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MINERALS, VITAMINS, AND ANTINUTRITIONAL CONTENTS OF MAIZE *OGI* ENRICHED WITH AFRICAN YAM BEAN (*Sphenostylis stenocarpa*) SOY FLOURS (*Glycine max*) AND THEIR PROTEIN ISOLATES

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ABSTRACT

Ogi is a traditional fermented cereal gruel produced from cereals. Its nutritional qualities were improved with enrichment with flours and protein isolates from African yam bean and soy bean, while antinutritional factors decreased. Material balance was used in formulation to attain 16% protein dry weight. Sample B contained 53.40% maize *ogi* and 46.60% African yam bean flour; Sample C contained 76.40% maize *ogi* and 23.40% soy flour; Sample D contained 89.40% maize *ogi* and 10.60% African yam bean protein isolate; and Sample E contained 90.20% maize *ogi* and 9.80% soy protein isolate. Standard laboratory procedures were used for all analyses. Enrichment significantly altered results ($p \leq 0.05$). Mineral and vitamin contents of maize *ogi* increased significantly following enrichment. Calcium rose from 56.03 mg/100g in Sample A to 170.95 mg/100g in Sample C. Phosphorus increased from 154.76 to 271.74 mg/100g. Sodium rose from 8.00 to 44.26 mg/100g, and potassium from 178.20 to 449.74 mg/100g. Thiamine levels increased from 0.51 to 0.96 mg/100g. Riboflavin rose from 0.27 to 0.57 mg/100g, and niacin from 1.97 to 2.70 mg/100g.Antinutritional factors also showed significant differences ($p \leq 0.05$). Phytate increased from 2.57 to 9.48 mg/100g, oxalate from 0.22 to 5.05 mg/100g in Sample B, tannins from 0.34 to 7.57 mg/100g, and trypsin inhibitor activity from 0.46 to 10.59 mg/100g. Protein isolate samples D and E recorded lower antinutritional values. Overall, addition of African yam bean, soy flours, and their protein isolates to maize *ogi* reduced antinutritional contents to tolerable levels while increased mineral and vitamin contents.

Keywords: Malnutrition, African Yam Bean Flour, Soy Flour, Protein Isolates, Maize Ogi, Vitamin Contents, Mineral Content, Antnutritional Contents

INTRODUCTION

A fermented gruel or porridge produced from grains (usually maize, sorghum, or millet) is referred to locally as "*ogi*" or "pap." In most African nations, it is a staple diet (Ameh et al., 2023). In northern and eastern Nigeria, it is also referred to as koko and akamu, respectively. It is frequently used as a regular morning cereal in many homes and as a supplemental diet for infants and young children. In Nigeria, wet-milled, fermented cereal grains are used to make this smooth, free-flowing, thin porridge, which is frequently provided as a breakfast cereal and newborn supplemental food (Darlington, 2015). Cereals, including sorghum, maize, and millet, or their combinations, are used to make *ogi* (Ameh et al., 2023). The starchy nature of the cereal-based gruels, such as maize *ogi*, makes them absorb too much water, which results in a bulky gruel with lower nutrient density (Adepeju et al., 2024).

A common cereal, maize can be processed into starch and used for mashed maize (egbo), pap (*ogi*), solid gel (eko), and soup thickeners. For every 100 g of dry seed, it has the following nutrients: calories (360–370 kcal), carbohydrates (72–75 g), protein (8–11 g), fat (3–5 g), crude fibre (2–3 g), ash (1-2 g), and moisture (10–12 g). Donkwa, popcorn, aadun, kokoro, and elebute are among the foods that may be made from it. After rice and wheat, it is a frequent food item in the family of carbohydrates that can be boiled or roasted (Adeyeye et al., 2017).

Soybean (*Glycine max*), a legume, has been used to improve the diets of millions of people, particularly low-income earners in developing nations, because of its high nutrient content. It is one of the healthy and reasonably priced sources of plant protein. For human nutrition, soybeans include 40% proteins, 20% fats, 5% minerals, and B vitamins (Lee et al., 2007). Legumes must be processed in order to increase their palatability or eliminate some of their unwanted components (Lee et al., 2007). African yam bean (*Sphenostylis stenocarpa*) is an underutilised legume having nutritional value comparable to other widely used legumes, unlike soybeans. This nutrient-rich legume has 340–380 kcal of calories, 19–30 g of protein, 50–65 g of carbohydrates, 1-3 g of fat, 3–8 g of crude fibre, 2–5 g of ash, and 8–12 g of moisture per 100 g of raw, dry seeds. Through direct consumption or fortification and enrichment of less nutritious staples, the crop's nutrient density makes it a suitable food crop for reducing the problems associated with hunger in many poor nations. Grown widely in Western, Eastern, and Central Africa, the African yam bean (*Sphenostylis stenocarpa*) is an underutilised, difficult-to-cook leguminous plant (6). According to Khushairay et al. (2023), protein isolates are the most refined type of protein products with the highest protein concentration (90%) based on dry weight. It is a perfect raw ingredient for usage in beverages, newborn and children's milk foods, and some speciality foods due to its high protein content, colour, flavour, and functional qualities (Fasolin et al., 2019; Khushairay et al., 2023). Many legumes, including soybean, bambaranut, cowpea, peanut, canola, cashew nut, almonds, sesame, pinto, and navy beans, have been used to make protein isolates (Ashfaq et al., 2021). The nutritional value of maize *ogi* was improved by combining flours and protein isolates from African yam bean and soybean with maize in *ogi* recipes. In many developing nations, malnutrition is still a serious problem, particularly for children and low-income groups whose diets frequently lack vital nutrients. *Ogi* is a popular cereal-based gruel in Nigeria that is often produced from maize and other cereals. It is nutritionally deficient due to its high starch content and low protein levels (Ameh et al., 2023). Protein-energy malnutrition and deficits in vital amino acids, vitamins, and minerals might result from regularly consuming *ogi* as a staple meal (World Health Organisation, 2009). The dearth of reasonably priced, nutrient-dense choices endures despite

numerous attempts to fortify diets based on cereals. Furthermore, despite their high protein and nutritional content (Teniola, 2021; Hew et al., 2024), legumes like soybean and African yam bean, which are rich in bioactive peptides, are still underutilised in traditional diets. By adding these nutrient-rich components, the nutritional profile of maize *ogi* could be improved. By creating and testing *ogi* enriched with flours from African yam bean, soybean, and their protein isolates, this study addressed the issue of malnutrition and evaluated the product's potential to offer a nutritionally balanced food source that can enhance the dietary intake of vulnerable populations.

Ogi, when produced solely from maize and other cereal grains, is low in protein and may put high-patronage communities especially those with children under five, at risk for protein energy malnutrition. In addition to resolving serious health issues, processing *ogi* enhanced with protein-rich legumes such as African yam beans, soy flours, and their protein isolates could fight malnutrition deficiencies. The broad objective of this study was to investigate the minerals, vitamins, and antinutritional contents of maize *ogi* enriched with African yam bean, soy flours, and their protein isolates.

