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Microbiological Profiles of Local Porridges and the Potential of Dietary Iodine in Children Aged 6 to 24 Months in the Prefecture of Fria

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Abstract

This study, conducted from November 4 to December 4, 2024, in Fria, evaluated the microbiological profiles of local porridges and the dynamics of dietary iodine among breastfed children aged 6 to 24 months. The approach combined laboratory analyses and a nutritional survey. Results showed that 95.6% of the porridges were made from industrial flour and 4.4% from local flour, consumed 2 to 4 times per day. However, 60% of mothers added iodized salt during cooking, which may reduce its nutritional efficacy. Microbiological analysis revealed levels of total aerobic mesophilic flora (10 to 57 CFU/g), yeasts and molds (1 to 10 CFU/g), total coliforms (1 to 22 CFU/g), and *Staphylococcus aureus* (1 to 18 CFU/g). *E. coli*, *Salmonella*, and fecal coliforms were absent, thus meeting health standards. Nonetheless, the presence of certain microorganisms indicates hygiene deficiencies. Physicochemical analysis showed moisture content ranging from 12.02% to 13.78% and ash content from 3.17% to 4.07%, indicating a good concentration of essential nutrients. Iodine content in the porridges (16.2 to 19.5 ppm) complied with recommended levels. TSH levels (1.3 to 3.2 mIU/L) and urinary iodine concentrations (100 to 199 μg/L) suggested adequate iodine intake. The starch content (57.76% to 59.39%) ensured a solid supply of complex carbohydrates to meet energy requirements. The low cellulose content (0.26% to 0.59%) favored digestibility. This study highlights the importance of local porridges and recommends improving iodine fortification practices to optimize infant nutrition.

Keywords

Local Porridges, Iodine, Microbiology, Fria, Children

1. Introduction

The diet of children aged 6 to 24 months relies on a combination of industrial products and local preparations, among which traditional porridges play a vital role. However, their microbiological, physicochemical, and nutritional quality raises serious concerns. The lack of thorough analyses exposes children to health risks, particularly gastrointestinal infections due to microbial contamination, as well as nutritional imbalances that may impair growth and development. Microbial contamination and deficiencies in essential micronutrients such as iron, vitamin A, and iodine are particularly alarming [1].

The absence of quality control for these porridges exposes children to pathogens such as total coliforms, yeasts, and molds, increasing the risk of diarrheal diseases and other infections. Moreover, diets lacking essential nutrients can lead to irreversible physical and cognitive development impairments [2].

Globally, malnutrition remains a major public health issue. Around 45% of deaths in children under the age of five are linked to malnutrition [2]. Additionally, 42% of children under five suffer from iron deficiency, the leading cause of anemia which affects cognitive development and immunity. Vitamin A deficiency affects approximately 190 million preschool-aged children and increases the risk of severe infections and infant mortality [3].

Iodine plays a key role in growth and brain development. However, about 1.88 billion people worldwide are at risk of iodine deficiency, with serious consequences such as cognitive disorders and stunted growth. Despite salt fortification strategies, iodine deficiency remains a challenge in sub-Saharan Africa. In 2021, although 89% of households consumed iodized salt, iodine concentrations varied, resulting in insufficient intake in certain regions [4].

In the Republic of Guinea, micronutrient deficiency-related disorders remain a concern, particularly among young children. Surveys conducted in 1994 revealed a national goiter prevalence of 63.4%, with regional rates ranging from 40.6% to 76.1% [5]. Despite the introduction of salt iodization in 1995, a 2003 survey estimated goiter prevalence at 26.7%, with 63% of households using iodized salt. These findings suggest that iodine deficiency persists despite interventions, calling for strengthened actions to improve micronutrient intake [6].

This study aims to improve infant nutrition by evaluating the microbiological profiles of local porridges and the evolution of dietary iodine intake among children aged 6 to 24 months in the Fria prefecture. By addressing a major gap in the study of food safety, this research will help identify health risks associated with these porridges and develop recommendations to enhance their quality, ensuring improved food and nutritional security particularly with regard to iodine intake, which is essential for child health.

Research Questions

This study addresses the following questions:

- What are the microbiological profiles of local porridges consumed by children aged 6 to 24 months in the Fria prefecture?

- How does dietary iodine intake evolve during continued breastfeeding in these children?
- What is the impact of the lack of microbiological and physicochemical analyses on the sanitary and nutritional quality of local porridges consumed by children?

Hypotheses

Based on the identified issues, three main hypotheses are proposed:

- Local porridges consumed by children aged 6 to 24 months present microbial contamination that compromises their sanitary safety.
- The absence of microbiological and physicochemical analyses promotes the consumption of porridges that are inadequate and potentially harmful to children's health.

General Objective

- The general objective of this study is to assess the microbiological profiles of local porridges and analyze the dynamics of dietary iodine intake during continued breastfeeding in children aged 6 to 24 months in the Fria prefecture.

Specific Objectives

The specific objectives pursued are:

- To identify and quantify pathogenic microorganisms present in local porridges consumed by children aged 6 to 24 months;
- To determine the levels of microbial contamination in the porridges and evaluate their compliance with health standards;
- To determine the iodine content of local porridges and analyze its variation over time;
- To assess the impact of consuming local porridges on the iodine status of breastfed children aged 6 to 24 months.

2. Materials and Methods

2.1. Equipment Used

2.1.1. Laboratory Equipment

- Digestion apparatus (Auto-Kjeldahl): Kjeltec™ 8200, FOSS Analytical, Denmark
- Analytical balance: Sartorius Entris224i-1S, Sartorius, Germany
- Petri dishes: Sterile polystyrene Ø90 mm, Ref. 82.1473.001, Sarstedt
- Porcelain crucibles – 50 mL volume, Ref. 10.190.11, VWR International
- Kjeldahl catalyst – K_2SO_4 + $CuSO_4$ (tablets), Merck KGaA, Germany
- Desiccator – With ceramic plate, Fisher Scientific
- Drying oven at 105˚C: Memmert UN110, Germany
- Soxhlet extractor: Büchi Extraction System B-811, Switzerland
- Muffle furnace (550˚C): Nabertherm LT 9/11/B180, German
- Microbiological hood – Laminar flow cabinet: Esco Airstream, Singapore
- Incubators at 25˚C, 30˚C, 37˚C, and 44˚C: Binder BD115, Germany
- Calibrated pH meter: Hanna Instruments HI5221 with standard buffer solu-

tions pH 4.01, 7.01, 10.01

- Micropipettes: Eppendorf Research® plus (0.5 - 1000 µL), Germany
- UV-Visible spectrophotometer 7600: Shimadzu UV-1800 or 7600, Japan
- Test tubes: Pyrex 16 × 150 mm, Ref. 9826, Corning Inc.

