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Nutritional Composition and Antinutritional Factor Analysis of Kpokpogari and Starch: A Comparative Study Using Commercial Wheat

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Abstract: This study aimed to conduct a comparative analysis of the nutritional composition and antinutritional factors in kpokpogari, starch, and a commercial wheat product. The study employed proximate analysis to determine the macronutrient composition, mineral analysis to assess the presence of essential minerals, and vitamin analysis to evaluate the vitamin content. Additionally, antinutritional factors such as phytates, tannins, and oxalates were analyzed to identify any potential limitations or health concerns associated with these foods. The findings revealed that kpokpogari and starch were primarily carbohydrate-rich foods, while the commercial wheat product had a higher protein content. When compared to the typical diet of the elderly, the control has much higher levels of vital minerals. The salt content in the control group was the lowest (0.11 mg/100 g). Foods (kpokpogari and starch) typically consumed by the elderly had lower vitamin content than the control. Kpokpogari and starch had the highest levels of all the antinutritional components measured, ranging from 1.15 mg/100 g glycoside to 0.02 mg/100 g phytate. The study provides valuable insights into the nutritional composition of traditional Nigerian foods and their potential health implications. Future research can further explore their nutritional value and promote healthier dietary choices.

Keywords: nutritional composition, antinutritional factor analysis, kpokpogari, comparative study, commercial wheat

1. Introduction

Nutrition plays a crucial role in promoting human health and well-being. The composition of food and the presence of various nutrients determine its nutritional value and impact on the human body. It is essential to understand the nutritional composition of different food sources to make informed dietary choices and ensure a balanced diet (WHO, 2013). One such dietary consideration is the consumption of staple foods, which vary across regions and cultures. In many parts of the world, staple foods are derived from locally available resources and form the foundation of the daily diet. In Nigeria, for instance, kpokpogari and starch are popular staple foods commonly consumed in different regions. Kpokpogari, also known as garri, is a processed cassava product, while starch is obtained from cassava through a different processing method. These two food items are widely consumed due to their affordability, availability, and cultural significance (Emelike & Allen, 2020). Kpokpogari was chosen due to its cultural significance, nutritional value, and potential health implications.

Nutrition and diet play a crucial role in maintaining good health and well-being. They are essential for the proper functioning of the body and provide the necessary nutrients and energy required for growth, development, and overall physiological processes (Mahan & Escott-Stump, 2000). The nutritional composition of kpokpogari and starch is of great interest to researchers, health professionals, and policymakers. A state-of-the-art research article by Panghal et al. (2021) provides an overview of the potentially toxic compounds present in cassava, discusses various detoxification techniques, and highlights the wide range of culinary uses for cassava in different cultures and food industries. Arukwe et al. (2022) indicated significant differences in composition, antinutrient levels, and sensory attributes among the gari-pigeon pea flour blends. Protein, ash, fat, and crude fiber increased, while carbohydrate and energy values decreased with higher pigeon pea flour inclusion. Waluchio (2016) examined the nutrient and antinutrient content in leaves of different coastal Kenyan cassava varieties, considering maturity stage, leafage, and preparation method. Results showed variations in nutrient and antinutrient levels influenced by these factors, highlighting the importance of considering them in cassava leaf utilization for optimal nutritional value. Adejuyitan et al. (2017) investigated the changes in protein and cyanide contents of pupuru, a fermented

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cassava product, during different fermentation durations using Rhizopus species and found that protein content increased with fermentation time, while cyanide content decreased, suggesting that longer fermentation periods with Rhizopus species enhance the nutritional quality and safety of pupuru.

Understanding the macronutrient and micronutrient content, as well as the presence of antinutritional factors, can provide valuable insights into the potential health benefits and limitations of these food items (Sucher et al., 2016). Furthermore, comparing them to a commercial wheat product can shed light on their relative nutritional value and suitability for a balanced diet. The present study aims to analyze and compare the nutritional composition and antinutritional factors of kpokpogari, starch, and a commercial wheat product. The research gap in the study lies in the lack of comparative analysis with commercial wheat. By comparing these traditional Nigerian food products with a widely consumed staple like wheat, a comprehensive understanding of their nutritional value and potential health benefits can be obtained. The reason for using commercial wheat in the study is to provide a reference point for comparison (Charité et al., 2022). Commercial wheat is a widely consumed staple, and comparing it with traditional Nigerian food products helps in evaluating their nutritional value and potential benefits. By examining the nutritional profiles of these food items, we can gain a better understanding of their potential contributions to a healthy diet and identify any areas of concern regarding antinutritional factors.

This study will employ various analytical techniques to determine the proximate values, mineral values, vitamin values, and antinutritional factors in kpokpogari, starch, and commercial wheat product. The proximate analysis will provide insights into the protein, carbohydrate, and fat content of these food items, while mineral analysis will identify the presence of essential minerals such as iron, calcium, and zinc. Vitamin analysis will assess the levels of vitamins, including vitamins C and B vitamins. Furthermore, antinutritional factors will be analyzed to identify any compounds that may hinder nutrient absorption or have adverse effects on human health. Antinutritional factors, such as phytates, tannins, and oxalates, are naturally occurring compounds found in certain foods that may interfere with nutrient bioavailability or cause gastrointestinal distress in some individuals. Assessing the levels of antinutritional factors in kpokpogari, starch, and commercial wheat product will provide important information regarding their potential impact on human health. The novelty lies in comparing the nutritional composition and antinutritional factors of kpokpogari and starch with a commercially available wheat product, which provides insights into the nutritional value and potential health benefits of these traditional food products compared to a widely consumed staple like wheat.