MATERIALS AND METHODS

Materials

Maize (*Zea mays*) var. Sammaz 13 (TZEE-Y), African yam bean *(Sphenostylis stenocarpa)* var. (TSa51), *and* soybean (*Glycine max*) var. (TGX-306-036C) were obtained from Wednesday Market, Dutsin-Ma, Kastina State. All equipment used was obtained from the Department of Food Science and Technology, Federal University, Dutsin-Ma, Katsina State.

Methods

Preparation of Maize *Ogi*

Ogi was prepared utilising the modified method of Chike and Onuoha (2016), as seen in Figure 1. Maize grains were procured, sorted to discard inferior grains, cleansed to eliminate debris and extraneous elements, and then soaked in purified tap water for 24 hours at ambient temperature. The soaked grains were subsequently rinsed with clean water, wet-milled utilising a commercial maize mill, and wet-sieved through a 250 µm sieve. The husks were discarded, and the filtrate (slurry) was fermented for 48 hours. Upon completion of the fermenting period, the *ogi* was extracted utilising a cheesecloth to expel the water. The moist *ogi* sample was subsequently desiccated in an oven at 60 °C for 12 hours. The desiccated starchy cake was ground and sifted to produce *ogi* flour. The blend formulation is displayed in Table 1.

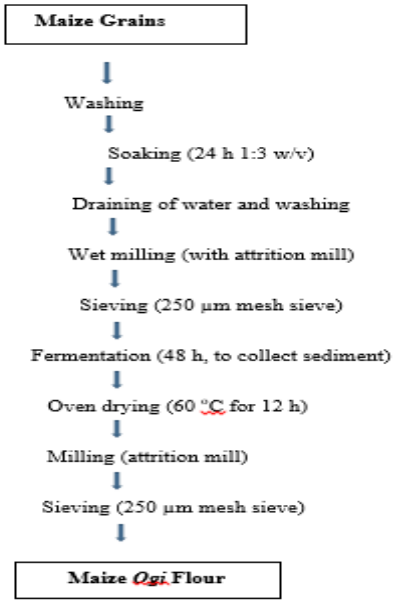

Figure 1: Flow Diagram for the Processing of Maize *Ogi*
Source: Chike and Onuoha (2016) Modified

Production of African Yam Bean Flour

African yam bean flour was produced following the modified procedure outlined by Igbokwe et al. (2024), as shown in Figure 2. African yam bean was sorted to eliminate foreign elements and defective seeds. Soaked for 10 hours at a 1:2 weight to volume ratio, boiled for 30 minutes, manually dehulled by friction between the palms, then oven dried in a Gallenkamp moisture extraction oven at 60°C for 12 hours. The desiccated African yam bean was processed in a disc attrition mill to produce fine flour, thereafter sieved through a 250 µm screen and stored in sealed plastic containers, which were then positioned on shelves at ambient temperature until utilised.

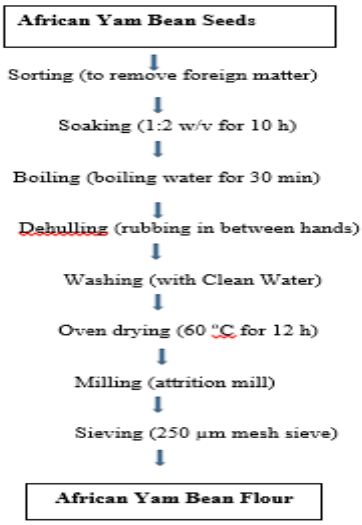

Figure 2: Flow Chart for the Processing of African Yam Bean Flour
Source: Igbokwe et al. (2024)

Production of Soybean Flour

The modified procedure reported by Bolarinwa et al. (2016) was used to process soybean flour. To get rid of pebbles, stones, and other unwanted items, the soybean seeds were sorted. They were soaked, cleaned, and soaked for 10 hours. After soaking the soybean seeds, they were drained and boiled for 15 minutes. Then, the hulls were removed by rubbing them between the palms and rinsing them with clean water. The soybean seeds were dried in the oven at 60 ºC for 12 hours and ground into fine flour. As shown in Figure 3, the soybean flour was sifted through a 250 µm mesh sieve to make it smooth. The flour was defatted with n-hexane (flour to solvent ratio 1:5 w/v) while being stirred with a magnet for four hours. To get rid of the trace of leftover hexane, the defatted flours were put in a fume cupboard for 6 hours to dry. The flours were put in plastic tubes until needed.

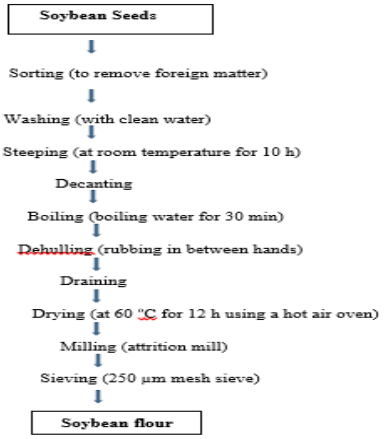

Figure 3: Flow Chart for the Processing of Soybean Flour
Source: Bolarinwa et al. (2016)

Processing of African Yam Bean Protein Isolate

A modified isoelectric precipitation method, as described by Gbadamosi et al. (2012), was used. African yam bean protein isolates were obtained from defatted African yam bean flour. The defatted flour was mixed with distilled water in a 1:10 (w:v) ratio. Then, 1.0 M NaOH was used to change the pH to 7.5 so that the protein could dissolve. A magnetic stirrer was used to mix the mixtures together for four hours and then spun them at 3,500 xg for thirty minutes. We threw away the waste and filtered the supernatant through cheesecloth. Thereafter, 1.0 M HCl was used to bring the pH down to 4.5, which caused most of the proteins to settle out. After that, the mixture was spun in a centrifuge for 30 minutes at 3500 x g. The resulting precipitate was mixed back into 25 ml of distilled water, frozen at 0 °C, and then freeze-dried at -52 °C to make a powder that flows freely. The African yam bean protein isolates were kept in a sealed tube at 4 °C until they were tested. Figure 4 shows the flow chart for processing African yam bean protein isolates.