2.1.2. Reagents Used

- Boric acid: ACS Reagent Grade, Ref. 100165, Merck
- Sulfuric acid 98%: Ref. 100731, Merck
- Sodium chloride 0.85%: Isotonic solution, Ref. 1.06404, Merck
- Sodium hydroxide (NaOH): Analytical grade pellets, Ref. 106462, Merck
- Solvents (hexane, petroleum ether): Hexane ≥ 95%, Ref. 104872; Petroleum ether 40˚C - 60˚C, Ref. 109018, Merck

2.1.3. Culture Media Used

- Plate Count Agar (PCA): Ref. CM0325, Oxoid/Thermo Fisher
- Violet Red Bile Dextrose Agar (VRBD): Ref. CM0107, Oxoid
- Tryptone Bile X-glucuronide Agar (TBX): Ref. CM0945, Oxoid
- Salmonella-Shigella Agar (SS): Ref. CM0099, Oxoid
- Baird-Parker Agar (BP): Ref. CM0275, Oxoid
- Sabouraud Agar (Sa): Ref. 105437, Merck

2.1.4. Type of Study

This was a cross-sectional analytical study using a mixed-methods approach (laboratory analysis and nutritional survey), conducted from November 4 to December 4, 2024. It aimed to collect data on the microbiological, physicochemical, and nutritional profiles of local porridges, as well as the dynamics of dietary iodine intake among breastfed children aged 6 to 24 months in the prefecture of Fria.

2.1.5. Target Population

The study population consisted of breastfed children aged 6 to 24 months, for the assessment of their nutritional status and dietary iodine dynamics, as well as their mothers, from whom data were collected regarding dietary habits and preparation practices of local porridges.

2.1.6. Study Area

Fria Prefecture, located in Lower Guinea within the administrative region of Boké, covers an area of 1811 km^2 and has approximately 82,000 inhabitants, with a population density of 45 inhabitants/km^2. It is crossed by the Konkouré River and lies 160 km north of Conakry. Historically, Fria is known for hosting Africa's first alumina plant, built in 1957 by Péchiney. Connected to Conakry by road and rail, this industry was once a major economic driver. However, its closure had profound socio-economic repercussions, worsening food insecurity and nutritional vulnerability among the local population. Administratively, the prefecture is divided into four sub-prefectures (Baguinet, Banguingny, Fria-Centre, and Tormelin), along with several urban districts. Fria was selected as the study area due to the impact of the industrial crisis on food security and childhood malnutrition. This situation justifies a thorough analysis of the nutritional and socio-economic factors influencing feeding practices and hematoparasitic profiles in children under five years of age in the region [7]. As shown in **Figure 1**, the map of the Prefecture of Fria highlights the enumeration zones

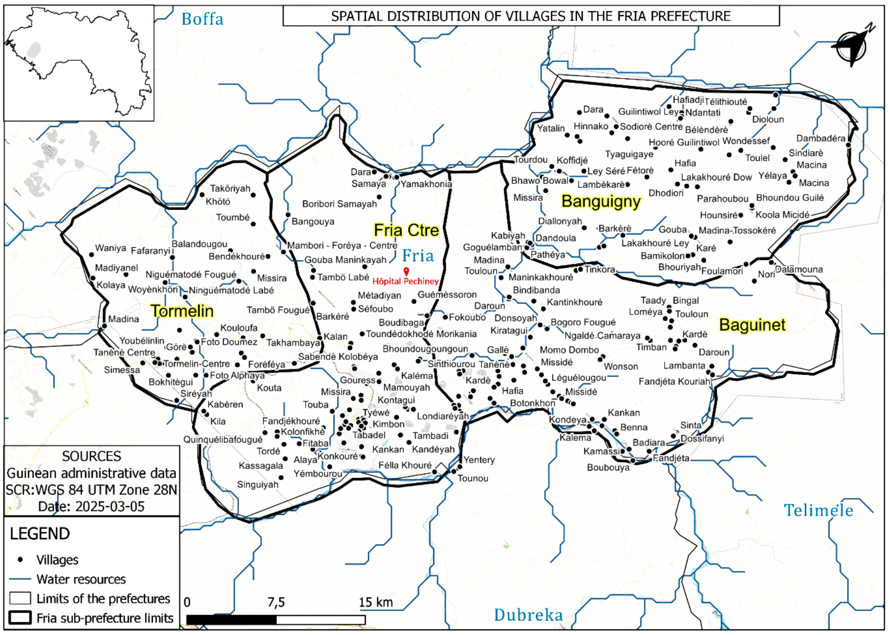

Figure 1. Map of the Prefecture of Fria showing the different enumeration areas and the location of Péchiney Hospital.

2.1.7. Study Setting

The study was conducted in collaboration with the National Office for Quality Control (ONCQ) and the Péchiney Hospital of Fria. The ONCQ, a public institution responsible for monitoring the quality of food and non-food products in the Republic of Guinea, operates a laboratory located in the Matoto municipality. This facility enabled the microbiological, physicochemical, and nutritional analyses of local porridges consumed by young children. Its technical expertise ensured scientific rigor and compliance with international food safety standards [8].

The Péchiney Hospital of Fria, the main healthcare facility in the prefecture, houses a laboratory equipped for biochemical, serological, parasitological, and hematological testing. This laboratory was used to assess urinary iodine concentration (UIC), as well as TSH and T4 levels in children aged 6 to 24 months, in order to analyze their iodine status. The collaboration between these two institutions facilitated a comprehensive evaluation of the microbiological, nutritional, and biological dimensions of the study, ensuring a rigorous and multidisciplinary scientific approach [9]. As shown in **Figure 2**, the map illustrates the location of the National Office of Quality Control and shows the image of the Péchiney Hospital in Fria.

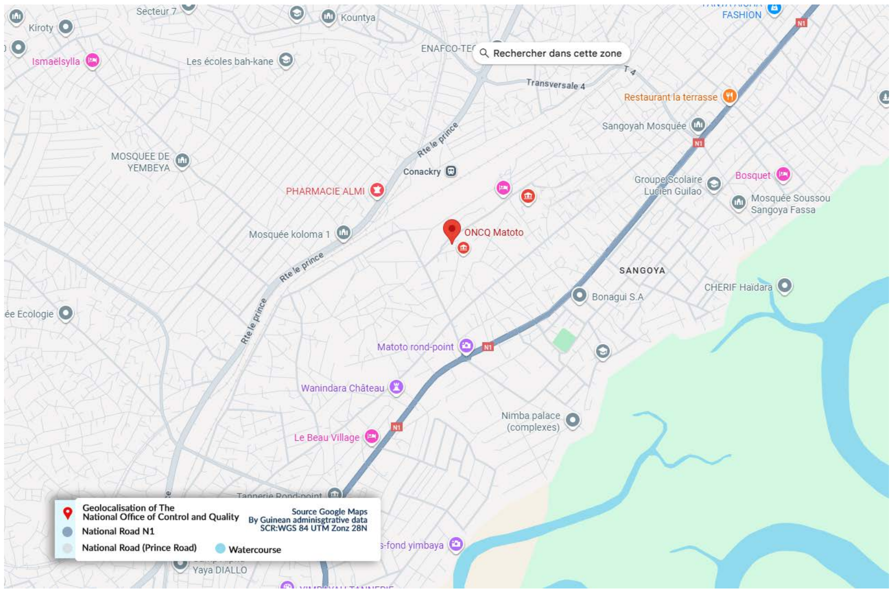

Figure 2. Map of the city of Conakry showing the location of the National Office of Quality Control (ONCQ) laboratory, Republic of Guinea.

2.2. Sampling

The sample size was calculated using Schwartz's formula for cross-sectional studies. Due to the absence of iodine deficiency prevalence data in the Guinea DHS 2018 and SMART 2022 surveys, a prevalence threshold of 5% was assumed for estimation purposes. The initial sample size was set at 384 participants. After adjusting for a non-response rate of 10%, the final sample size was increased to 423 children.

$$N = \frac{Z^2 \times p(1-P)}{d^2}$$

With:

- *N*: sample size
- *Z*: confidence coefficient (1.96% for 95% confidence level)
- *P*: estimated prevalence of iodine deficiency (if unknown, $P = 0.5$ is used to maximize sample size)
- *d*: allowable margin of error (5%)
- An adjustment for the non-response rate (+10% to −15%) was taken into account.