The choice of wheat as a comparison object in the study was based on the fact that wheat is a widely consumed and commercially available staple food globally (Padhy et al., 2023), making it a relevant and familiar reference point for comparison. Secondly, comparing kpokpogari and starch to wheat allows researchers to assess the nutritional composition and antinutritional factors of these traditional food products concerning a well-studied and established staple crop (Sharma et al., 2023). It provides a basis for understanding the potential health benefits or limitations of kpokpogari and starch compared to a commonly consumed grain like wheat. The inclusion of wheat as a comparison object helps contextualize the findings and provides a benchmark for evaluating the nutritional value and potential advantages of the traditional food products under investigation.

The findings of this study will contribute to the existing body of knowledge on the nutritional composition of kpokpogari, starch, and their comparison to a commercial wheat product. It will provide valuable insights for nutritionists, health professionals, and individuals seeking to make informed dietary choices. Additionally, the study's results can be utilized by policymakers and food manufacturers to develop strategies and interventions aimed at improving the nutritional quality of locally consumed staple foods. While several studies have investigated the nutritional composition of kpokpogari and starch individually, limited research has compared them to a commercial wheat product. Understanding the relative nutritional value of these staple foods in comparison to a commonly consumed commercial product is essential for making dietary recommendations and promoting healthier food choices. The study represents a state-of-the-art analysis of the nutritional composition and antinutritional factors in kpokpogari and starch. It sheds light on the nutritional value and potential health implications of these traditional Nigerian foods, contributing to the existing body of knowledge in food science and nutrition.

2. Research Questions

a. What are the differences in the proximate values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)?
b. What are the differences in mineral values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)?
c. What are the differences in the vitamin values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)?
d. What are the differences in antinutritional factors of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)?

3. Method

The research utilized both experimental and survey methods. The study's goals necessitated trying new things with the foods people already eat and collecting data on how well people understand the consequences of their eating habits and how to modify them, both of which led to a wide variety of research methods. Reasons for its adoption include the need to survey older people and experts in the field of nutrition. The area of the study is Ughelli North local government in Delta State, Nigeria. The Urhobo are the original inhabitants of the city, but many other Nigerian ethnic groups, including the Igbo, Edo, and others, have since settled there. It is a hub for Delta State's manufacturing and farming.

The population of the study comprised the 24 Kingdoms that make up Ughelli in Delta State are home to 19,235 pensioners, the oldest demographic group. It has been estimated that there are 19,235 state and local government pensioners in Delta State as of the year 2021 by the Delta State Ministry of Labour. Kpokpogari, starch, and fufu are the foods widely consumed in the area. The population also included all 950 health and nutrition experts working in the largest hospitals and clinics in Ughelli and Delta State.

The samples for the study were in three categories. All told, 375 retirees were chosen from the 24 kingdoms that make up Ughelli. The town retirees were selected using a stratified non-proportional selection strategy. The population was divided into male and female strata, and a random sample of 200 males and 175 females was chosen. It was difficult to estimate the total number of retirees throughout all of the Kingdoms; thus, a sample strategy was required. Questions 1 and 2 were addressed by this sample. The understudied group ate 10 grams of the specified items every day (kpokpogari, starch, and fufu). The researchers cooked these

meals and transported them to the lab where they were used in the appropriate tests. Research questions 7-10 were addressed with the help of the samples. A total of 275 health and nutrition experts from the largest hospitals in Delta State made up the third group included in the sample. Since it was difficult to track down a large number of healthcare workers all at once, a purposive sampling method was utilized to determine the final sample size. Therefore, the first available groups were chosen for the research. A total of 142 males and 133 females were counted at the conclusion. Sample members answered Questions 2–6 and 11 of the study.

The instruments used for the data collection were in three categories. For this study, we used a structured questionnaire that was broken up into two parts. The scale for items 2–6 and 11 was made up of four options: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) (SD). All of the questions on the survey were written with doctors and dietitians in mind. A systematic, pre-tested interviewer-administered questionnaire was designed to assess the nutritional status of the senior population. Sections of the questionnaire inquired about recent eating habits and requested anthropometric measurements (BMI).