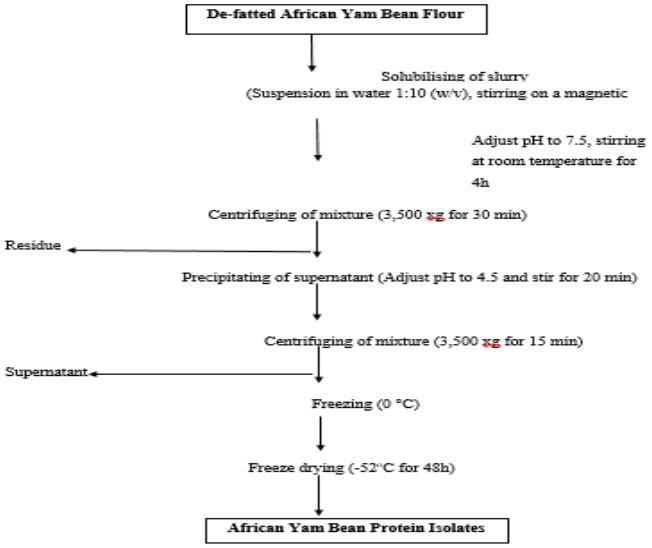

Figure 4: Flow Chart for the Processing of African Yam Bean Protein Isolates
Source: Gbadamosi et al. (2012) Modified

Processing of Soy Protein Isolate

Protein was isolated from defatted soy flour utilising a modified isoelectric precipitation method as described by Gbadamosi et al. (2012). The defatted flour was suspended in distilled water at a 1:10 (w:v) ratio. An adjustment to pH 8.5 was subsequently made using 1.0 M NaOH to solubilise the protein. The resultant mixture was agitated with a magnetic stirrer for 4 hours and subsequently centrifuged at 3,500 xg for 30 minutes. The residue was disposed of, and the supernatant was filtered through cheesecloth and adjusted to pH 4.5 with 1.0 M HCl to precipitate the majority of the proteins. Subsequently, the mixture was subjected to centrifugation at 3500 x g for 30 minutes. The resulting precipitate was re-dispersed in 25 ml of distilled water, frozen at 0 °C, and subsequently freeze-dried at -52 °C to produce a free-flowing powder. The soy protein isolate was preserved in a sealed tube at 4 °C until analysis. Figure 6 illustrates the flow chart for the preparation of soy protein isolates. The blend formulation is presented in Table 1.

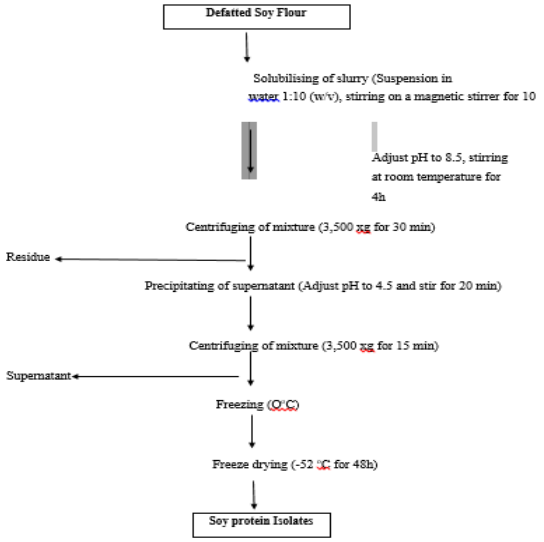

Figure 5: Flow Chart for the Processing of Soy Protein Isolates
Source: Gbadamosi et al. (2012) Modified

Table 1: Blend Formulation to Achieve (16 %) Protein Content for *Ogi* Blended Pap

Samples	Maize Flour (MF)	African Yam Bean (AYBF)	Soybean Flour (SF)	African Yam Bean Protein Isolate (AYBPI)	Soy Protein Isolate (SPI)	Total
A	100	-	-	-	-	100
B	53.40	46.60	-	-	-	100
C	76.40	-	23.60	-	-	100
D	89.40	-		10.60	-	100
E	90.20	-	-	-	9.80	100

Determination of Mineral and Vitamin Composition of Maize *Ogi* Enriched African Yambean, Soy Flours, and Their Protein Isolates.

Determination of Potassium Content

The method of AOAC (AOAC, 2016) was used in determining the potassium content of samples. One gram of the sample was dissolved in 20 ml of acid mixture (650ml of concentrated HNO_3; 80ml PCA; 20ml conc H_2SO_4) and aliquots of the diluted clear digest were taken for photometry using Flame analyser.

Determination of Phosphorus Content

The method of AOAC (AOAC, 2016) was used in determining the potassium content of the samples. Two gram of food samples was ashed for 4 hours at 60 ^oC and five millilitres of 6N HCl and several drops of nitric acid were added. It was then heated to dissolve the ash completely, cooled and transferred to a 100 ml volume flask and diluted to volume with the volume flask. An aliquot was pipetted, which contained five milligrams of phosphorus, into a 100ml volume flask. The sample was added to the molydovanadate reagent to 100 ml, and the colour was allowed to develop for 10 minutes. The absorbance was read at 400nm against a phosphorus standard curve.

Determination of Sodium Content

The method of AOAC (AOAC, 2016) was used. The weight of 0.2542 g of NaCl was dissolved in 1 litre of distilled water to give 100ppm sodium. This working standard solution was diluted to produce a range containing 0 – 10ppm sodium and made up to the 100 ml mark, and a 2 ml sample aliquot (sample stock solution) was read using a JENWAY PFP7 flame photometer. The concentration of the test mineral in the sample was calculated with reference to the graph (standard curve) and obtained as follows:

$$Na\ (mg/100g) = \frac{100 \times X \times VF \times D}{W \times 100 \times Va} \quad (x)$$

W = Weight of the sample analysed
X = Concentration of Na obtained from the standard curve
VF = Total volume of digest/extract (100ml)
Va = Volume of extract used
D = Dilution factor

Determination of Calcium Content

Calcium was determined using the atomic absorption spectrophotometer described by AOAC (AOAC, 2016). Calcium carbonate (2.495 g) was dissolved and diluted to 100ml with de-ionised water. This solution contained 1000 mg Ca^{2+} ions, and from this stock solution, calcium standards of the following concentration levels 0.0, 3.0, 6.0, 9.0 were prepared. The absorbance of both the sample and the standard working aliquot was determined in the AGILENT (Model 5805, Agilent Spec England) atomic absorption spectrophotometer at 239.9 nm. The concentration of the test mineral in the sample was calculated with reference to the graph (standard curve) and obtained as follows:

$$Ca\ (mg/100g) = \frac{100 \times X \times Vf \times D}{W \times 100 \times Va} \quad 9 \quad (xi)$$

W = Weight of the sample analysed
X = Concentration of Ca obtained from the standard curve
Vf = Total volume of extract
Va = Volume of extract used
D = Dilution factor

Determination of Thiamine Content

The method of AOAC (AOAC, 2016) was used. Five grams of homogenized sample was poured into 100 ml volumetric flasks, and 0.1 N HCI was added and mixed. It was autoclaved for 30 minutes at 121 ^oC. The samples were allowed to cool, and interfering substances were precipitated by adjusting the pH to 6.0, followed immediately by readjusting the pH to 4.5. This was then diluted to volume with water and filtered. Five millilitres of 6% enzyme (mylase) was added and incubated for 3 hours at 45-50 ^oC. This was then cooled and pH adjusted to 3.5 and diluted with water to volume, mixed and filtered. Ten millilitres of the diluted extract was oxidised by passing it through a SepPak C_{18} cartridge followed by 5ml 0.01 M phosphate buffer at pH 7.0. The Vitamin was separated by HPLC using a 4.6 mm X 25 cm ultraphere ODS, 5 columns and detected by fluorescence at 360 nm/415 nmex/em. The thiamine content was measured by the calculation below:

$$\mu g/g = CX\ VX\ (DF/WT) \quad (xii)$$

Where C = Concentration of vitamin in µg/ml obtained from peak height or area of sample and standard
V = Sample Volume, ml
DF = Dilution factor
WT = Sample weight, g.