2.2.1. Household and Child Sampling

Household and child sampling was carried out using a stratified random sampling method based on two main criteria: geographical location (neighborhoods or villages) and the socioeconomic status of participants. This approach was adopted to ensure adequate representation of the various strata within the target population. The sample size was estimated considering the expected prevalence of iodine deficiency and the consumption of local porridges among children. A sample of between 300 and 500 breastfed children aged 6 to 24 months was selected to allow for statistically reliable and representative analyses. A 95% confidence interval was used for result interpretation. Additionally, a 10% anticipated non-response rate was included in the sample size calculation to ensure the validity of conclusions despite potential absences or refusals to participate.

2.2.2. Sampling of Local Porridges

The selection of porridge types consumed by children was based on a list of commonly used local ingredients, such as millet, maize, rice, sorghum, and other traditional cereals used in infant meals. The porridges included were selected based on their consumption frequency among households in the Fria prefecture, as established through a preliminary survey. Samples were collected directly from households to ensure the porridge analyzed reflected what children actually consumed. These samples were then transported to laboratories for microbiological, physicochemical, and nutritional analyses to assess their sanitary quality and nutritional value.

2.2.3. Biological Sampling (Children's Iodine Status)

1) Urine (iodide measurement)

Morning fasting urine samples (5 to 10 ml) were collected from each child and immediately transferred to sterile containers for laboratory analysis.

2) Blood (to measure free thyroxine (Free T4) and thyroid-stimulating hormone (TSH))

A 3 to 5 ml venous blood sample was collected in a tube without anticoagulant to analyze thyroid hormone levels.

3. Data and Sample Collection

3.1. Collection of Local Porridge Samples

To collect local porridge samples, a volume of 100 to 200 ml was taken directly from households using sterile containers to avoid contamination. Samples were immediately stored at 4˚C to preserve their microbiological and nutritional integrity and transported to the laboratory for analysis. At the time of sampling, porridge preparation conditions were carefully recorded. This included checking for the addition of iodized salt, which could influence children's iodine status, and the porridge cooking time, as duration may impact the nutritional value of foods. These data were collected to allow for a comprehensive analysis of how preparation methods affect the nutritional quality of porridges.

3.2. Collection of Biological Samples

3.2.1. Urine

Urine samples were collected in sterile containers, preferably in the morning, and immediately stored at −20˚C until laboratory analysis. This preservation ensured the stability of iodine concentration in the urine, used as an indicator of the child's iodine status.

3.2.2. Blood

Blood samples were collected via venipuncture, followed by centrifugation to separate the serum. The serum was then stored at −80˚C to allow for accurate analysis of free T4 and TSH levels, which reflect the functional status of the thyroid gland and the impact of iodine deficiency.

3.3. Collection of Nutritional and Socioeconomic Data

3.3.1. Frequency and Types of Porridges Consumed

Mothers reported meal frequency and the types of porridges consumed, to better understand the children's dietary habits.

3.3.2. Use of Iodized Salt or Other Dietary Supplements

Mothers were asked about the use of iodized salt in meal preparation and the administration of dietary supplements, such as vitamins or iodine-based products, which could influence the child's nutritional status.

3.3.3. Direct Observation of Porridge Preparation Practices and Hygiene Conditions

Observations were conducted to document porridge preparation practices, including mothers' hand hygiene, the use of clean cooking utensils, and general cooking conditions, all of which can influence the microbiological and nutritional quality of porridges. These observations were recorded in the field to complement the data collected through the questionnaires.

4. Laboratory Analyses

4.1. Microbiological Analyses

Porridge samples were tested to detect the presence of microorganisms that could impact child health. These tests were conducted at the ONCQ laboratory using standard culture media and in accordance with international standards.

4.1.1. Fecal Coliforms

The detection of fecal coliforms evaluates fecal contamination and compliance with hygiene practices. The method used was plating on Violet Red Bile Dextrose Agar (VRBD) and incubation at 44˚C for 24 hours, according to ISO 4832:2006 [10].

4.1.2. Total Coliforms

These are indicators of environmental contamination and possible hygiene lapses during porridge preparation. The method used was VRBD plating and incubation at 37˚C for 24 hours, also according to ISO 4832:2006 [10].

4.1.3. Total Aerobic Mesophilic Flora (TAMF)

Used to assess overall microbial load and the general microbiological quality of the porridges. Analysis was performed using deep plating on Plate Count Agar (PCA) and incubation at 30˚C for 72 hours, following ISO 4833-1:2022 [11].

4.1.4. *Salmonella* spp.

Testing for Salmonella is essential as it causes serious foodborne illnesses. The method used included pre-enrichment in Buffered Peptone Water (BPW), isolation on Salmonella-Shigella Agar (SS) at 37˚C for 24 to 48 hours, and biochemical confirmation in accordance with ISO 6579-1:2017/Amd 1:2020 [12].

4.1.5. *Staphylococcus aureus*

This pathogen can produce toxins responsible for food poisoning. The analysis involved plating on Baird-Parker Agar (BP), incubation at 37˚C for 24 to 48 hours, and confirmation via coagulase testing, in line with ISO 6888-1:2021 [13].

4.1.6. Yeasts and Molds

Their presence can affect porridge quality and pose health risks through potential mycotoxin production. The method used was plating on Potato Dextrose Agar (PDA) and incubation at 25˚C for 5 days, following ISO 21527-1:2008 [14].

4.1.7. *Escherichia coli* (*E. coli*)

This bacterium indicates fecal contamination and is a public health concern. The method involved enrichment in a non-selective broth, followed by plating on a selective medium such as EC Agar and incubation at 37˚C for 18 to 24 hours, according to ISO 16649-2:2001 [15].

4.2. Physicochemical and Nutritional Analyses

The physicochemical characteristics of porridges were analyzed to determine their composition and stability in compliance with applicable standards. These analyses included:

4.2.1. pH

The pH measurement assessed the acidity or alkalinity of the porridges, influencing both preservation and digestibility. Analysis was performed using potentiometry with a pH meter, according to ISO 4316:1977 [16].

4.2.2. Moisture Content

Moisture determination is essential as high levels can promote microbial growth and shorten shelf life. The method used was oven drying (gravimetry) at 105˚C until constant weight, in line with ISO 712:2009 [17].

4.2.3. Dry Matter

Dry matter refers to the portion remaining after moisture removal, serving as a key indicator of nutrient concentration. The method was an indirect calculation by subtracting moisture content, as per ISO 712:2009 [17].

4.2.4. Ash Content

Ash content indicates the total mineral and inorganic matter in porridges. The analysis was performed via incineration at 550˚C to 600˚C according to ISO 2171:2023 [18].

4.3. Nutritional Parameters

4.3.1. Macronutrients

1) Carbohydrates

The carbohydrate content was calculated by difference after determining the other components (moisture, proteins, fats, and ash). Carbohydrates are a major source of energy for the body. The analytical method is based on subtraction, following the FAO/WHO 2003 standard [19].

2) Energy Value

The energy value of porridges was calculated using the Atwater conversion factors: 4 kcal/g for proteins, 9 kcal/g for fats, and 4 kcal/g for carbohydrates, as recommended by FAO/WHO 2003 [19].