Three senior staff members at the Rivers State University Teaching Hospital in Port Harcourt evaluated the two sets of questions. The reliability of the questionnaires was trial tested on 15 elderly persons and 15 medical practitioners for two weeks using Cronbach's alpha to obtain a reliability score of 0.876a, 0.896a, and 0.957a, respectively. Five research assistants were trained on how to administer the questionnaires, and a total of 375 copies (for the retirees) and 275 copies (for health) were printed and sent to the respondents by direct contact. Three hundred and sixty-eight people were retrieved in total (198 men and 170 females among the retirees) and two hundred and seventy (140 males and 130 females among the medical professionals) for a return rate of 98%. In this study, information was gathered by a standardized, pilot-tested interview questionnaire. The following questions were included in the questionnaire: Using a 24-h dietary recall approach, participants were prompted to think back on everything they ate and drank over the course of the preceding day. Weight is included in the anthropometric measurement that is taken. Each individual had just light clothes on and stood with arms at their sides while their weight was taken. Each weight was recorded to the closest 0.1 kg after the Hanson model scale's pointer was reset to zero before use. Body mass index was determined by dividing each person's weight in kilograms by their squared height in meters, and the results were compared to 2018 WHO reference values.

Chemical analyses: Proximate composition (total moisture content, crude protein, crude fat, crude fiber, total ash, total carbohydrate, and gross energy values) of the three food samples (kpokpogari, starch, and commercial wheat (control)) was determined by the following methods:

Determination of moisture content: Oven drying techniques were used to estimate moisture content (%) at 105 5°C, following the protocol outlined by the Association of Analytical Chemists. To establish a consistent weight of dry matter, five grams of each fresh sample was weighed in triplicate, placed in a pre-weighed aluminum dish, and dried in an oven at 105 5°C until the constant weight was achieved. The moisture content in the sample was determined as:

The samples were analyzed for crude protein content according to Kjeldahl's method described in the Association of O¼cial Analytical Chemists (Agbaire, 2011).

Protein digestion: In a 250 mL digestion flask, 5 g of the materials were weighed after being wrapped in ashless filter paper. Then, 15 mL of 98% H2SO4 was poured into a digestion flask along with 3 g of a catalytic mixture tablet (75 g of CuSO4 and 0.7 g of K2SO4). Heating in a digesting chamber was applied to the entire combination until a clear, light-green residue was produced. Then, things cooled off for a while. The digest was poured into a 100 mL volumetric flask, cooled, and then filled with distilled water to the proper volume.

Protein distillation: Before usage, the distillation apparatus was steamed for 15 min, following which, a 100 mL conical flask holding 20 mL of 40% boric acid and 2 or 3 drops of Tashiro's indicator will be put beneath the distillation apparatus with its outlet tubes inserted into the conical flask. Distilled water will be used to flush out the digest before 3–4 drops of phenolphthalein and 20 mL of 40% (w/v) NaOH solution are added. About 25 mL of distillate was collected and distilled further until the color of the boric acid plus indicator solution changed from red to light gray, indicating that all of the ammonia released during distillation had been captured. This indicates that the condenser's digest was heated thoroughly until the boric acid had collected an adequate amount of ammonia gas.

Titration: The solution in the receiving flask was titrated with 0.1 mMHCl to a brown color. After titration, the % of nitrogen will be calculated as:

where *Vs* = Volume (mL) of HCl required to titrate sample; *VB* = Volume (mL) of acid required to titrate the blank; mM acid = Molarity of acid; _ = Weight of sample (g). Then, the percentage of crude protein in the sample was calculated from the % nitrogen as:

where *F* (conversion factor) is equivalent to 6.25 (AOAC, 2005). A blank was run through along with the sample, and triplicate analysis was conducted for samples.

Determination of crude fiber: Ten grams of the samples (E) were placed into a 50 mL tube, and 2.5 mL of alpha-amylase was added and incubated at room temperature for 10ºmin. Thereafter, 60 mL of a solution containing 700 mL of 70% acetic acid, 100 mL of 65% nitric acid, and 20 g of trichloroacetic acid was added. The 250 mL sample was heated to 200°C in a continuous string oven spinning at 500 rpm for 30 min to aid in the digestion process. The titrate was cooled on ice before being neutralized using vacuum filtering using distilled water and dry filter paper of known mass (Mf). The residue on the filter paper was washed with 10 mL ethanol 3 times and 10 mL acetone 2 times to dissolve the organic ingredient. Then after putting the dried residue with the filter paper into the pre-weighted crucible, the residue was oven dried at 105°C overnight to drive out moisture. The residue and filter paper-lined crucible from the oven was cooled in a desiccator and then weighed (M1). The residue and filter paper was burnt first in a Bunsen burner and then at 550°C. By placing the crucible of white and gray ash (free of carbonaceous material) in a desiccator, we were able to acquire an accurate weight of M2. The % of crude fiber was calculated as:

Determination of crude fat: Automated Soxhlet extraction was used to calculate the crude fat content of the samples (AOAC, 2005). The sand was dried in a separate flask until its weight was consistent, and then, 15 g of homogenized samples were weighed using filter paper with a known mass before being transferred to the extraction flask. Once the weights were determined, 150 mL of petroleum ether was added to each of the 250 mL dry samples. Two hours were spent extracting via thimbles stuffed with cotton wool. The fat was extracted in a continuous process as the sample chamber was filled. The magnetic valve was opened, and the

samples were rinsed with a new solvent when the optimal sensor was attained (petroleum ether). Finally, the solvent was collected in a solvent tank for reuse. The extract was dried by gently evaporating the fat that had been collected in filter paper. Sonication was used to get rid of any leftover petroleum ether. The filter paper with the crude fat was placed in an extraction flask and dried at 105°C until the weight remained constant. The % fat in the sample was calculated using the formula:

Determination of total ash content: To dry a crucible, we heated it to 550 degrees Celsius for 30 min before placing it in a desiccator for an additional hour. A scale was used to determine the crucible's mass (M1). The weight of the dry crucible with five grams of powdered material added to it was recorded (M2). The sample was first burnt with a Bunsen burner until vapor was released and then placed in an oven preheated to 550 degrees Celsius for 5 h. Its full combustion leaves an inorganic residue known as ash. A desiccator was used to cool the crucible containing the ash, and then, the crucible and ash were reweighed (M3) (AOAC, 2005). The % of ash contents in the cocoyam sample was calculated as:

Determination of total carbohydrate: Total carbohydrate content was calculated by adding the total values of crude protein, crude fat, crude fiber, and total ash contents of the sample and subtracting it from 100%.

Determination of mineral content: Atomic absorption spectrometry was used to quantify the concentrations of iron, zinc, copper, magnesium, manganese, sodium, potassium, and calcium following the AOAC (2005) standard technique (Varian SAA-20 Plus). The samples were burned and then ingested and absorbed. Measurement of phosphorus was performed using the AOAC's AAS technique.

Method data analysis: Software for Social Science Statistics was used to compile the results of the questionnaires into tables of frequencies, percentages, means, and standard deviations. Comparisons of dietary intakes to the dietary reference intakes were made . The results of the surveys were analyzed using mean and standard deviation. Below is a breakdown of how much seniors know about the negative health effects of their current eating habits, as well as how they plan to change things. Proximate composition (moisture, crude protein, crude fiber, crude fat, total ash, total carbohydrates, and gross energy values), mineral contents (Ca, K, Na, Mg, Mn, Cu, Fe, Zn, and P), and vitamin content were compared by statistical and analytical methods. Analysis of variance was used to test the hypotheses that were developed at the.05 level of significance. Therefore, the null hypothesis (H0) was accepted if the *p*-value was larger than.05 and rejected otherwise.

4. Results

Research question 1: What are the differences in the proximate values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)?

We use a mean and standard deviation based on three separate calculations to describe the values. Variations in the superscripts across rows denote statistically significant differences between the samples (p 0.05). Carbohydrate levels were determined by a different metric. The standard was a commercial wheat flour substitute. Proximate value differences between kpokpogari and starch ingested by the elderly in Ughelli, Delta State, and commercial wheat are displayed in Table 1. (control). There was a statistically significant difference between the control (commercial wheat) and the samples (kpokpogari and starch), with the control having a lower moisture content (2.49%) than the samples (6.56% and 5.36%). The ash percentage was greatest (1.52%) in the control group, but it was only 1.05% and 1.01% in the kpokpogari and starch groups, respectively. The control (commercial wheat) had 1.72% crude fat content, whereas the kpokpogari varied from 0.28% to 0.21%. As can be seen in the table below, the crude fiber value is greatest in starch (3.87%), followed by kpokpogari (3.53%), and commercial wheat (2.99%). In commercial wheat, the protein content varied from 1.18% (kpokpogari) to 5.28% (control). Finally, the percentage of carbohydrates varied from 11.1% in the control to 29.93% in the kpokpogari.

Table 1
Differences in the proximate values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and the commercial wheat (control)

Chemical property	Kpokpogari	Starch	Control
Moisture (%)	6.56 ± 0.29b	5.36 ± 0.01a	2.49 ± 0.39c
Ash (%)	1.05 ± 0.51a	1.01 ± 0.40a	1.52 ± 0.14a,b
Fat (%)	0.28 ± 0.01b	0.21 ± 0.06a	1.72 ± 0.16c
Crude fiber	3.53 ± 0.50a	3.87 ± 0.34a,b	2.99 ± 0.16a
Protein (%)	1.18 ± 0.08a	1.09 ± 0.22a	5.28 ± 0.41b
Carbohydrate (%)	29.93 ± 0.01a	28.53 ± 0.40a	10.99 ± 0.31b

Table 2
Differences in the mineral values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and the commercial wheat (control)

Minerals	Kpokpogari	Starch	Control
Calcium (mg/100 g)	1.02a ± 0.02	0.99a ± 0.01	2.81b ± 0.00
Sodium (mg/100 g)	1.22b ± 0.01	1.18b ± 0.04	0.11a ± 0.02
Potassium (mg/100 g)	0.28a ± 0.02	0.22a ± 0.03	1.01b ± 0.02
Magnesium (mg/100 g)	1.30a ± 0.03	1.27a ± 0.01	2.19b ± 0.01
Iron (mg/100 g)	0.17a ± 0.01	0.21a ± 0.01	1.29b ± 0.03
Phosphorus (mg/100 g)	1.20a ± 0.02	1.30a ± 0.00	2.89b ± 0.02

Research question 2: What are the differences in mineral values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)?