Determination of Riboflavin Content

The method of AOAC (AOAC, 2016) was used to determine the riboflavin content. Riboflavin was extracted with dilute acids, and after removing the interfering substances by treatment with $KMn0_4$, it was then determined in a fluorimeter at 450-500 mm wavelength. Two grams of the sample and 10 mg of riboflavin were poured into a conical flask, 50 ml of 0.2 M NaHCO3 was boiled on a water bath for an hour, allowed to cool and the pH adjusted to 6.0 using NaOH, also 1N HCl was added to lower the pH to 4.5, it was filtered in a 100 ml measuring flask and volume was made up to the mark. Two test tubes were marked as 1 and 2 to remove interference. One millilitre (1 ml) of acetic acid (glacial) was added to each test tube, it was mixed, and 0.5ml of 3% $KMn0_4$ was added. The fluorimeter was adjusted to zero deflection against $0.1NH_2SO_4$ and 100 against tube no 2. 20mg of sodium hydrogen sulphate was added to the test tubes, and fluorescence was measured within 10 seconds and was recorded as blank.

The riboflavin content was measured by the calculation below:

W=Weight of sample.
X = (reading of sample 1) - (reading of sample blank)
Y= (reading of sample + standard tube 2)- (reading of sample + standard blank)

$$\text{Riboflavin (mg per g of sample)} = \frac{x}{Y-X} = \frac{1}{w} \quad (xiii)$$

Determination of Niacin Content

The method described by AOAC (AOAC, 2016) using High Performance Liquid Chromatography was used in determining the niacin content. The first step was the use of alkaline digestion on the food sample. Niacin derivatives such as coenzymes and niacinamide were converted into total niacin by alkaline digestion with aqueous calcium hydroxide. Following alkaline extraction of food, niacin was purified and concentrated using C18 and a cation exchange cartridge (SCX). The purified extract was determined by HPLC at a detection wavelength of 254 nm using a C8 column and PIC A reagent in 15 % methanol. Food samples were finely ground and mixed well before taking a sample aliquot. An analytical balance was used to weigh accurately 1 g of sample and put it into a 50 ml PP centrifuge tube. Alkaline Extraction was performed by weighing 0.75 g Ca $(OH)_2$ and added into

the centrifuge tubes, which contained the 1.0 g sample. Including a 'duplicate' sample, a 'control' sample, a 'recovery' sample, a 'niacin standard' and a 'blank'. and to the 'recovery' sample, 1.0 g of food sample was added in 1.0 ml niacin stock standard of 100 ug/ml and then 0.75 g Ca $(OH)_2$. To the 'niacin standard' tube was added 1 ml stock standard (100 ug/ml) and then 0.75 g of Ca (OH). The 'blank' sample, which contained only water and Ca (OH). A 25 ml measuring cylinder was used to add 10 ml UHQ water into all tubes, and finally, a glass rod was used to mix each tube well, and then 10 ml of UHQ water was added. The glass rod was rinsed as well.

Determination of Selected Antinutritional Composition of Maize *Ogi* Enriched with Flours and Protein Isolates from African Yam Bean and Soybean.

Determination of Phytate

Phytic acid content was determined as described by Onwuka (Onwuka, 2005). The test sample was extracted with 0.2N hydrochloric acid. The extract (0.5 ml) was transferred into a test tube fitted with a ground glass stopper. Ferric solution (1 ml) was added, the tube was covered and heated in a boiling water bath for 30 minutes. After cooling, the content of the tube was centrifuged (3000 xg) for 30 min. The supernatant (1 ml) was transferred to another test tube, and 1.5 ml of 2,2-bipyridine solution was added. Absorbance of the solution was measured at 519 nm against distilled water, and the concentration was obtained from a calibration curve.

Determination of Tannins

Tannins were quantified as outlined by Onwuka (Onwuka, 2005). Each sample (1g) was suspended in distilled water (10ml) and stirred. The mixture was allowed to remain at room temperature for 30 minutes and subsequently centrifuged. 2.5 ml of the supernatant was transferred into a 50 ml volumetric flask. 2.5 ml of standard tannic acid solution was placed into a distinct 50 ml flask. One millilitre of Folin-Denis reagent was added to each flask, followed by 2.5 millilitres of saturated sodium carbonate solution. The solution was diluted to the 50 ml level and allowed to stand for 90 minutes at ambient temperature. Absorbance was recorded at 250 nm, with the reagent blank set to zero. The tannin content was calculated using An (absorbance of test sample), As (absorbance of standard solution), C (concentration of standard solution), W (weight of sample utilised), Vf (total volume of extract), and Va (volume of extract analysed), as detailed below.

$$\%\ Tannin = \frac{An}{As} X\ C\ X\ \frac{100}{w}\ X\ \frac{Vf}{VaA} \qquad \text{(xiv)}$$

Trypsin Inhibitor Assay

The trypsin inhibitory activity (TIA) was assessed according to the methodology outlined by Ijarotimi and Keshinro (2013). The measurement was based on the degree to which an extract of the test sample inhibited bovine trypsin's action on the substrate benzoyl-DL-arginine-p-nitroanilide (BAPNA). Each sample (1 g) was subjected to continuous extraction at ambient temperature for 3 hours with 50 ml of 10 mmol/L NaOH, utilising a mechanical shaker (GallenKamp orbital shaker, Surrey, UK). The pH of the resultant slurry was modified from 9.4 to 9.6 using 1 mol/L sodium hydroxide. After extraction, the solution was agitated and diluted with distilled water to achieve a trypsin inhibition of 40-60% at 37 ℃ with 1 cm^3 of the extract. The corresponding dilutions were recorded, and TIA was computed in milligrams of pure trypsin per gram of material, utilising the following equation:

$$TIA = \frac{2.632\ DA}{} \qquad \text{(xv)}$$

Where: D - dilution factor, A -change in absorbance at 410nm due to trypsin inhibition per cm^3 of diluted sample extract, and S -weight of the sample.