3) Fats

Fat content was determined using Soxhlet extraction with petroleum ether as a solvent, in accordance with AOAC 2000 [20].

4) Proteins

Protein content was measured using the Kjeldahl method for total nitrogen, followed by conversion to protein using a factor of 6.25, as described by AOAC 2000 [20].

4.3.2. Micronutrients

1) Iodine

Iodine content in salt and porridges was determined using the iodometric titration method, in accordance with WHO/UNICEF/ICCIDD 2007 guidelines [21].

2) Iron

Iron content was measured via atomic absorption spectroscopy (AAS) following AOAC 2000 [20].

3) Zinc

Zinc was determined using AAS as described in AOAC 2000 [20].

4) Vitamin A

Vitamin A content was analyzed using High Performance Liquid Chromatography (HPLC) as per AOAC 2000 [20].

5) Calcium

Calcium was determined using titration with EDTA according to AOAC 2000 [20].

6) Magnesium

Magnesium was measured using AAS as per AOAC 2000 [20].

7) Starch

Starch content was analyzed enzymatically using AOAC 2000 [20].

8) Cellulose

Cellulose content was determined by the Weende method according to AOAC 2000 [20].

4.4. Analysis of Biological Parameters in Children

4.4.1. Urinary Iodine

Urinary iodine concentration (UIC) was measured using the Sandell-Kolthoff reaction, following WHO/UNICEF/ICCIDD 2007 guidelines [21].

4.4.2. Free Thyroxine (T4) and TSH (Thyroid Stimulating Hormone)

Serum free T4 and TSH concentrations were determined using enzyme-linked immunosorbent assay (ELISA) kits, according to the manufacturer's instructions [22].

4.4.3. Goiter

Goiter was assessed via palpation according to WHO 2001 criteria [23].

5. Data Processing and Analysis

Data were entered and processed using Microsoft Excel 2016 and analyzed using SPSS version 26.0. Descriptive statistics (mean, standard deviation, frequency, and percentage) were calculated. Comparisons between groups were made using the Student's t-test or ANOVA for continuous variables and the chi-square test for categorical variables. Statistical significance was set at $p < 0.05$.

Descriptive Statistics

Mean, standard deviation, and proportions were calculated for all variables of interest.

6. Interpretation According to WHO, FAO, and Codex Alimentarius Standards

The results were interpreted based on WHO, FAO, and Codex Alimentarius standards for nutrient intake, microbiological safety, and iodine deficiency [24]-[26].

7. Limitations of the Study

The main limitations included reliance on mother-reported dietary data, potential seasonal variations in food availability, and constraints in laboratory analysis due to resource limitations.

8. Constraints of the Study

Constraints encountered included limited access to some households, transportation challenges for sample collection, and occasional electricity outages affecting laboratory equipment.

9. Ethical Considerations

The study protocol was approved by the National Ethics Committee for Health Research in Guinea (Ref: CNERS/2024/05). Written informed consent was obtained from all mothers or legal guardians before participation. Confidentiality and anonymity were strictly maintained throughout the study.

10. Results and Discussion

The results from Table 1 show that 95.6% of children consume porridge made from industrial infant flour, while only 4.4% consume porridge made from local flour. This predominance of industrial porridge could be attributed to its accessibility and the perception of higher quality. However, if strict hygiene practices were followed, the use of local cereals for porridge preparation could offer a more cost-effective and nutritionally beneficial alternative.

Table 1. Distribution of children based on the type of porridge consumed.

No.	Type of Porridge	Number	%
1	Porridge made from local flour	20	4.4
2	Porridge made from industrial infant flour	430	95.6
	Total		**450**

It is possible that mothers are not fully informed about the advantages of using locally available cereals, which are lower in cost and can ensure food safety. Our results differ from those of Marius S. Kanhounnon (2017) in Benin, where 71% of porridge was prepared with local flours, compared to only 7% with industrial flours. This difference may be due to factors such as the availability of local flours, the transition towards industrialized products, and marketing influences promoting industrial flours.

While our study did not specifically assess economic factors or policy influences, it is possible that changes in purchasing power and limited promotion of local flours contribute to the observed patterns. These aspects could be explored in future research to better understand the consumption of industrial versus local porridges in the study area [24].

Table 2. Frequency of consumption of porridge made from local flour by children.

Frequency of Porridge Consumption per Day	Number	%	Criteria
2 - 3	**7**	**35**	
4 - 6	13	65	**≥2 times/day**
Total	**20**	**100**	

The results from **Table 2** show that the majority of children (65%) consume porridge 4 to 6 times per day, while 35% consume it 2 to 3 times per day. This distribution aligns with nutritional recommendations, which suggest a sufficient feeding frequency to ensure optimal intake of essential nutrients for the child's proper development. Increasing the frequency of consumption could further enhance the nutritional intake, particularly for nutrients necessary for optimal physical and cognitive development. Our results are comparable to those reported by Kouton *et al.* (2017) in Benin, where 50.49% of children consumed porridge at a frequency of 2 to 3 times per day, distributed as follows: 26.66% consumed it twice a day, and 23.83% consumed it three times a day. Additionally, 14.16% of children had a higher consumption frequency, ranging from 4 to 5 times per day, with

5.83% consuming it four times per day and 8.33% consuming it five times per day. This difference could be explained by factors such as food availability, cultural practices, nutrition education, socio-economic conditions, and the nutritional density of the porridge consumed [25].

Table 3. Results of mothers' statements regarding the timing of the addition of iodized salt, during and/or after cooking.

Mother's Statement	Number	%
Mother who reported adding salt after cooking	9	45
Mother who reported adding salt during cooking	11	55
Total	**20**	**100**

The data from **Table 3** show that 55% of mothers add iodized salt during cooking, while 45% add it after cooking. However, the WHO recommends adding salt after cooking to minimize nutrient losses due to heat and ensure an adequate iodine intake, which is crucial for the child's cognitive and physical development. The failure to adhere to this recommendation by more than half of the participants could potentially compromise the effectiveness of iodine enrichment in the porridge. Similar trends were observed in the study by Karmakar *et al.*, in 2018, conducted in India, where only 1.9% of women added salt at the end of cooking, compared to 60.4% during cooking and 37.4% at the beginning. Unlike this study, ours did not differentiate the exact stages of cooking, limiting the precision of quantifying potential iodine losses. The higher proportion of mothers following the recommendation in our sample (45% compared to 1.9%) could be explained by contextual differences, particularly in terms of nutritional information or local cooking practices [26].

10.1. Microbiological Profile of Porridges Made from Local Flours Prepared by Mothers and Given to Children Aged 6 to 24 Months Included in Our Study

Table 4. Microorganism count in samples of porridges made from local flour.