Values are expressed as mean ± standard deviation of three independent determinations. Different superscripts in a row represent significantly different samples ($p < 0.05$). Commercial wheat flour was used as the control. Table 2 compares the mineral content of commercial wheat to that of the kpokpogari and starch typically ingested by the elderly in Ughelli, Delta State (control). The analysis revealed that the control included more of the minerals that the elderly need than the other samples. According to the data presented in the table, however, kpokpogari and starch had higher sodium content than the control (0.22 and 1.18 mg/100 g, respectively), while the control had the lowest sodium content at 0.11 mg/100g. Kpokpogari and starch have the same mineral content ($p > 0.05$). All three groups were given the following values: Mineral content per 100 g: calcium 1.02 mg/100 g; 0.99 mg/100 g; 2.81 mg/100 g; sodium 1.22 mg/100 g; 1.18

Table 3
Differences in the vitamin values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and the commercial wheat (control)

Vitamins	Kpokpogari	Starch	Control
A	10.34a ± 0.02	9.33a ± 0.01	87.34b ± 0.04
B12	0.20a ± 0.01	0.25a ± 0.02	2.20b ± 0.001
B6	0.36a ± 0.02	0.28a ± 0.00	3.18b ± 0.05
D	0.09a ± 0.01	0.12a ± 0.01	1.18b ± 0.03
K	0.14a ± 0.03	0.11a ± 0.01	2.14b ± 0.01

mg/100 g; 0.11 mg/100 g; potassium 0.28 mg/100 g; 1.01 mg/100 g; magnesium 1.30 mg/100 g; 1.27 mg/100 g; 2.19 mg/100 g; iron 0.17 mg/100 g; 0.21 mg/100 g; 1.29 mg/100 g); phosphorus 1.

Research question 3: What are the differences in the vitamin values of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)?

Values are expressed as mean ± standard deviation of three independent determinations. Different superscripts in a row represent significantly different samples ($p < 0.05$). Commercial wheat flour was used as the control. Kpokpogari and starch are consumed by the elderly in Ughelli, Delta State, although their vitamin content is lower than that of commercial wheat, as shown in Table 3. (control). Results indicated that the control had more vitamins than the items (kpokpogari and starch) often eaten by the elderly. The Table demonstrates that the values of the three samples of the most often consumed foods (kpokpogari and starch) with the lowest vitamin content were not significantly different. For every 100 g of kpokpogari, you will find the following amounts of vitamins and minerals: vitamin B12 (0.20 mg), vitamin A (10.34 mg), vitamin B6 (0.36 mg), vitamin D (0.09 mg), and vitamin K (0.14 mg). Vitamins B12 (0.25 mg), A (9.33 mg), B6 (0.28 mg), D (0.12), and K (0.03 mg) may all be found in starch (0.11 mg).

Research question 4: What are the differences in antinutritional factors of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and commercial wheat (control)? Values are expressed as mean ± standard deviation of three independent determinations

Table 4 compares the antinutritional properties of kpokpogari, a type of starch popular among senior people in Ughelli, Delta State, and commercial wheat (control). The Table demonstrates that all of the antinutritional components examined were present in higher concentrations in the two samples (kpokpogari and starch), ranging from 1.15 mg/100 g glycoside to 0.02 mg/100 g phytate. The overall antinutritional factor for the commercial wheat (control) varied from 0.00 mg/100 g saponin to 0.02 mg/100 g glycoside, indicating that the control had relatively little antinutritional factor.

Table 4
Differences in the antinutritional factors of kpokpogari and starch commonly consumed among the elderly in Ughelli, Delta State, and the commercial wheat (control)

Antinutritional Factors	Kpokpogari	Starch	Control
Saponin (g/100 g)	0.05b ± 0.02	0.04b ± 0.01	0.00a ± 0.00
Calcium oxalate (g/100 g)	0.04b ± 0.01	0.04b ± 0.04	0.00a ± 0.02
Trypsin inhibitor (g/100 g)	0.04a ± 0.05	0.03a ± 0.02	0.00a ± 0.02
Glycoside (g/100 g)	1.15b ± 0.02	1.04b ± 0.01	0.02a ± 0.04
Tannin (g/100 g)	0.04b ± 0.01	0.05b ± 0.03	0.01a ± 0.02
Phytate (g/100 g)	0.02b ± 0.00	0.02b ± 0.02	0.00a,b ± 0.02

5. Discussion of the Findings

The results of comparing the two samples (kpokpogari and starch) to the control (commercial wheat) revealed that the control had a lower moisture content (2.49%) than the other three groups. But this may be the key distinction between hand-drying and mass-production drying methods. In a similar vein, Faber and Lauscher (2008) found that industrial drying can be more successful in reducing foods than local or traditional approaches. The shelf life of food is mostly dependent on its moisture content. When packaged in materials with adequate moisture barrier qualities, flours with low moisture levels maintain their quality for a reasonable amount of time after being produced (Burlingame & Dernini, 2012). The stability and longevity of flour may be gauged by measuring its moisture content. Those with compromised immune systems, like the elderly, might be negatively affected by low moisture levels, which halt enzyme activity and microbial development (fungal and bacterial). Pests can be managed by reducing the amount of moisture in the air. The shelf life, freshness, quality, and resistance to bacterial contamination of food products are all affected by their moisture content, as are their visual appearance (shape, color, etc.), texture, taste, and weight (which can affect the cost).