Determination of Oxalates

Oxalates were quantified by the AOAC method (AOAC, 2016). Each sample (1 g) was placed in 100 ml conical flasks, to which 75 ml of 3 mol/L H2SO4 was added. The solution was periodically agitated with a magnetic stirrer for approximately 1 hour and subsequently filtered using Whatman No. 1 filter paper. A 25 ml sample filtrate was collected and titrated with hot (80-90 ℃) 0.1 N potassium permanganate (KMnO4) until a subtle pink hue, lasting at least 30 seconds, was observed. The oxalate concentration in each sample was derived using the conversion: 1 ml of 0.1 permanganate equals 0.006303 g of oxalate.

Statistical Analysis of Samples

Data obtained were subjected to analysis of variance (ANOVA) followed by Duncan's Multiple Range Test to compare treatment means; differences were considered significant at 95% ($p \leq 0.05$) (SPSS V21 software)

RESULTS AND DISCUSSION

Mineral Contents of Maize *Ogi* Enriched with African Yam bean, Soy Flours, and Their Protein Isolates

The results of the vitamin and mineral contents of maize *ogi* enriched with African yam bean, soy flours, and their protein isolates (mg/100 g protein) are presented in Tables 2 and 3.

The sodium content of the control (100 % maize *ogi*) and fortified samples ranged between 8.00 and 44.26 mg/100 g. The 100 % maize *ogi* had the lowest sodium content (8.00) mg/100 while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest sodium content (44.26) mg/100g. *Ogi* from 89.40 maize flour and 10.60 African yam protein isolate, 90.20 maize flour and 9.80 soy protein isolates, 53:40 maize flour and 46.60 African yam bean flour had 8.95, 10.02, and 31.01 mg/100 g, respectively. The results of the sodium content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

Calcium content of the control (100 % maize *ogi*) and fortified samples ranged between 56.03 and 101.95 mg/100 g. The 100 % maize *ogi* had the lowest calcium content (56.03) mg/100 while the *ogi* from 76.40 maize flour and 23.40 soy flour had the highest calcium content (101.95) mg/100 g. *Ogi* from composites of 89.40 maize flour and 10.60 African yam protein isolate, 90.20 maize flour and 9.80 soy protein isolates, 53:40 maize flour and 46.60 African yam bean flour had 58.19, 61.50, and 81.64 mg/100g, respectively. The results of the calcium content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

The phosphorus content of the control (100 % maize *ogi*) and fortified samples ranged between 154.76 and 271.74 mg/100 g. The 100 % maize *ogi* had the lowest phosphorus content (154.76) mg/100 while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest phosphorus content (271.74) mg/100 g. *Ogi* from 89.40 maize flour and 10.60 African yam protein isolate, 90.20 maize flour and 9.80 soy protein isolates, 53:40 maize flour and 46.60 African yam bean flour had 179.67, 195.73, and 201.93 mg/100 g phosphorus content, respectively. The results of the phosphorus content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

Potassium content of the control (100 % maize *ogi*) and fortified samples ranged between 178.20 and 449.74 mg/100 g. The 100 % maize *ogi* had the lowest potassium content (178.20) mg/100 while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest potassium content (449.74) mg/100 g. *Ogi* from composites of 89.40 maize flour and 10.60 African yam protein isolate, 90.20 maize flour and 9.80 soy protein isolates, 53:40 maize flour and 46.60 African yam bean flour had 181.24, 203.70, and 283.70 mg/100 g potassium content, respectively. The results of the potassium content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

Vitamin Contents of Maize *Ogi* Enriched with African Yam Bean, Soy Flours, and Their Protein Isolates

The thiamine content of the control (100 % maize *ogi*) and fortified samples ranged between 0.23 and 0.96 mg/100 g. *Ogi* from 89.40 maize flour and 10.60 African yam protein isolate had the lowest thiamine content of 0.23 mg/100g, while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest thiamine content (0.96 mg/100 g. *Ogi* from 90.20 maize flour and 9.80 protein isolates, 100 % maize *ogi,* and 53:40 maize flour and 46.60 African yam bean flour had 0.35, 0.51, and 0.64 mg/100 g thiamine content, respectively. The results of the thiamine content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

The riboflavin content of the control (100 % maize *ogi*) and fortified samples ranged between 0.14 and 0.57 mg/100 g. *Ogi* from 89.40 maize flour and 10.60 African yam protein isolate had the lowest riboflavin content of 0.14 mg/100g, while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest riboflavin content (0.57 mg/100 g. *Ogi* produced from 90.20 maize flour and 9.80 protein isolates, 100 % maize *ogi,* and 53:40 maize flour and 46.60 African yam bean flour had 0.19, 0.27, and 0.32 mg/100 g riboflavin content, respectively. The results of the riboflavin content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends. Niacin content of the control (100 % maize *ogi*) and fortified samples ranged between 1.21 and 2.70 mg/100 g. *Ogi* from 89.40 maize flour and 10.60 African yam protein isolate had the lowest niacin content of 1.21 mg/100g, while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest niacin content (2.70 mg/100 g. *Ogi* from 90.20 maize flour and 9.80 soy protein isolates, 100 % maize *ogi,* and 53:40 maize flour and 46.60 African yam bean flour had 1.26, 1.97, and 2.23 mg/100 g niacin content, respectively. The results of the niacin content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

Antinutritional Composition of Maize *Ogi* Enriched with African Yam Bean, Soy Flours, and Their Protein Isolates (mg/100g).

The results of the antinutritional composition of the maize *ogi* enriched with African yam bean, soy flours, and their protein isolates are shown in Table 4. The oxalate content of the control (100 % maize *ogi*) and supplemented samples ranged between 0.10 and 5.05 mg/100 g. *Ogi* from 100 % maize flour had the lowest oxalate content of 0.10 mg/100 g, while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest oxalate content of 5.05mg/100g. Composite *ogi* from 90.20 maize flour and 9.80 soy protein isolates, 89.40 maize flour and 10.60 African yam protein isolate, and 53:40 maize flour and 46.60 African yam bean flour had 0.13, 0.22, and 3.18 mg/100 g oxalate content, respectively. The results of the oxalate content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends. The phytate content of the control (100 % maize *ogi*) and fortified samples ranged between 1.85 and 9.48 mg/100 g. *Ogi* from 100 % maize flour had the lowest phytate content (1.85 mg/100 g while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest phytate content of 9.48 mg/100g. *Ogi* produced from composites of 90.20 maize flour and 9.80 soy protein isolates, 89.40 maize flour and 10.60 African yam protein isolate, and 53:40 maize flour and 46.60 African yam bean flour had 1.86, 2.57, and 8.6 mg/100 g phytate content, respectively. The results of the phytate content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends. Tannin content of the control (100 % maize *ogi*) and the supplemented ranged between 0.21 and 7.57 mg/100 g. *Ogi* from 100 % maize flour had the lowest tannin content of 0.21 mg/100 g, while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest tannin content of 7.57 mg/100g. *Ogi* produced from composites of 90.20 maize flour and 9.80 soy protein isolates, 89.40 maize flour and 10.60 African yam protein isolate, and 53:40 maize flour and 46.60 African yam bean flour had 0.26, 0.34, and 5.18 mg/100 g tannin content, respectively. The results of the tannin content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

The trypsin inhibitor content of the control (100 % maize *ogi*) and fortified samples ranged between 0.11 and 10.59 mg/100 g. *Ogi* from 100 % maize flour had the lowest trypsin inhibitor content (0.11 mg/100 g), while *ogi* from 76.40 maize flour and 23.40 soy flour had the highest trypsin inhibitor content 10.59 mg/100g. *Ogi* from 90.20 maize flour and 9.80 soy protein isolates, 89.40 maize flour and 10.60 African yam protein isolate, and 53:40 maize flour and 46.60 African yam bean flour had 0.38, 0.46 and 6.90 mg/100 g trypsin inhibitor content, respectively. The results of the trypsin inhibitor content of the maize *ogi* showed a significant difference ($p \leq 0.05$) among flour blends.

