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PHYSICOCHEMICAL AND SENSORY PROPERTIES OF BREAD PRODUCED FROM BLEND OF WHEAT UNRIPE PLANTAIN AND WATERMELON SEEDFLOUR

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ABSTRACT

The study evaluated the quality of bread produced from the addition of unripe plantain and watermelon seed to wheat flour. Flours were prepared from unripe plantain, watermelon seed and wheat flour and blended in the ratios 100:0:0, 90:5:5, 80:10:10, 70:15:15 and 60:20:20 (Wheat: unripe plantain: watermelon seed flour). Bread were prepared from the blends and evaluated for the physical, chemical composition, antinutrient properties and sensory properties using standard methods. The loaf volume, specific loaf volume and loaf weight content varied from 430.00 to 780.00 cm^3 158.13 to 221.7 g and 2.71 to 3.51 cm^3/g respectively. The moisture, ash, crude fiber, fat, crude protein and carbohydrate contents varied from 28.35 to 32.46%, 0.93 to 1.38%, 0.79 to 1.24%, 9.39 to 14.20%, 11.38 to 18.24% and 32.48 to 49.99%,respectively. The potassium, magnesium, calcium and iron contents of the bread varied from 191.30 to 333.65 mg/kg, 88.50 to 199.50 mg/kg, 180.75 to 310.10 mg/kg and 11.10 to 20.55mg/kg, respectively. The phytate, oxalate, tannin, saponin and alkaloid varied from 3.87 to 8.02 mg/100g, 6.21 to 16.15 mg/1oog, 5.82 to 8.27 mg/100g,5.84 to 13.74 mg/100g and 0.18 to 0.54 mg/100g respectively. The mean score of the bread showed taste, flavor, crust/crumb colour, texture, mouth feel and overall acceptability ranged from 7.65 to 8.70, 7.05 to 8.20, 7.00 to 8.30, 7.00 to 8.45, 6.95 to 7.85 and 6.60 to 8.75respectively. It is concluded that substitution of wheat unripe plantain and watermelon seed flour in bread production up to 40% improved the macro- and micronutrient content of the composite breads and also had a higher preference in terms of sensory properties. Substitution level of 20% unripe plantain and 20% watermelon seed flour to wheat flour produced bread with highest ash, protein and crude fibre content.

Keyword; *Bread, Wheat, Substitution, Nutrient*

INTRODUCTION

Bread is the result of baked dough obtained from a mixture of flour, salt, sugar, yeast and water by a chain of processes that comprises mixing, kneading, proofing, shaping and baking according to Mebpa *et al*. (2017). Additional ingredients like fats, milk, milk-solids, sugar, egg, and antioxidants may be added. Bread is a vital staple food with steady and increasing consumption in Nigeria. It is the most popular among all wheat-based products such as biscuits, cakes, doughnuts, chin-chin, cookies, etc. (Ubbor*et al*., 2022). Bread is an exotic food which has for years gained wide consumer acceptance in Nigeria (Abulude, 2015). Bread is the most popular among all the wheat-based products. In Nigeria, bread is consumed by people in every socio-economic class and it is acceptable to both children and adults. Nutritionally it is rated as a good source of carbohydrate, minerals and vitamins. Bread is sometimes not so cheap for an average Nigerian due to the fact that it comes from wheat flour which has to be imported into the country. For this reason, the use of composite flours have been greatly encouraged to decrease the demand for imported wheat flour and make the food available to low in come earners and also reduce the amounts of wheat being consumed per head (Giami, 2014).
Unripe plantain is traditionally processed into flour in Nigeria and in other West and Central African countries (Ukhum, 2011). It is however gradually finding applications in weaning food formulation and composite flour preparations in line with Ogazi*et al*. (2016) and Mepba*et al*. (2017). Unripe plantain is a popular dietary staple food due to its versatility and good nutritional value. Unripe plantain fingers are valuable sources of iron and fibre to the body in contrast to the ripe variety which are invaluable source of carbohydrate, comparable in nutritive value to yam or potato, and are useful as a variant on the usual staple foods. Unripe plantain is used to produce plantain flour, since it has high starch content of about 35% on wet weight basis (Simmond, 2016). Nutritionally, plantain (*Musa paradisiaca*) constitute a rich energy source with carbohydrate accounting for 22 and 32% of the fruit weight for banana and plantain respectively and also rich in vitamins A, B6, C, dietary fibre, iron potassium and calcium (Adeniji*et al*., 2016).