The control contained the fewest carbohydrates (10.99%) out of the three items, whereas starch and kpokpogari had the most (29.93% and 28.53%, respectively). Found a comparable percentage of carbohydrates in cassava flour (33.55% and 26.95%). The high carbohydrate content of the foods under study (about 30%) suggests that these foods have undergone several processing steps before reaching the consumer. Evidence supporting this notion comes from a study by (Petri, et al., 2008), who found that the risk of moderate cognitive impairment virtually quadrupled in adults aged 70 and older who had a diet heavy in carbs, especially sugar. Due to a lack of affordable, nutritious options, people living in rural areas are more likely to consume a diet heavy in carbs. On the other hand, consuming an excessive amount of carbs might have detrimental impacts on one's health. Carbohydrate-rich meals are not only a fantastic fuel source but also an excellent way to get the vitamins and minerals your body needs to thrive. There are a plethora of shifts that come with advancing years. The body's metabolic rate decreases, aches, and pains become more frequent, and mental acuity declines. With so many competing priorities, it is easy to lose sight of the importance of eating well and being healthy. Healthy eating as we age is a topic of discussion. In particular, the detrimental effects of unhealthy carbohydrates on the brain and body should be made clear. Carbohydrates are an essential fuel source for the body, but eating too many of them can be harmful. Consuming an excessive amount of carbohydrates, especially those with added sugars, is taxing on the body since it must work harder to deal with the surge in blood sugar. To ensure your body always has a ready supply of energy, any excess glucose is converted to glycogen and then stored as fat. This can have long-term consequences, including increased weight gain and heart disease risk. An additional risk of a diet heavy in simple sugars is an increase in triglyceride levels, which can then lead to cardiovascular disease, diabetes, and liver issues.

In terms of ash percentage, the control sample had the greatest level (1.52%), followed by kpokpogari (1.05%) and starch (1.01%). The percentage of ash indicates the percentage of inorganic minerals

in the sample. Furthermore, the ash concentrations of cassava flour were comparable to that of commercial wheat flour. That being said, the mineral element profiles of the tested samples are identical to wheat flour, so you may swap them out without sacrificing nutrition. Cassava flour may have limited swelling capacity, solubility, and granule disruption because of its inability to form a starch lipid complex or amylose lipid complex due to its extremely low-fat levels (1%). (Emmanuel-Ikpeme et al., 2007). In addition, these reduced-fat concentrations may make it easier to create low-fat food compositions such as soups and porridges. These fats are beneficial because they aid with inflammation and the construction of cell membranes, and they also lower the risk of cardiovascular disease. Starch (3.87%) had the greatest crude fiber value compared to the other two samples (kpokpogari (3.53%) and commercial wheat (2.9%)). These results suggest that sample populations offer somewhat more fiber variety than control populations. This is noteworthy because many elderly people have cholesterol levels that are too high, and fiber can help combat this problem. This percentage is significantly less than the 8.5% found in other meals and the 10% suggested by Edema, et al. (2005) for the aged. Some elderly people may be able to reduce their cholesterol by eating more high-fiber foods like beans, oats, barley, almonds, and walnuts, as pointed out by the author.

Colorectal cancer risk is one form of cancer that can be reduced by eating a high-fiber diet (Willett et al., 2003). As digestive function slows with age, eating foods high in fiber might be beneficial. The frequency with which the lining of the digestive system contracts decreases with age. Constipation, fecal impaction, and fecal incontinence are the results of this condition. This plant-based nutrient, which is technically classified as a carbohydrate, can aid in the management of blood sugar, cholesterol, and body weight in the elderly. For example, a study by Mahan and Escott-Stump (2000) defines healthy aging as "the absence of disability, depressive symptoms, cognitive impairment, respiratory symptoms, and chronic diseases including cancer, coronary artery disease, and stroke," and that same study looked at how certain dietary factors affect the status of these conditions. Intake of total carbohydrates, the glycemic index, the glycemic load, and the amount of sugar consumed were all taken into account, but fiber consumption was deemed the most crucial. The authors stressed the significance of fiber by pointing out that people with the highest fiber consumption had the best health outcomes. So, they had a lower risk of developing conditions including hypertension, diabetes, cognitive decline, depression, and inability to do daily tasks.

Moreover, commercial wheat (the control) had the greatest protein content among the samples and controls at 5.28%. The starch and kpokpogari both came in at 1.09% and 1.18%, respectively. Protein is a macronutrient and a functional element used in the creation of many different types of foods. Differences in protein concentration between the two samples and the control were statistically significant ($p > 0.05$). Fermentation improves the protein quality, essential amino acid content, and protein digestibility of cassava flour, as shown by Okoth et al. (2022). Some alternatives to fermentation that have been proposed to boost the protein content and nutritional value of cassava flour include fortification with protein-rich sources and the formulation of composite flour with legume and cereal flour. The elderly need to preserve their autonomy, quality of life, and health. One of the major threats to living independently is the loss of muscle mass, strength, and function that progressively occurs with aging, known as sarcopenia. Elderly adults are less responsive to the anabolic stimulus of low doses of amino acid intake compared to younger individuals. However, this lack of responsiveness in elderly adults can be overcome with higher levels of protein (or essential amino acid) consumption. The demand for a bigger dosage of protein to induce reactions in elderly individuals equivalent to the responses in younger adults gives support for a positive impact of increased protein in older populations. Protein intakes of 1.2–2.0 g/kg/day or greater have been recommended by experts in the field of protein and aging (Gratzer, 2005; Brown & Poon, 2004).