Discussion

Mineral Contents of Maize-Based Ogi Enriched with African Yam Bean, Soybean Flours and Their Protein Isolates (mg/100 g)

The results of the mineral contents of maize *ogi* enriched with African yam bean, soy flours, and their protein isolates is presented in Table 2. The sodium concentration in the soy isolates enriched *ogi* (C) (44.26 mg/100g) was greater than that of the control and isolate samples, although comparable to the value of 43.76 mg/100g reported by Ameh et al. (2022). The unfortified *ogi* (A) exhibited the minimal sodium concentration of 8.00mg per 100g. All results exhibited substantial differences ($p \leq 0.05$) from one another. The sodium content ranged from 8.00 to 44.26 mg/100g, exceeding the 7.12 to 8.56 mg/100g reported by Akinsola et al. (2017) in their nutritional evaluation of maize-millet-based complementary foods fortified with soybean, yet falling short of the 58.60 to 67.99 mg/100g documented by Adeoti and Osundahunsi (2017) in their study of the nutritional characteristics of maize-based complementary food enriched with fermented and germinated Moringa oleifera seed flour. Sodium is typically ingested as salt; it is crucial for regulating water content and maintaining the osmotic pressure of bodily fluids. It also facilitates the transportation of CO2 in the bloodstream. Nonetheless, sodium is a mineral whose consumption is regarded as a contributing element in the aetiology of hypertension, so a reduced intake is recommendedThe calcium concentration in the *ogi* samples varied from 56.03 to 101.95 mg per 100 g. The control sample exhibited the lowest calcium concentration (56.03 mg/100 g), whereas the soy-enriched *ogi* sample (C) demonstrated the highest calcium concentration (101.95 mg/100 g). The elevated calcium concentration in the flour-enriched *ogi,* in

comparison to the isolates-enriched *ogi* and the control sample, may be ascribed to superior mineral retention in whole flours, whereas protein isolation diminishes some minerals (Adeyeye et al., 2024). The calcium levels in both the control and enriched *ogi* align with the lower range documented by Ijarotimi (2013) for maize-cowpea supplemental foods (50-80 mg/100 g) and by Oluwole et al. (2012) for maize-soy blends (40-90 mg/100 g). The elevated calcium levels in flour-enriched *ogi* above the documented values indicated that fortification with legumes (African yam bean and soy flours) significantly enhances calcium content, which is advantageous for newborn bone growth and neuromuscular function. The phosphorus concentration in both fortified and unfortified *ogi* (154.76 to 271.74 mg/100 g) is comparable to the values reported by Ameh et al. (2022) (155.90 to 272.00 mg/100 g). The results exhibited significant differences ($p \leq 0.05$) across the samples. The inclusion of flours and protein isolates from African yam bean and soy flours increased phosphorus content, indicating that both African yam bean and soybean are abundant in phosphorus. Comparison of flour-enriched *ogi* with protein isolate-enriched *ogi* indicated that the former contained a higher concentration of phosphorus than the latter. This may be ascribed to the presence of ash in the flours in contrast to the protein isolate flours. The ash level of food serves as an indicator of its mineral contents, as ash represents the inorganic residue left after the removal of water and organic matter through heating in the presence of an oxidising agent (2012). The phosphorus concentration in this study exceeded the range of 159.30-182.00 mg/100 g reported by Bello et al. (2020), who evaluated the physico-chemical and sensory aspects of supplemental foods derived from blends of malted and non-malted sorghum, soybean, and moringa oleifera seed flours. The recommended dietary allowance (RDA) for phosphorus in infant nutrition is ≥180 mg/100 g (FAO & WHO, 1998; Haque et al., 2013). All fortified *ogi* samples contained phosphorus levels exceeding this threshold, indicating that both the flours and protein isolates enriched *ogi* are sufficient in phosphorus, which is essential for the growth, maintenance, and repair of body tissues, as well as for the proper development and formation of bones in infants and children, in conjunction with calcium and magnesium. The potassium concentration in the control and enriched ogi varied from 178.20 to 449.74 mg/100 g, with the control ogi exhibiting the lowest value of 178.20 mg/100 g, and the soy-enriched ogi displaying the highest at 449.74 mg/100 g. Flour-enriched *ogi* retained a greater quantity of potassium than isolates, attributable to superior mineral retention in whole flours, whereas the processing of protein isolates incurs some losses (Okafor et al., 2023). The potassium content in both control and enhanced *ogi* isolates aligns with the lower range documented by Adeleke and Odedeji (2023) for maize-cowpea composite flours (150 - 250 mg/100 g).

Flour-enriched *ogi* exhibited values above those previously documented, indicating the efficacy of flour fortification in augmenting potassium levels, which facilitates fluid equilibrium, nerve conduction, and muscular function in newborns.

Table 2: Mineral Contents of Maize *Ogi* Enriched With African Yam Bean, Soy Flours, and Their Protein Isolates (Mg/100g)

Samples	Sodium (mg/100g)	Calcium (mg/100g)	Phosphorus (mg/100g)	Potassium (mg/100g)
A	8.00 ± 0.02^{e}	56.03 ± 0.06^{e}	154.76 ± 1.41^{e}	178.20 ± 1.15^{a}
B	31.01 ± 0.51^{b}	81.64 ± 0.53^{b}	201.93 ± 2.08^{b}	283.70 ± 1.04^{a}
C	44.26 ± 0.66^{a}	101.95 ± 0.73^{a}	271.74 ± 0.54^{a}	449.74 ± 336.65^{a}
D	8.95 ± 0.03^{d}	58.18 ± 0.04^{d}	179.67 ± 0.71^{d}	181.24 ± 1.86^{a}
E	10.02 ± 0.05^{c}	61.50 ± 0.05^{c}	195.73 ± 0.95^{c}	203.70 ± 7.20^{a}

Values are means ± standard deviations of triplicate determinations.
Means within the same column with different superscripts differed significantly ($p \leq 0.05$)
Key: Sample A (100 % maize *ogi*), Sample B (53:40 maize *ogi* and 46.60 African yam bean flour), Sample C (76.40 maize *ogi* and 23.40 soy flour), Sample D (89.40 maize *ogi* and 10.60 African yam protein isolate) and Sample E (90.20 maize *ogi* and 9.80 soybean protein isolates).