Watermelon (*Citrulluslanatus*) is a typical fruit from the family of cucurbitaceae grown in the warmer part of the world whose seeds are underutilized. The seeds are rich source of dietary fibre, (5%) high in protein and fat (50%) ,it is a rich source of magnesium, calcium, potassium, iron, phosphorus and zinc (Odibo *etal*.,2012) and with excellent functional properties which have been found to be effective in baking (El-Adawy and Taha, 2011).Water melon seeds are known to be highly nutritional: they are rich sources of protein, B vitamins, Minerals(such as magnesium, potassium, phosphorus, sodium, iron, zinc, manganese and copper) and fat among others as well as phytochemicals (Braide *et al*., 2012), Water melon seeds are rich for strong bones and teeth as well as hemoglobin formation. Watermelon seed is one of the major under-utilized fruits grown in the warmer part of the world. The juice or pulp from watermelon is used for human consumption, while rind and seeds are major solid wastes. The seeds can be cooked and dried and served as snacks and fermented for use as a flavour enhancer in gravies and soups (Koocheki *et al*., 2017). This study was carried out to evaluate the quality of bread produced from blends of wheat unripe plantain and watermelon seed flour

MATERIALS AND METHODS

Sources of Raw Materials

Fresh unripe plantain (*Musa paradisiaca*), watermelon (*Citrulluslanatus*)pod and Golden Penny (Nigeria) wheat flour and other ingredients used in the production of bread were obtained from a local market in Anyigba, Dekina Local Government Area, Kogi State, Nigeria.

Sample preparation

Preparation of unripe plantain flour

Unripe plantain flour was produced according to the method of Uzoukwu *et al*. (2015). Mature green plantain bunches was cut into individual fingers, washed and weighed. The fingers were peeled and was manually sliced with kitchen knife to chips of about 1.2cm thickness and oven dried at 60°C. The dried chips were milled and sieved into flour using a 60BSS standard sieve. The flow chat for the production of plantain flours is shown in Figure3.1.

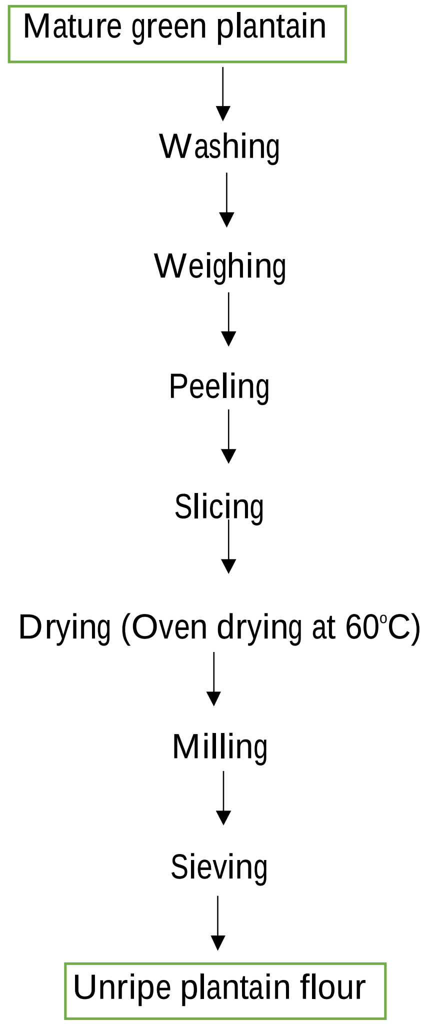

Figure 3.1: Flow chart for the production of unripe plantain flour
Source: Uzoukwu*et al*. (2015)

Preparation of Watermelon Seed Flour

Watermelon pods were washed, cut into slices and the seeds were extracted, washed, drained and dried at temperature of 60 °C for 6 h. The dried seeds were milled and sieved through 0.45 mm mesh sieve. The watermelon seed flour was sealed in a cellophane bag and stored at room temperature, for further analysis modifying Ubbor and Akobundu (2009) method. The procedure is shown in Figure 3.2.