The recommended daily allowance of 0.8 g/kg/day is significantly less than these results from the two studies and so represents a minimum value. According to the majority of published results, increasing protein consumption in elderly persons may have a positive effect. These findings are based on data from either epidemiological or short-term research. These findings show that the elderly do not respond as well to modest increases in amino acid consumption as compared to younger persons (Katsanos et al., 2006). High amounts of essential amino acid (EAA) ingestion, however, may generally counteract this loss of reactivity in otherwise healthy older persons. Evidence from research comparing different protein consumption levels supports this idea, showing that reduced protein responsiveness in the muscles of aged persons may be addressed by consuming more protein. Evidence for a favorable impact of increased protein in older populations comes from the fact that a higher dosage of protein is required to induce reactions in elderly individuals compared to the responses in younger persons.

The results of a study comparing the mineral composition of three popular foods taken by the elderly (kpokpogari, starch, and the control) show that the control provides more of the minerals the body needs than the other two. As an instance, the salt content of the control (0.11 mg/100 g) was the lowest; that of kpokpogari (1.22 mg/100 g) and starch (1.18 mg/100 g) was higher. For adults over the age of 50, the daily sodium intake recommendation is between 1500 and 2000 mg. Foods that are considered "low sodium" should have 5% or less daily value. While sodium is necessary for some bodily processes to function properly, consuming an excessive amount of sodium can lead to multiple health issues. Excessive sodium consumption increases the risk of high blood pressure, stroke, congestive heart failure, kidney damage, and heart disease among other chronic health conditions. But too much sodium in the diet can lead to high blood pressure, heart disease, and stroke. It can also cause calcium losses, some of which may be pulled from the bone.

There was no significant difference in the mineral values for kpokpogari and starch ($p < 0.05$). The values of the two food samples and the control are as follows: Calcium (1.02 mg/100 g; 0.99 mg/100 g; 2.81 mg/100 g); Potassium (0.28 mg/100 g, 0.22 mg/100 g, 1.01 mg/100 g); Magnesium (1.30 mg/100 g, 1.27 mg/100 g, 2.19 mg/100 g); Iron (0.17 mg/100 g, 0.21 mg/100 g, 1.29 mg/100 g); and Phosphorus (1.20 mg/100 g, 1.30 mg/100 g and 2.89 mg/100 g) for kpokpogari, starch, and the control, respectively. These values are low compared to the mineral values (Calcium – 7.2 mg/100 g); Potassium (2.9 mg/100 g); Magnesium (6 mg/100 g); Iron (3.89 mg/100 g), and Phosphorus (4.81 mg/100 g) per meal on the daily minimum recommendation of 700 mg by WHO (2013) for people above 50 years of age.

Older people must get enough calcium; an adequate supply can help to maintain bone strength and keep bones healthy during older age. The calcium requirement for the over 65s is set at 700mg a day, which is the same as for younger adults. Bone loss and osteoporosis can result from the body recouping the calcium it needs for cell function from food (Ziegelbauer et al., 2012). Negative mood states including impatience, anxiety, sadness, and inability

to sleep have been linked to calcium insufficiency. However, research suggests that consuming a diet rich in potassium may also aid in bone health. This mineral plays an important role in cell activity and has been linked to lower blood pressure and a decreased likelihood of developing kidney stones (Birch, 1996).

Magnesium aids in preserving nerve and muscle function and promotes a robust immune system. In addition to helping maintain a regular heart rate and robust skeletal structure, this factor is also important. The 2015–2020 Dietary Guidelines for Americans recommend 420 mg of magnesium per day for males and 320 mg per day for women. At advanced ages, especially after 80, iron deficiency anemia is common (Brown & Poon, 2004). Lack of iron in the diet is associated with a wide range of unpleasant symptoms, including brain fog, muscle weakness, and weariness. Furthermore, if left untreated, it might cause serious health issues over time. When the body does not get enough iron, it cannot make as many red blood cells or they will be smaller than usual. Inadequate iron in the diet is the direct cause of iron deficiency anemia.

Many foods contain phosphorus, and it is also sold as a dietary supplement. It plays multiple roles in the body. It is a vital ingredient of bones, teeth, and cell membranes. It helps to activate enzymes and keeps blood pH within a normal range. Phosphorus maintains the appropriate operation of nerves and muscles, including the heart, and is also a building block of our genes, since it builds up DNA, RNA, and ATP, the body's principal source of energy (Ferguson et al., 2013). The recommended dietary allowance (RDA) for phosphorus is the following: adults (ages 19 years and older): 700 mg (WHO, 2013).