Vitamin Contents of Maize-Based Ogi Enriched With African Yam Bean, Soybean Flours and Their Protein Isolates (Mg/100 G)

The results of the vitamin contents of maize *ogi* enriched with African yam bean, soy flours, and their protein isolates is presented in Table 3. The thiamine concentration (0.23 - 0.51 mg/100 g) was lower in the protein isolate-enriched *ogi* (E) and greater in the flour-enriched *ogi* (B and C). All results exhibited substantial differences ($p \leq 0.05$) from one another. The thiamine concentration was greater than the 0.20 to 0.33 mg/100 g reported by Bello et al. (2020). The fortified and unfortified *ogi* satisfied the Adequate Intake (AI) for infants aged 0 to 1 year (0.2 to 0.3 mg/day), indicating that *ogi* can be produced from various combinations while ensuring the niacin requirements of infants are met. The diminished thiamine levels in the protein isolates enriched *ogi* (D and E) may be ascribed to the processing methods utilised from the raw materials to the extraction of African yam bean and soybean incorporated in the mixtures. Thiamine functions as a cofactor for essential enzymes in carbohydrate metabolism. Moderate thiamine deficiency constitutes a notable public health issue globally. A significant deficiency results in beriberi, a condition linked to excessive consumption of refined grains and cereals, coupled with inadequate intake of animal and dairy products. The riboflavin concentration in this study (0.14 to 0.57 mg/100 g) falls within the range reported by Adepoju and Etukumoh (2014) (0.29 to 0.64 mg/100 g) for the nutrient composition and appropriateness of four regularly utilised local supplemental foods in Akwa Ibom State, Nigeria. The incorporation of flours from African yam bean and soybean with maize *ogi* resulted in a proportional enhancement of riboflavin levels, but the opposite effect was observed in the protein-enriched porridge. This may be ascribed to the significant vitamin content present in bean flours. The Institute of Medicine, Food and Nutrition Board, states that the Adequate Intake (AI) for infants aged 0-1 year is 0.3 to 0.4 mg/day, and the flour-enriched *ogi* (B and C) satisfies this criterion. Riboflavin is crucial to the metabolism of carbohydrates. It supplies the reactive components of the flavin coenzymes (FMN and FAD), which function as electron carriers in redox processes (FAO & WHO, 2004). Deficiency results in stunted growth, compromised vision, dermatitis, chapped and erythematous lips, and inflammation of the oral mucosa and tongue. *ogi* varied from 1.21 to 2.70

mg/100 g, which is within the range of 3.25 to 3.31 mg/100 g reported by Ogomegbunam (Ogomegbunam, 2025) for *ogi* enhanced with termite protein hydrolysate, yet lower than the value of 0.3 to 0.61 mg/100 g reported by Ochelle et al. (2019) for bread made from wheat, water yam, and soybean. A significant difference ($p \leq 0.05$) was observed between the samples. Niacin contributes to energy metabolism and tissue creation, and it also supports normal growth and development (Boronovskiy et al., 2024).

Table 3: Vitamin Contents of Maize *Ogi* Enriched With African Yam Bean, Soy Flours, and Their Protein Isolates (Mg/100g)

Samples	Thiamine (mg/100 g)	Riboflavin (mg/100g)	Niacin (mg/100g)
A	0.51 ± 0.02^{c}	0.27 ± 0.02^{c}	1.97 ± 0.01^{c}
B	0.64 ± 0.02^{b}	0.32 ± 0.02^{b}	2.23 ± 0.03^{b}
C	0.96 ± 0.02^{a}	0.57 ± 0.02^{a}	2.70 ± 0.03^{a}
D	0.23 ± 0.02^{e}	0.14 ± 0.01^{e}	1.21 ± 0.02^{e}
E	0.35 ± 0.02^{d}	0.19 ± 0.01^{d}	1.26 ± 0.02^{d}

Values are means ± standard deviations of triplicate determinations.
Means within the same column with different superscripts differed significantly ($p \leq 0.05$)
Key: Sample A (100 % maize *ogi*), Sample B (53:40 maize *ogi* and 46.60 African yam bean flour), Sample C (76.40 maize *ogi* and 23.40 soy flour), Sample D (89.40 maize *ogi* and 10.60 African yam protein isolate) and Sample E (90.20 maize *ogi* and 9.80 soybean protein isolates).

Antinutritional Composition of Maize-Based Ogi Enriched With African Yam Bean, Soybean Flours and Their Protein Isolates

The results of the antinutritional contents of maize *ogi* enriched with African yam bean, soy flours, and their protein isolates is presented in Table 4. Cereals and legumes are nutrient-dense; yet, the bioavailability of these nutrients is often diminished by antinutritional substances, such as phytate, oxalate, tannin, and trypsin inhibitors. Soaking, boiling, fermentation, and sprouting are processing procedures commonly utilised to diminish or eradicate these anti-nutritional elements in foods (Amadike et al., 2013). This study revealed that the 100 % maize *ogi* (A) exhibited the lowest oxalate concentration (0.10 mg/100g), whereas the soybean flour-enriched *ogi* (C) demonstrated the greatest oxalate concentration (5.05 mg/100g). Nonetheless, the values of the results exhibited substantial differences ($p \leq 0.05$) from one another. The higher oxalate levels in the flour-enriched samples (B and C) relative to the other samples may be attributed to the inclusion of African yam bean and soybean in the mixtures. The oxalate levels in this study vary from 0.20 to 7.10 mg/100g, which was consistent with the findings of Opeifa et al. (2015), who investigated the production and quality assessment of *ogi* derived from fermented maize and horse eye bean. Oxalates influence calcium and magnesium metabolism and interact with proteins to create complexes that hinder peptic digestion. Patients with calcium oxalate kidney stones are recommended to restrict their consumption of foods containing 410 mg of oxalate per serving, ensuring that total oxalate intake does not surpass 50 to 60 mg per day (Asouzu & Umerah, 2020). Given that none of the *ogi* samples have oxalate levels over 50 mg/g, it can be concluded that both the fortified and unfortified *ogi* in this study are safe for consumption and will not negatively impact nutritional bioavailability. Phytate is a highly stable and effective chelating agent regarded as an anti-nutrient due to its capacity to bind divalent minerals and inhibit their absorption. The phytate levels (1.85 to 9.48 mg/100 g) were lower than the range (2.54 to 13.36 mg/100 g) documented by Uchechukwu et al. (2017) in their study on the nutritional composition and antinutritional properties of maize *ogi* cofermented with pigeon pea, but higher than the range (2.16 to 2.45 mg/g) reported by Agbaje et al. (2022) in their investigation of the anti-nutrient and mineral properties of complementary food derived from a blend of malted red sorghum and defatted soybean flour. The reduced phytate concentration of unfortified *ogi* (100% maize flour) relative to enriched *ogi* may be attributed to the leaching effect resulting from the soaking and dehulling processes applied to maize grain before milling. The reduced phytate concentration in the 100% maize *ogi* may result from the hydrolysis of phytate by the enzyme phytase into lower inositol phosphates, which are thought to be activated during fermentation by organisms (yeasts) whose hydrolytic capacity is augmented by the fermentation process. Phytates are recognised for forming complexes with iron, zinc, calcium, and magnesium, rendering these minerals less bioavailable and consequently insufficient in food samples, particularly for youngsters, as noted by Uchechukwu et al. (2023). Phytate concentrations of 10 to 50 mg per 100 g do not adversely affect zinc and iron absorption. Consequently, the phytate levels in the different ogi analysed in this study indicate that the porridges are within safe limits and pose no health risks.