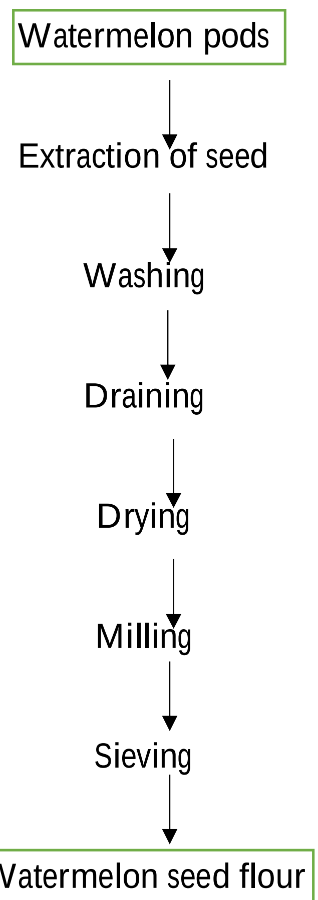

Figure 3.2: Preparation of watermelon seed flour
Source: Ubbor and Akobundu (2009)

Table 3.1 Sample formulation

Samples	Wheat flour (%)	Unripe plantain flour (%)	Watermelon seed flour (%)
AAA	100	0	0
BBB	90	5	5
CCC	80	10	10
DDD	70	15	15
EEE	60	20	20

Keys:
AAA (control) = 100% Wheat flour
BBB = 90% wheat flour +5% Unripe plantain flour +5% Watermelon seed flour
CCC= 80% wheat flour +10% Unripe plantain flour +10% Watermelon seed flour
DDD = 70% wheat flour +15% Unripe plantain flour +15% Watermelon seed flour
EEE = 60% wheat flour +20% Unripe plantain flour +20% Watermelon seed flour

Table 3.2 Recipe formulation for bread production

Ingredients	Quantity
Flour samples	450g
Yeast	10.8g
Salt	5.4g
Fat	27g
Sugar	16.2g
Water	Variable

Source: Uzoukwu*et al*. (2015)

Production of bread

Baking of the bread samples was done according to the method of Uzoukwu*et al*. (2015) using the sample formulation table and the recipe table with slight modification. The bread samples were prepared by mixing all the ingredients such as flour, yeast, sugar, fat and salt according to desired formulation. The quantities of products are shown in Table 3.2 (Recipe for Composite Bread). Mixing was done by hand, after which water was added and mixed to a desired consistency by hand kneading. The dough was allowed to proof for 40min after which it was knocked back (de-gas) and shaped into already greased baking pans and allowed to proof for the second time for 20min before it was loaded in the oven and baked at a temperature range of 180°C – 200°C for 45min. After baking, the bread was allowed to cool at room temperature and used for sensory evaluation. Flow diagram for bread production is shown in Figure 3.3.

