target consumers are families with children aged 3–10 who pay attention to healthy nutrition, as well as preschool institutions, general education schools, and children's health facilities. Potential sales channels include school and kindergarten catering systems and wholesale sales under direct contracts with institutions. A phased introduction in educational institutions is advisable: first a small pilot, followed by expansion.

A controlled pilot study could be planned to assess the product's effect on children's iodine status. Urinary iodine concentration would be measured at the beginning and end, and the results compared with the WHO criterion (100–199 $\mu\text{g/L}$) [6]. Such a study would require approval from an ethics committee and written consent from parents. Future directions may include adapting the recipe and serving size to different age groups, expanding the product range, establishing production in other regions, and exploring opportunities to enter Central Asian markets.

Study limitations

The main limitation is that “NutriBun” is currently a project rather than a finished, tested product. Actual iodine losses, shelf life, sensory characteristics, and acceptance by children have not yet been measured. Some literature data were obtained in other countries using different types of bread and different technologies, so they cannot be transferred directly. The economic assessment was limited to gross profit.

5. Conclusions



The analysis indicates that, although the salt-iodization programme has made an important positive contribution to iodine-deficiency prevention in Uzbekistan, problems with iodine adequacy persist among children in some regions. In this context, food products with a controlled iodine content that can be easily incorporated into the daily diet may be considered a complementary approach to existing preventive measures.

For the “NutriBun” functional bun, a target of 40 µg of iodine per serving was considered theoretically appropriate. Allowing for a possible 15–20% iodine loss during baking, approximately 47–50 µg of iodine would need to be added to the dough. This amount represents around 33–44% of the recommended daily iodine requirement for different age groups and would allow the product to serve as an additional source of iodine.

At the same time, the calculations presented are theoretical. Actual iodine retention depends on the recipe, the chemical form of the iodine compound, and baking and storage conditions. The proposed dose and technological approaches therefore need to be tested experimentally under laboratory conditions.

Overall, the “NutriBun” project may be considered a promising functional food product for supplementary iodine fortification of the diets of children aged 3–10 years. Before definitive conclusions can be drawn about its practical effectiveness, laboratory and pilot studies are needed to evaluate iodine retention, safety, sensory properties, and its effect on children’s iodine status.

REFERENCES

1. Nortaeva N.A., Nortaev A.B. Morphological changes in teeth against the background of experimental hypothyroidism. In: Topical Issues of Modern Scientific Research. Dushanbe, 2022, p. 168.
2. Nortaeva N.A., Nortaev A.B. Morphological changes in the tooth in experimental hypothyroidism. In: Issues of Innovative Development of Science, Education and Technology. Andijan, 2022, pp. 273–275.



3. Nortaeва N.A. Morphological changes in teeth as a result of malnutrition in preschool children. In: Proceedings of the Conference Dedicated to the 95th Anniversary of Academician, Morphologist and Scientist Komiljon Zufarov. Tashkent, 2021, pp. 34–36.