Tannins are naturally occurring polyphenolic compounds found in plants. Their primary property is to bind and precipitate proteins, hence obstructing their digestion and absorption. The tannin concentrations (0.21 to 7.57 mg/100g) are inferior to the range (0.92 to 8.70 mg/100g) documented by Opeifa et al. (2015) for *ogi* derived from both fermented and unfermented horse eye bean. The results indicated a significant difference ($p \leq 0.05$) across the samples. The reduced tannin levels observed in the protein isolate-enriched *ogi* (D and E) compared to the flour-enriched *ogi* may be attributed to the isolative impact of the protein isolates incorporated in those mixtures. The low tannin content in the 100% maize flour (A) may be attributed to fermentation. Food processing methods such as fermentation, sprouting, and decanting diminish the anti-nutritional components of food, consequently activating hydrolytic enzymes (α and β amylases) and proteolytic enzymes (Asouzu & Umerah, 2020). Tannins can induce browning or other pigmentation issues in both fresh and processed foods (Uchechukwu et al., 2017). Trypsin inhibitors are antinutritional agents that diminish protein digestibility by obstructing the function of digestive enzymes. This investigation revealed that TIA varied from 0.11 to 10.59 mg/100 g, with statistically significant differences ($p \leq 0.05$) among the samples. Samples enhanced with protein isolate (D and E) and the control (A) exhibited significantly lower TIA compared to the flour-enriched ogi (B and C), which demonstrated greater levels. The elevated TIA in flour-enriched *ogi* is attributed to the presence of trypsin inhibitors in legume flours, which are

predominantly eliminated during the manufacture of protein isolates (Nwokolo & Smart, 2022). The low TIA in protein isolates indicates that processing methods, including heating, soaking, and isoelectric precipitation, efficiently diminish antinutrients, enhancing the safety and digestibility of these products for newborns (Adeyeye et al., 2023). In comparison to prior studies, the TIA in flour-enriched *ogi* (6.90 - 10.59 mg/100 g) falls within the range reported for maize-soy and maize-legume complementary foods (5 - 12 mg/100 g), whereas the TIA in isolates and control (0.11 - 0.46 mg/100 g) is significantly lower, thereby affirming the efficacy of protein isolate processing in diminishing antinutrients. Minimising trypsin inhibitors is crucial as elevated TIA might hinder protein assimilation and growth in newborns, whereas reduced TIA in protein isolates enhances the nutritional value of supplemented *ogi.* The anti-nutritional components were observed to be elevated in the flours compared to the protein isolate samples. This may result from the methods involved in protein isolation. The nutritional impact of these anti-nutrients pertains to their interaction with proteins and minerals. Despite the rise in anti-nutritional components in the flour-enriched *ogi* (D and E), their levels remain within the recommended safe limits. All samples were minimal and are unlikely to adversely affect nutrient bioavailability.

Table 4: Antinutritional Contents of Maize *Ogi* Enriched With African Yam Bean, Soy Flours, and Their Protein Isolates

Samples	Oxalate (mg/100g)	Phytate (mg/100g)	Tannins (mg/100g)	Trypsin Inhibitors Activity(mg/100)
A	0.10 ± 0.02^{c}	1.85 ± 0.06^{d}	0.21 ± 0.02^{c}	0.11 ± 0.01^{c}
B	3.18 ± 0.79^{b}	8.61 ± 0.53^{b}	5.18 ± 0.04^{b}	6.90 ± 0.06^{b}
C	5.05 ± 1.07^{a}	9.48 ± 0.03^{a}	7.57 ± 0.26^{a}	10.59 ± 0.19^{a}
D	0.22 ± 0.03^{c}	2.57 ± 0.03^{c}	0.34 ± 0.02^{c}	0.46 ± 0.02^{c}
E	0.13 ± 0.02^{c}	1.86 ± 0.02^{d}	0.26 ± 0.02^{c}	0.38 ± 0.53^{c}

Values are means ± standard deviations of triplicate determinations.
Means within the same column with different superscripts differed significantly ($p\leq0.05$)
Key: Sample A (100 % maize *ogi*), Sample B (53:40 maize *ogi* and 46.60 African yam bean flour), Sample C (76.40 maize *ogi* and 23.40 soy flour), Sample D (89.40 maize *ogi* and 10.60 African yam protein isolate) and Sample E (90.20 maize *ogi* and 9.80 soybean protein isolates).

CONCLUSION

The study examined how the mineral, vitamin, and antinutritional contents of five *ogi* (porridge) formulations were affected by the addition of flours and protein isolates from African yam bean and soy flours with maize *ogi*. And the following conclusions were reached. Legume flours and protein isolates from African yam beans and soybeans were added to the maize *ogi* flour, which considerably changed its quality parameters. The addition of African yam bean, soybean flours, and their protein isolates greatly enhanced the mineral and vitamin content of maize *ogi.* Sodium, calcium, phosphorus, potassium, thiamine, riboflavin, and niacin were all higher in the enriched samples than in the control sample. Sample C had the highest mineral and vitamin contents from the enrichment materials, as evidenced by the highest micronutrient values across the majority of criteria. Enrichment with African yam bean, soybean flours, and their protein isolates had a substantial impact on the antinutritional content of maize *ogi.* Samples (B and C) containing bean flours showed higher levels of oxalate, phytate, tannins, and trypsin inhibitor activity than the control and protein isolate samples.

Antinutritional levels were highest in sample B and lowest in samples D and E. Enriching maize *ogi* with flour or protein isolates from African yam beans or soyflour is advised to assist boost its nutritious content, especially in an environment with limited resources. Where protein isolates from legume sources, like African yam beans and soybeans, might be difficult to prepare at the home level, their flours should be used to enhance maize *ogi.*

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