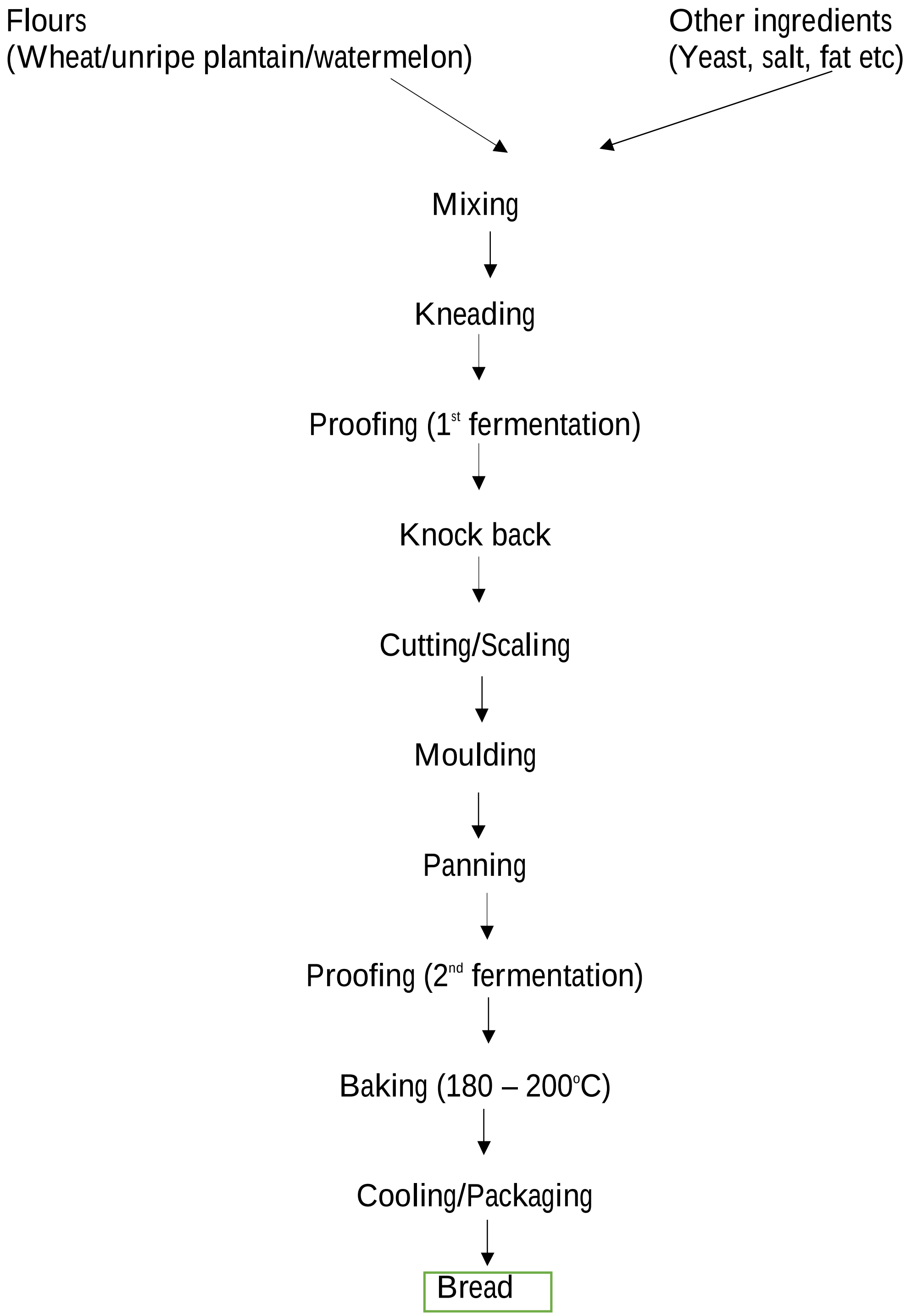

Figure 3.3: Flow chart for the production of bread
Source: Uzoukwu*et al*. (2015)

Proximate composition determination

Determination of moisture content

Moisture content was determined according to the standard methods of Association of Official Analytical Chemists (AOAC, 2012). Stainless steel oven dishes was cleaned and dried in the oven at 100 °C for 1 hour to achieve a constant weight. They was covered in a desiccator and then weighed. Two grams of sample was placed in each dish and dried in the oven at 100 °C until constant weight achieved. The dishes together with the samples was cooled in a desiccator and weighed.

$$\% \text{ Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where;
W_1 = weight of dish
W_2 = weight of dish + sample before drying
W_3 = weight of dish + sample after drying

Determination of Crude protein

Crude protein was determined using kjeldhal method (AOAC, 2012). Two grams of sample was placed in the kjeldhal flask, a anhydrous sodium sulphate (5 g of kjeldhal catalyst) was added to the flask, concentrated H_2SO_4 (25 ml) was added with few boiling chips. The flask was heated in the fume chamber until the sample solution becomes clear. The sample solution was allowed to cool to room temperature then transferred into a 250 ml volumetric flask and made up to volume with distilled water. The distillation unit was cleared and the apparatus set up. Five milliliters of 2% Boric acid solution with few drops of methyl red indicator was introduced into a distillate collector (100 ml conical flask). The conical flask was placed under the condenser then 5ml of the sample digest was pipetted into the apparatus and washed down with distilled water. Five milliliters of 60% sodium hydroxide solution was added to the digest. The sample were heated until 100 ml of distillate was collected in the receiving flask. The content of the receiving flask was titrated with 0.049M H_2SO_4 to a pink coloured end point. A blank with filter paper was subjected to the same procedure

Calculation

$$\% \text{ Total Nitrogen} = \frac{(Titre - blank) \times Normality\ of\ acid \times N_2}{weight\ of\ sample}$$

Nitrogen factor = 6.25
Crude protein = % Total N × 6.25

Determination of Fat

The fat content was determined according to AOAC (2012) using soxhlet extraction method. A 500 ml capacity round bottom flask was filled with 300 ml petroleum ether and fixed to the soxhlet extractor. Two grams of sample was placed in a labeled thimble, the extractor thimble was sealed with cotton wool. Heat was applied to the reflux the apparatus for six hours. The thimble was removed with care, the petroleum ether was recovered for re-use. When the flask is free of ether it was removed and dried at 105 °C for 1 hour in an oven. The flask was cooled in a desiccator and weighed.