CODES	FMAT (cfu/g)	Yeasts and Molds (cfu/g)	Total Coliforms (cfu/g)	Fecal Coliforms (cfu/g)	E. coli (cfu/g)	Salmonella (cfu/g)	Staphylococcus aureus (cfu/g)
E1	57	10	22	Absent	Absent	Absent	03
E2	30	06	04	Absent	Absent	Absent	07
E3	22	02	01	Absent	Absent	Absent	02
E4	10	01	02	Absent	Absent	Absent	02
E5	18	05	02	Absent	Absent	Absent	10
E6	18	02	06	Absent	Absent	Absent	09
E7	22	04	09	Absent	Absent	Absent	01

Continued

E8	34	06	01	Absent	Absent	Absent	06
E9	42	07	09	Absent	Absent	Absent	08
E10	25	04	02	Absent	Absent	Absent	04
E11	15	02	01	Absent	Absent	Absent	02
E12	28	01	01	Absent	Absent	Absent	02
E13	10	01	02	Absent	Absent	Absent	04
E14	12	03	05	Absent	Absent	Absent	09
E15	20	04	03	Absent	Absent	Absent	03
E16	23	10	12	Absent	Absent	Absent	02
E17	19	02	05	Absent	Absent	Absent	10
E18	26	04	07	Absent	Absent	Absent	12
E19	18	03	05	Absent	Absent	Absent	14
E20	15	02	07	Absent	Absent	Absent	18
Criteria	**$\leq 10^6$**	**$\leq 10^2$**	**$\leq 10^3$**	**Absent/25 g**	**Absent/25 g**	**Absent/25 g**	**≤100**

The results from **Table 4** indicate that the samples of local porridge analyzed exhibit relatively low concentrations of total coliforms, ranging from 1 to 22 cfu/g. Higher concentrations were observed in samples E1, E7, E9, and E16, which could suggest variations in hygiene conditions during preparation or storage. Nonetheless, these values remain below the maximum criterion of 10^3 cfu/g, in compliance with food safety standards. Regarding *Staphylococcus aureus*, concentrations ranged from 1 to 18 cfu/g. Although these levels are well below the safety limit of 100 cfu/g, the presence of this pathogenic bacterium indicates a potential risk of contamination by toxins, particularly if the porridge is stored at room temperature for prolonged periods.

Furthermore, the presence of spoilage microorganisms such as total aerobic mesophilic flora, total coliforms, yeasts, and molds, as well as the absence of contamination indicator germs like fecal coliforms, suggests that proper hygiene practices were not always consistently applied during preparation, and that storage conditions could be improved. This microbiological profile highlights the need for rigorous measures to ensure the sanitary safety of the products.

Table 5. Average results of physicochemical parameters and energy values of porridge samples from children aged 6 to 24 months included in our study.

CODES	%M	%C	%L	%P	%A	%Starch	%Cellulose	%DM	pH	EV (Kcal/100 g)
E1	13.78 ± 0.22	64.18 ± 0.30	8.40 ± 0.20	10.32 ± 0.08	3.33 ± 0.12	57.76 ± 0.27	0.29 ± 0.30	86.22 ± 0.22	6.23 ± 0.05	373.60
E2	12.02 ± 0.02	65.62 ± 0.23	8.13 ± 0.12	10.16 ± 0.02	4.07 ± 0.12	59.06 ± 0.21	0.59 ± 0.24	87.98 ± 0.02	6.24 ± 0.04	376.29
E3	13.56 ± 0.21	64.44 ± 0.15	7.91 ± 0.02	10.13 ± 0.05	3.97 ± 0.02	58.00 ± 0.14	0.44 ± 0.22	86.44 ± 0.21	6.23 ± 0.05	369.47
E4	13.62 ± 0.37	64.26 ± 0.36	8.13 ± 0.02	10.22 ± 0.03	3.77 ± 0.02	57.83 ± 0.32	0.42 ± 0.29	86.38 ± 0.37	6.26 ± 0.04	371.09

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E5	12.02 ± 0.02	65.18 ± 0.11	8.27 ± 0.12	10.56 ± 0.05	3.97 ± 0.02	58.66 ± 0.10	0.36 ± 0.22	87.98 ± 0.02	6.28 ± 0.06	377.39
E6	13.21 ± 0.17	64.51 ± 0.34	8.15 ± 0.03	10.56 ± 0.02	3.57 ± 0.20	58.06 ± 0.31	0.46 ± 0.25	86.79 ± 0.17	6.26 ± 0.05	373.63
E7	13.21 ± 0.17	64.88 ± 0.19	8.13 ± 0.02	10.59 ± 0.01	3.18 ± 0.01	58.39 ± 0.17	0.42 ± 0.24	86.79 ± 0.17	6.26 ± 0.04	375.05
E8	13.21 ± 0.17	65.30 ± 0.10	8.23 ± 0.12	10.08 ± 0.01	3.17 ± 0.01	58.77 ± 0.09	0.45 ± 0.22	86.79 ± 0.17	6.29 ± 0.05	375.59
E9	13.20 ± 0.00	64.93 ± 0.06	8.38 ± 0.01	10.11 ± 0.05	3.39 ± 0.01	58.44 ± 0.05	0.50 ± 0.22	86.80 ± 0.00	6.17 ± 0.07	375.58
E10	13.05 ± 0.01	65.16 ± 0.01	8.15 ± 0.01	10.06 ± 0.01	3.59 ± 0.01	58.64 ± 0.01	0.53 ± 0.22	86.95 ± 0.01	6.22 ± 0.05	374.23
E11	12.29 ± 0.01	65.99 ± 0.01	8.13 ± 0.01	10.00 ± 0.01	3.58 ± 0.01	59.39 ± 0.01	0.26 ± 0.21	87.71 ± 0.01	6.24 ± 0.05	393.13
E12	13.33 ± 0.10	65.02 ± 0.13	8.11 ± 0.01	10.01 ± 0.01	3.52 ± 0.11	58.52 ± 0.12	0.39 ± 0.24	86.67 ± 0.10	6.26 ± 0.05	373.11
E13	13.27 ± 0.10	65.05 ± 0.08	8.10 ± 0.01	10.03 ± 0.01	3.56 ± 0.01	58.55 ± 0.07	0.41 ± 0.23	86.73 ± 0.10	6.28 ± 0.05	373.22
E14	13.67 ± 0.10	64.61 ± 0.09	8.08 ± 0.01	10.07 ± 0.03	3.56 ± 0.01	58.15 ± 0.09	0.48 ± 0.24	86.33 ± 0.10	6.29 ± 0.05	371.44
E15	13.24 ± 0.01	65.07 ± 0.01	8.07 ± 0.01	10.07 ± 0.01	3.55 ± 0.01	58.56 ± 0.01	0.47 ± 0.23	86.76 ± 0.01	6.34 ± 0.05	373.19
E16	13.26 ± 0.10	65.16 ± 0.16	8.03 ± 0.01	10.29 ± 0.01	3.26 ± 0.11	58.64 ± 0.14	0.50 ± 0.24	86.74 ± 0.10	6.39 ± 0.05	374.07
E17	13.16 ± 0.01	64.84 ± 0.04	8.02 ± 0.01	10.47 ± 0.04	3.51 ± 0.01	58.36 ± 0.04	0.53 ± 0.22	86.84 ± 0.01	6.44 ± 0.05	373.42
E18	13.10 ± 0.01	65.02 ± 0.10	8.07 ± 0.01	10.36 ± 0.02	3.45 ± 0.11	58.52 ± 0.09	0.50 ± 0.23	86.90 ± 0.01	6.46 ± 0.05	374.15
E19	13.09 ± 0.01	64.88 ± 0.04	8.03 ± 0.01	10.46 ± 0.02	3.54 ± 0.01	58.39 ± 0.05	0.51 ± 0.23	86.91 ± 0.01	6.44 ± 0.05	373.63
E20	13.21 ± 0.01	65.07 ± 0.09	8.06 ± 0.01	10.39 ± 0.05	3.28 ± 0.12	58.56 ± 0.08	0.44 ± 0.23	86.79 ± 0.01	6.45 ± 0.05	374.38
Criteria	**≤14**	**60 - 75**	**≥8**	**≥10**	**3 - 5**	**50 - 70**	**≤5%**	**≤88**	**4.5 - 6.8**	**≥400**