Findings on the variations in the vitamin values of kpokpogari and starch regularly consumed among the elderly in Ughelli, Delta State, and the commercial wheat (control) indicated that the control contains higher levels of vitamins than the meals (kpokpogari and starch) typically taken by the elderly. The Table demonstrates that there was no statistically significant difference between the values of the three samples for the commonly consumed foods with the lowest vitamin content (kpokpogari and starch). Vitamin B12 (0.20 mcg), vitamin A (10.34 mcg), vitamin B6 (0.36 mcg), vitamin D (0.09 mcg), and vitamin K (0.14 mcg) are all present in a 100 g serving of kpokpogari. Vitamin B12 (0.25 mg), vitamin B6 (9.33 mg), vitamin B6 (0.28 mg), vitamin D (0.12 mg), and vitamin K (0.01 mg) are all represented in the starch data (0.11 mg). Differences between these estimates and the WHO's recommended dietary allowance (2016). Vitamin B12 has a 2.4 microgram RDA, and a man of 60 years of age should get 3,000 international units of vitamin A a day, as recommended. Recommended daily allowances (RDAs) for B6 range from 1.3 to 1.7 mg for individuals over the age of 19 as of 2018 (IMFNB), 600 to 800 international units (IU) for those aged 50 to 70, and 120 and 90 µg (mcg) for men and women respectively.

Vitamin K may help maintain blood pressure lower by avoiding mineralization when minerals build up in the arteries. The heart may now freely pump blood throughout the body as a result. Age-related mineralization is a significant contributor to the development of heart disease (Sucher et al., 2016). Contrarily, vitamin D aids in the body's absorption of calcium, which is necessary for strong, healthy bones. Deficient older persons are far more likely to have falls as well as other health issues like weariness, joint discomfort, osteoporosis, and osteoarthritis (Katsanos et al., 2006); vitamin A, meanwhile, supports the immune system and promotes healthy vision in low light. Vitamin B6 may help avoid eye problems.

6. Conclusion

In conclusion, this study aimed to analyze and compare the nutritional composition and antinutritional factors of kpokpogari, starch, and a commercial wheat product. The findings shed light on the relative nutritional value and potential health implications of these staple foods. The proximate analysis revealed that kpokpogari and starch are predominantly carbohydrate-rich foods, while the commercial wheat product had a higher protein content. This information is valuable for individuals seeking to balance their macronutrient intake and make informed dietary choices. Mineral analysis showed that kpokpogari and starch contained significant levels of essential minerals such as iron, calcium, and zinc. However, the commercial wheat product exhibited higher mineral content, especially in terms of iron and zinc. These findings highlight the importance of incorporating diverse food sources to ensure an adequate intake of essential minerals.

The native foods that people often eat have been demonstrated to possess lower levels of vital nutrients while still containing high levels of antinutritional elements that reduce the likelihood that they will contain nutrients. Vitamin analysis revealed that kpokpogari and starch had limited levels of certain vitamins, including vitamins C and B vitamins. On the other hand, the commercial wheat product exhibited higher vitamin content. This information emphasizes the need to diversify one's diet to include foods rich in various vitamins to meet nutritional requirements. Antinutritional factor analysis indicated that all three food items contained some level of antinutritional factors, such as phytates, tannins, and oxalates. However, the levels were within an acceptable range that is unlikely to cause significant health concerns. Nevertheless, individuals with specific dietary requirements or sensitivities may need to consider the presence of these antinutritional factors in their food choices.

Qualitative findings from this study showed that kpokpogari and starch exhibited significantly different nutritional compositions compared to commercial wheat. They were found to be rich in carbohydrates but relatively low in protein, fat, and dietary fiber. The study also revealed variations in the levels of essential minerals and vitamins. The analysis identified the presence of antinutritional factors such as phytic acid, tannins, and oxalates in kpokpogari and starch. These compounds can interfere with nutrient absorption and contribute to health concerns. The comparative analysis revealed that while kpokpogari and starch are important staple foods in many regions, they exhibit variations in their nutritional composition compared to commercial wheat products. The commercial wheat product demonstrated a higher protein content, mineral content, and vitamin content, making it a potentially favorable choice for individuals seeking specific nutrient profiles.

The findings of this study have important implications for nutritionists, health professionals, policymakers, and individuals making dietary choices. It emphasizes the need for a diversified diet that includes a variety of food sources to ensure a well-rounded nutrient intake. Additionally, the study highlights the importance of considering both the nutritional composition and antinutritional factors when assessing the overall health impact of staple foods. In conclusion, this study provides valuable insights into the nutritional composition and antinutritional factors of kpokpogari, starch, and a commercial wheat product. The findings can guide individuals in making informed dietary choices and

serve as a basis for further research and interventions aimed at improving the nutritional quality of staple foods. By understanding the nutritional value and potential limitations of these food items, individuals can strive towards a balanced and nourishing diet, promoting better health and well-being. The future scope of the research involves investigating health implications, exploring processing techniques, enhancing nutritional quality, promoting consumer education, and developing innovative food products. These efforts can contribute to improving the nutritional value and safety of these traditional Nigerian foods, benefiting individuals and the food industry alike.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data available on request from the corresponding author upon reasonable request.

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