$$\% \text{ Fat} = \frac{weight\ of\ fat}{weight\ of\ sample} \times 100$$

Determination of Crude fibre

Crude fibre was determined using the method of AOAC (2012). Three (3 g) grams of the sample was weighed into a 50 ml beaker and fat was extracted with petroleum ether by stirring, setting and decanting three times. The extracted sample was air dried and transferred to a 600 ml dried beaker. Then 200 ml of 1.25% sulphuric acid and few drops of anti-foaming agent was added to the beaker, the beaker was placed on digestion apparatus with pre-adjusted hot plate and boiled for 30 minutes, rotating beaker periodically to keep solid from adhering on the sides of the beaker. At the end of 30 minutes period, the mixture was allowed to stand for one minute and then filtered through a Buchner funnel. Without breaking suction, the insoluble matter was washed with boiling water until it was free of the acid. The residue was weighed back into the original flask by means of a wash bottle back into the original flask by means of a wash bottle containing 200 ml of 1.25% sodium hydroxide solution. It was boiled briskly for 30 minutes with similar precautions as before. After boiling for 30 minutes, it was allowed to stand for a minute and then filtered immediately under suction. The residues was washed with boiling water followed by 1% hydrochloric acid. It was washed twice with alcohol and then with ether for three times. The residue was transferred into ash dish and dried at 100 °C to a constant weight. Incineration to ash was done at 600 °C for 30 minutes. Cooled in a desiccator and weighed. The difference in weight between oven dry weight and the weight after incineration was taken as the fibre content of the sample. This was expressed as a percentage weight of the original sample taken for analysis.

$$\% \text{ Fat} = \frac{oven\ dried\ sample - weight\ of\ sample\ incinerated}{weight\ of\ sample\ taken}$$

Determination of Ash content

Ash determination was carried out according to AOAC (2012) procedure. Two grams of sample was placed in silica dish which had been ignited, cooled and weighed. The dish and sample was ignited first gently and then at 550 °C in the muffle furnace for 3 hours, until a white or grey ash is obtained. The dish and content was cooled in a desiccator and weighed

$$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where;

W_1 = weight of dish

W_2 = weight of dish + sample before ashing

W_3 = weight of dish + sample after ashing

Determination of Carbohydrates

The carbohydrate was determined by difference according to AOAC, (2012) as follows:

% Carbohydrate = 100 – (% moisture + % fat + % ash + % protein + % crude fibre)

Determination of physical properties of Bread Loaves

Physical of attribute of the blended bread sample products were evaluated for loaf weight, loaf volume and specific loaf volume.

Loaf Weight and Loaf Volume of the Bread

Loaf weight was measured 30 minutes after the loaves are removed from the oven using a weighing balance whereas loaf volume of the blended bread samples were determined by rape seed displacement method (Giami *et al*., 2004). A beaker of 200ml was filled with rice and powder into a measuring cylinder in other to note the volume of the beaker after filling it with rice and leveled appropriate using a ruler (xml). The bread loaf was then placed in the empty beaker and filled to equivalent height of the beaker with the rice, the rice was measured with measuring cylinder so as to note the volume rice, displaced which an equivalent of bread sample placed in the beaker (Zml). This analytical method will be carried repeatedly for each bread sample produced. Loaf volume is calculated (Xml)-(Zml).The difference between the initial volume (Xml) and final volume (Zml) is the loaf volume.

Specific Loaf Volume

The specific loaf was calculated by dividing the individual loaf volume of the various samples by the individual weight of loaf of the sample;

Specific loaf volume = $\frac{\text{loaf volume (ml)}}{\text{Loaf weight (g)}}$

Mineral Composition

The bread samples was digested after which the mineral contents of each of the samples was determined.

Determination of Potassium (K) Contents

Potassium contents of digested samples was determined by flame photometric method as described by Ndife *et al*. (2013). The samples was run in a flame photometer with standards of sodium and potassium, respectively, and the sodium and potassium contents of the samples was calculated from the readings obtained.