The results in Table 5 show that the local porridges have a relatively stable moisture content (%H) ranging from 12.02% to 13.78%, which contributes to a good consistency while preserving the nutrients. The dry matter (%MS), ranging from 86.22% to 87.98%, reflects a high concentration of nutrients, characteristic of porridges made from cereals. The ash content, indicative of mineral richness, ranges from 3.17% to 4.07%, which is consistent with expectations for this type of preparation. The pH, varying between 6.17 and 6.46, falls within a slightly acidic to neutral range, limiting microbial growth and promoting product stability. The lipid content (%L), ranging from 7.91% to 8.40%, provides essential energy intake. The carbohydrate content (%G), the main source of energy, ranges from 64.18% to 65.99%, while the protein content (%P), ranging from 10% to 10.59%, supports muscle growth. The starch content (%Ami), in line with the expected standards (57.76% to 59.39%), ensures an adequate supply of complex carbohydrates. The cellulose content, ranging from 0.26% to 0.59%, remains low, which is beneficial for digestibility in young children, while still contributing a moderate amount of dietary fiber essential for healthy intestinal transit. Finally, the energy value (VE) of the porridges, ranging from 369.47 to 393.13 Kcal/100 g, is slightly below the recommended threshold of ≥400 Kcal/100 g, suggesting that nutritional supplementation might be needed to fully meet the energy needs of children aged 6 to 24 months.

10.2. Nutritional Profile of Local Flour-Based Porridges Prepared by Mothers and Given to Children Aged 6 to 24 Months Included in Our Study

Table 6. Average results of nutritional parameters of porridge samples from children aged 6 to 24 months included in our study.

CODES	Iron (mg/100 g)	Zinc (mg/100g)	Calcium (mg/100 g)	Magnesium (mg/100 g)	Vit. A (µgER/100 g)	Iodine (ppm)
E1	7.5 ± 0.10	4.2 ± 0.10	300.43 ± 0.40	85.0 ± 0.30	310.66 ± 0.25	15.65 ± 0.01
E2	7.5 ± 0.10	4.3 ± 0.10	300.5 ± 0.40	85.0 ± 0.20	310.9 ± 0.10	15.64 ± 0.01
E3	7.6 ± 0.10	4.3 ± 0.10	300.77 ± 0.20	85.27 ± 0.20	311.00 ± 0.20	15.67 ± 0.01
E4	7.7 ± 0.10	4.4 ± 0.10	301.17 ± 0.10	85.53 ± 0.20	311.27 ± 0.20	15.68 ± 0.01
E5	7.6 ± 0.10	4.3 ± 0.10	300.93 ± 0.20	85.40 ± 0.10	311.23 ± 0.20	15.70 ± 0.02
E6	7.7 ± 0.10	4.4 ± 0.10	301.23 ± 0.20	85.53 ± 0.20	311.70 ± 0.10	15.72 ± 0.02
E7	7.50 ± 0.10	4.30 ± 0.10	300.77 ± 0.15	85.13 ± 0.15	310.83 ± 0.25	15.60 ± 0.04
E8	7.60 ± 0.10	4.33 ± 0.05	300.87 ± 0.35	85.23 ± 0.15	310.9 ± 0.10	15.80 ± 0.05
E9	7.63 ± 0.05	4.33 ± 0.05	300.70 ± 0.10	85.33 ± 0.10	310.90 ± 0.10	15.80 ± 0.04
E10	7.70 ± 0.10	4.40 ± 0.10	300.80 ± 0.10	85.50 ± 0.10	311.50 ± 0.10	15.85 ± 0.05
E11	7.75 ± 0.10	4.45 ± 0.10	301.00 ± 0.10	85.55 ± 0.10	311.70 ± 0.10	15.88 ± 0.05
E12	7.78 ± 0.10	4.48 ± 0.10	301.20 ± 0.10	85.60 ± 0.10	311.90 ± 0.10	15.90 ± 0.05
E13	7.80 ± 0.10	4.50 ± 0.10	301.50 ± 0.10	85.70 ± 0.10	312.20 ± 0.10	15.95 ± 0.05
E14	7.85 ± 0.10	4.55 ± 0.10	302.00 ± 0.10	85.80 ± 0.10	312.50 ± 0.10	16.00 ± 0.05
E15	7.90 ± 0.10	4.60 ± 0.10	303.00 ± 0.10	86.00 ± 0.10	313.00 ± 0.10	16.10 ± 0.05
E16	8.00 ± 0.10	4.70 ± 0.10	304.00 ± 0.10	87.00 ± 0.10	314.00 ± 0.10	16.20 ± 0.05
E17	8.10 ± 0.10	4.80 ± 0.10	305.00 ± 0.10	88.00 ± 0.10	315.00 ± 0.10	16.30 ± 0.05
E18	8.20 ± 0.10	4.90 ± 0.10	306.00 ± 0.10	89.00 ± 0.10	316.00 ± 0.10	16.40 ± 0.05
E19	8.10 ± 0.10	4.80 ± 0.10	305.50 ± 0.10	88.50 ± 0.10	315.00 ± 0.10	16.30 ± 0.05
E20	8.15 ± 0.10	4.85 ± 0.10	305.60 ± 0.10	88.55 ± 0.10	315.10 ± 0.10	16.35 ± 0.05
Criteria	**5 - 10**	**≥3**	**300 - 500**	**50 - 100**	**300 - 500**	**10 - 40**

The results in Table 6 reveal that the iron content, ranging from 7.5 to 8.2 mg/100 g, falls within the recommended range (5 - 10 mg/100 g), which is essential for preventing infant anemia. Zinc concentrations, ranging from 4.2 to 4.9 mg/100 g, exceed the minimum required threshold (≥3 mg/100 g) and play a key role in immune development and growth. Calcium levels (300.43 to 306 mg/100 g) and magnesium levels (85.0 to 89.0 mg/100 g) meet the established standards, contributing to bone mineralization and cellular metabolism.

Furthermore, vitamin A levels, ranging from 310.66 to 316 µg ER/100 g, and iodine concentrations, ranging from 15.64 to 16.35 ppm, meet the nutritional requirements essential for maintaining vision, strengthening immunity, and supporting proper thyroid function. These results confirm that the porridges studied provide a balanced nutritional intake, suitable for the needs of growing children.

10.3. Iodine Content Profile of Salt Used by Mothers in the Preparation of Porridge Made from Local Flours, and Ioduria, T4, and TSH in Children Aged 6 to 24 Months Included in Our Study

Table 7. Iodine content results of salt samples used by mothers for porridge preparation.

Iodine Content (ppm)	Number (n = 20)	%	Criteria
16.2 ± 0.1 - 17.8 ± 0.2	8	40	
18.0 ± 0.3 - 19.5 ± 0.3	12	60	≥15 ppm
Total	**20**	**100**	

The results presented in **Table 7** show that the iodine content of the 20 salt samples used in the preparation of porridge made from local flours for children aged 6 to 24 months ranged from 16.2 ± 0.1 ppm to 19.5 ± 0.3 ppm. Specifically, 40% of the samples had iodine levels between 16.2 and 17.8 ppm, while 60% showed higher concentrations, from 18.0 to 19.5 ppm. These values meet the minimum recommended threshold of 15 ppm, thereby ensuring an adequate iodine intake to prevent iodine deficiency disorders such as endemic goiter or delays in neurocognitive development in children. Iodine is an essential trace element required for the synthesis of thyroid hormones (thyroxine and triiodothyronine), which are crucial for energy metabolism regulation, growth, and brain development. However, even when measured levels are satisfactory, iodine stability in salt remains a critical factor. Improper storage particularly exposure to humidity, heat, or light can lead to significant losses, thereby reducing the effectiveness of iodized salt. It is therefore essential to promote proper storage practices, such as using airtight containers and avoiding unfavorable environments. Beyond the use of iodized salt, an integrated nutritional approach should be encouraged. Regular consumption of iodine-rich foods (such as marine fish, seafood, eggs, and dairy products) helps diversify intake sources and improves the micronutrient's bioavailability, reducing the risk of deficiency. In comparison with the study by GOMINA ASSOUMANOU *et al.* conducted in 2011 in Benin, our results show both similarities and notable differences. In their survey, the average iodine content in table salt was 33.836 ± 17.046 ppm, significantly higher than in our study. Additionally, 86.24% of the analyzed samples had an iodine content ≥ 15 ppm, compared to 100% in our case. However, their study also revealed a non-negligible proportion of inadequately iodized salt (11.31% < 15 ppm and 2.45% at 0 ppm), which contrasts with our findings, where none of the samples fell below the critical threshold. Another important distinction is that although iodine levels in the Benin study were higher, only 54.74% of the samples were considered adequately iodized according to the 15 - 40 ppm standard, whereas all the samples analyzed in our study fell within this normative range. This difference may reflect better uniformity in iodization or stricter supply chain management in our study area. Thus, while both studies highlight the importance of iodized salt as a public health tool, our findings are distinguished by the consistency of the measured concentrations, all of which comply with current recommendations. This likely reflects better local control of iodization procedures or improved salt storage practices at the household level [27].

Table 8. Urinary Iodine Concentration (UIC) results in children included in our study.

Urinary Iodine (μg/L)	Number (n = 20)	%	Criteria
110 ± 5 - 150 ± 3	9	45	
155 ± 3 - 198 ± 3	11	55	**100 - 199 μg/L**
Total	**20**	**100**	

The results presented in **Table 8** reveal that the urinary iodine concentration (UIC) among the 20 children included in this study ranges from 110 ± 5 μg/L to 198 ± 3 μg/L. Of these, 45% had UIC levels between 110 and 150 μg/L, and 55% between 155 and 198 μg/L. These values all fall within the World Health Organization (WHO) recommended range of 100 - 199 μg/L, indicating an optimal iodine status in this population.

This finding aligns with WHO guidelines, which state that a median UIC of 100 - 199 μg/L in school-aged children and by extension in children under five years of age, according to some studies reflects adequate iodine intake at the population level. Maintaining this range is essential to effectively prevent iodine deficiency disorders, including neurocognitive development delays, thyroid dysfunctions, and, in severe cases, endemic cretinism in at-risk regions. Our findings may be compared to those of the study by Delange *et al.* (2002), conducted across 17 countries and involving over 55,000 individuals. That study reported that 48% of the populations examined had a median UIC within the 100 - 199 μg/L range, considered the optimal threshold. However, the same study also highlighted significant inter-country and inter-regional variability, with some records showing very high UIC values (up to 540 μg/L), reflecting potential excessive iodine intake in certain areas.

In contrast to these multicentric findings, where extreme UIC values were frequently observed, our data are more homogeneous and remain strictly within the recommended limits, with no cases below 100 μg/L or exceeding 200 μg/L. This narrower distribution around the mean likely reflects greater stability in iodine intake among the surveyed children, possibly due to the quality of iodized salt used in households as corroborated by the findings in **Table 7**. Moreover, although our results follow the same trend as those of Delange *et al.* in terms of adequate iodine intake, our study stands out due to the absence of extreme cases, suggesting greater uniformity in iodine exposure. This indicates better control of the nutritional and environmental factors influencing urinary iodine levels in children [28].

Table 9. Free thyroxine (pmol/L).

Free Thyroxine (pmol/L)	Number (n = 20)	%	Criteria
11.0 ± 0.5 - 14.5 ± 0.4	7	35	**10 - 23 pmol/L**
15.0 ± 0.6 - 22.0 ± 0.4	13	65	
Total	**20**	**100**	

The results in Table 9 show that the free thyroxine (T4) concentrations measured in the 20 samples ranged from 11.0 ± 0.5 pmol/L to 22.0 ± 0.4 pmol/L, entirely within the established reference range of 10 to 23 pmol/L. Among these samples, 35% had concentrations between 11.0 ± 0.5 and 14.5 ± 0.4 pmol/L, while 65% showed values between 15.0 ± 0.6 and 22.0 ± 0.4 pmol/L. These findings indicate that all individuals studied exhibited free T4 levels consistent with physiological norms, suggesting normal thyroid function. Free thyroxine (T4) is a critical thyroid hormone that plays a key role in regulating metabolism and cellular energy production. Assessing its concentration within the reference interval is crucial for identifying potential thyroid abnormalities that could negatively impact overall health. In this context, the results support the notion of hormonal balance essential for proper metabolism, growth, and optimal development in the children included in the study. Such hormonally normal levels are particularly important to ensure healthy development, especially in a young population.

Table 10. TSH (mIU/L).

TSH (mIU/L)	Number (n = 20)	%	Criteria
1.3 ± 0.2 - 1.8 ± 0.2	6	30	
2.0 ± 0.2 - 3.2 ± 0.3	14	70	**0.5 - 4.5 mIU/L**
Total	**20**	**100**	

The TSH concentrations measured in the 20 samples, as presented in Table 10, ranged from 1.3 ± 0.2 mIU/L to 3.2 ± 0.3 mIU/L, all within the established reference interval of 0.5 to 4.5 mIU/L. Among these, 30% of samples showed levels between 1.3 ± 0.2 and 1.8 ± 0.2 mIU/L, while 70% displayed values ranging from 2.0 ± 0.2 to 3.2 ± 0.3 mIU/L. These findings suggest overall stable thyroid function among the study subjects, with TSH concentrations consistent with physiological norms. Thyroid-stimulating hormone (TSH), also known as thyrotropin, plays a fundamental role in regulating the thyroid gland by stimulating the secretion of thyroid hormones T3 and T4, which are essential for maintaining metabolic balance and cellular energy production. The absence of elevated TSH levels in the study population is an important indicator of the absence of iodine deficiency or overt hypothyroidism. Elevated TSH levels typically reflect excessive stimulation of the thyroid gland, often associated with insufficient thyroid hormone production. These results thus indicate appropriate hormonal regulation in the children studied, which is critical for optimal metabolic development. From a public health perspective, these findings can help identify at-risk populations and guide preventive strategies, particularly in regions where iodine deficiency might be prevalent. Moreover, the crucial role of thyroid hormones in neurocognitive development and growth, especially in children, underscores the importance of maintaining normal hormonal balance. Our results differ from those reported by Xueqin Yan *et al.* (2023, China), who studied children under the age of five with elevated TSH levels at birth. In their sample, several groups exhibited TSH concentrations between 5 and over 20 mIU/L, indicating subclinical or congenital hypothyroidism. Their study noted an initial impact on growth (lower height z-scores), although these differences diminished with age. However, the developmental quotient (DQ) at two years did not significantly differ between groups. In contrast to Yan *et al.*'s findings, our study population showed no elevated TSH levels, reflecting normal thyroid status. This comparison highlights the importance of pathophysiological context: our study describes a population with no identified endocrine disorders, while Yan *et al.* Focused on children affected by or at risk for thyroid dysfunction [29].

11. Conclusions

This study, focusing on locally prepared porridges consumed by children aged 6 to 24 months in the prefecture of Fria, highlighted several key findings related to the microbiological, physicochemical, and nutritional quality of these porridges, as well as the iodine status of the children. From a microbiological perspective, the porridges exhibited total coliform concentrations ranging from 1 to 22 CFU/g, and *Staphylococcus aureus* levels ranging from 1 to 18 CFU/g, both below the regulatory thresholds of 10^3 CFU/g and 100 CFU/g, respectively. Although these values comply with standards, they nonetheless indicate the need to improve hygiene practices during preparation to minimize health risks. Nutritionally, the porridges demonstrated satisfactory levels of iron (7.5 to 8.2 mg/100 g), zinc (4.2 to 4.9 mg/100 g), calcium (300.43 to 306 mg/100 g), and vitamin A (310.66 to 316 μg RE/100 g), confirming their potential to enhance the nutritional status of young children.

Regarding iodine intake, 55% of mothers added iodized salt during cooking, which may result in some iodine losses due to heat. However, biological analyses revealed that children's urinary iodine concentrations (110 ± 5 μg/L to 198 ± 3 μg/L), free T4 levels (11.0 to 22.0 pmol/L), and TSH levels (1.3 to 3.2 mIU/L) were all within normal ranges, indicating an overall satisfactory iodine status and preserved thyroid function.

These results highlight the importance of reinforcing good hygiene practices throughout porridge preparation, ensuring the proper use and storage of iodized salt, and promoting regular quality monitoring of local porridges to support the health and development of children in the prefecture of Fria.

12. Recommendations

Based on the findings presented, we propose several recommendations aimed at sustainably improving the nutritional status of children and the quality of the porridges intended for them:

12.1. To the Health Authorities of the Fria Prefecture

- Strengthen community nutrition programs by promoting the use of locally produced flours, coupled with training sessions on hygiene and infant nutrition.
- Develop awareness campaigns to correct cooking practices related to iodized salt, emphasizing the importance of adding salt after cooking.
- Support the improvement of local porridges by introducing enriched formulations to meet the recommended energy intake of 400 kcal/100 g.

12.2. To Healthcare Professionals

- Regularly organize awareness sessions and culinary demonstrations for mothers, incorporating modules on hygiene, proper preparation of local porridges, and correct use of iodized salt.
- Establish a nutritional monitoring system for children, including regular checks of urinary iodine levels and the promotion of dietary diversification.
- Encourage the consumption of natural dietary sources of iodine, such as fish, seafood, and eggs.

12.3. To Mothers of Young Children

- Prioritize the preparation of porridges using local flours, strictly adhering to hygiene practices (e.g., hand washing, clean utensils, proper food storage).
- Add iodized salt only after cooking to preserve its iodine content.
- Store iodized salt in airtight containers, protected from humidity, heat, and light.
- Gradually diversify children's diets by introducing foods rich in iodine and essential micronutrients at the appropriate age.

12.4. To the General Population

- Promote the value of local food products for infant feeding, highlighting their nutritional value and economic accessibility.
- Adopt and disseminate good food and hygiene practices at the household level to reduce the risk of contamination.
- Support local initiatives for the production and marketing of quality iodized salt to ensure adequate iodine status across the community.

Conflicts of Interest

The authors of this work certify that they have no conflicts of interest to declare in relation to the publication of this article.

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Annexes: Survey Form

I. Identification

1. Survey Location: Fria Prefecture, Republic of Guinea
2. Survey Date: ______________________
3. Surveyor's Name: ______________________
4. Sample Number/Child: ______________________

II. General Information about the Child

5. Child's Age (months): ______________________
6. Child's Gender: ☐ Male ☐ Female
7. Child's Weight (kg): __________
8. Child's Height (cm): __________
9. Nutritional Status (weight/height z-score): __________
10. Recent Illness (last 7 days): ☐ Yes ☐ No — If yes, specify: ____________

III. Type of Porridge Consumed

11. Local flour-based porridge:

☐ Yes ☐ No — Frequency: ☐ 1 ☐ 2 - 3 ☐ 4- 6 times/day

12. Industrial infant flour-based porridge:

☐ Yes ☐ No — Frequency: ☐ 1 ☐ 2 ☐ 3+ times/day

13. Other types of porridge (specify): ________________________________
14. Age when porridge consumption began: _________ months
15. Porridge boiling duration (minutes): _________

IV. Hygiene and Preparation Practices

16. When is iodized salt added?

☐ During cooking ☐ After cooking ☐ No addition

17. Water source used for preparation:

☐ Tap water ☐ Well water ☐ Well ☐ River/other: ___________

18. Method for cleaning utensils: ☐ Water + soap ☐ Water only

☐ Other: _________

19. Frequency of porridge preparation:

☐ At every meal ☐ Once a day ☐ Prepared in large quantities and stored

V. Sample Collection for Local Porridge Analysis

20. Sample Code: E[_____]
21. Date and time of sample collection: _________
22. Storage condition: ☐ Warm ☐ Room temperature ☐ Refrigerated

VI. Microbiological Results of the Sample (to be filled by the laboratory)

23. FMAT (cfu/g): __________ ☐ Compliant ☐ Non-compliant
24. Yeasts and molds (cfu/g): __________ ☐ Compliant ☐ Non-compliant
25. Total coliforms (cfu/g): __________ ☐ Compliant ☐ Non-compliant
26. Fecal coliforms (cfu/g): __________ ☐ Compliant ☐ Non-compliant
27. E. coli: ☐ Absence ☐ Presence ☐ Compliant ☐ Non-compliant
28. Salmonella spp.: ☐ Absence ☐ Presence ☐ Compliant ☐ Non-compliant

29. Staphylococcus aureus (cfu/g): ______ ☐ Compliant ☐ Non-compliant

VII. Physicochemical Results (to be filled by the laboratory)

30. Moisture (%H): ___________ %
31. Carbohydrates (%C): ___________ %
32. Lipids (%L): ___________ %
33. Proteins (%P): ___________ %
34. Ash (%A): ___________ %
35. Starch (%S): ___________ %
36. Crude fiber: ___________ %
37. Dry matter (%DM): ___________ %
38. pH: ___________
39. Energy value (EV): ___________ Kcal/100g

VIII. Iodine Profile (iodine in salt and biomarkers in the child)

A. Information about the salt used

40. Type of salt: ☐ Coarse unrefined salt
☐ Iodized refined salt (packet/packaged)
☐ Non-iodized refined salt
☐ Other: _______________________
41. Salt brand (if known): _______________________
42. Method of salt storage:
☐ Exposed to air ☐ In a closed container ☐ Other: ____________

B. Rapid test with i-check iodine

43. Results: ____________
44. Evaluation: ☐ No iodine ☐ Low iodization ☐ Good iodization

C. Biological analysis in the child

45. Urinary iodine (µg/L): ___________
46. T4 (nmol/L): ___________
47. TSH (µIU/mL): ___________

IX. Additional Observations

48. ____
49. ____