Concentration (g/100ml) = $\frac{\text{Absorbance of sample}}{\text{Slope of standard curve}}$ × Dilution factor

Dilution factor = Total volume/ volume of sample used

Determination of Magnesium (Mg) Content

Magnesium content of digested samples was determined by complexometric titration using EDTA as described by Okoye and Ibeto (2011). Ten (10) ml of each of the digested samples was added into appropriately labelled conical flasks after which distilled water (25 ml) and ammonium chloride buffer (25 ml) was added. Erichrome black T-indicator was added to each of the conical flasks. A blank was prepared with water and other reagents after which the preparations was titrated with 0.01 N EDTA. The Mg content of each of the samples was calculated from the titre readings obtained.

Concentration (mg/100ml) = $\frac{\text{TV} \times \text{NE} \times \text{AM} \times \text{DF}}{\text{WD} \times \text{AT}}$

Where; TV = Titre value, NE= Normality of EDTA, AM= Atomic mass of magnesium, DF= Dilution factor, WD= Weight of the digested sample and AT= Aliquot (ml) for titration.

Determination of Calcium (Ca) Content

Calcium content of digested samples was determined by complexometric titration using EDTA as described by Okoye and Ibeto (2011). Ten (10) ml of each of the digested samples was added into appropriately labeled conical flasks after which distilled water (25 ml) and 10% w/v KOH (25 ml) was added. A pinch of calcine indicator was added to each of the conical flasks. A blank was prepared with water and other reagents without the samples. The preparations were titrated with 0.01 N EDTA. The Ca content of each of the samples was calculated from the titre readings obtained.

$$\text{Concentration (mg/100ml)} = \frac{TV \times NE \times AM \times DF}{WD \times AT}$$

Determination of Iron (Fe) Content

Iron contents of digested samples was determined as described by AOAC (2012). Five (5) ml of each of the digested samples was added into appropriately labeled test tubes after which 2% hydroquinone (1 ml), acetate buffer (5 ml) and 0.1% 2, 2 dipyridyl (1 ml) was added. The solution was shaken vigorously and a change of colour to pink will be closely observed after which the absorbance was read at 530 nm against the blank. The Fe content of each of the samples was calculated from the readings obtained.

$$\text{Concentration (g/100ml)} = \frac{\textbf{Absorbanceofsample}}{\textbf{Slopeofstandardcurve}} \times \text{ Dilution factor}$$

Determination Anti-nutritional factor

The anti-nutritional factors of the bread will be determined according to the method of Okwu and Emenike (2016).

Alkaloids

Two (2) grams of sample was weighed and added to 1 ml of concentrated acetic acid and ethanol (1:2), covered and kept to stand for 4 hrs then filtered and concentrated in a water bath to one-quarter (1/4) of the original volume. Concentrated ammonium hydroxide was added drop-wise to the extract until the precipitate formation was completed. It was then allowed to settle and washed and filtered with dilute ammonium hydroxide solution. The residue was dried in an oven and taken as crude alkaloid. It was weighed and recorded.

Tannins

Tannin was extracted from 0.5 ml of the sample with methanol then purified with Whatman filter paper. Colour was developed using Vanillin hydrochloric acid reagent and the concentration was quantitatively measured using a spectrophotometer at 500 nm.

Saponins

Two (2) grams of sample was extracted with ethanol which was subsequently removed using a rotary evaporator. The solution was washed with diethyl ether until colorless. The pH was adjusted to 5.0 with sodium chloride. Finally, it was extracted with n-butanol and washed with sodium chloride and evaporated to dryness to give saponins which was weighed and recorded.

Phytic acid

Two (2) ml of sample were weighed and added to 25 ml of 0.5N NaCl then was shaken for 30 minutes. 2 ml of ferric chloride was added to the extract. The precipitate (ferric phytate) was converted to sodium phytate by adding 3 ml of sodium hydroxide. The precipitate was digested with acid mixture of equal portions of concentrated tetraoxosulphate (VI) acid and perchloric acid in a digestion set. Phytate content was estimated with the expression:
Phytate phosphorus = iron equivalent x 1.95 g of titre
Phytate = phytate phosphorus x 3.65g

Oxalate

Two (2) g of sample were weighed and extracted with dilute hydrochloric acid. The oxalate in the extract was precipitated with calcium chloride as salts. The precipitated extract was washed with 50ml of 25% H_2SO_4 and dissolved in hot water then was titrated with 0.05 N $KMnO_4$.

$$\text{Oxalate (\%)} = \frac{Titre \times molKMnO4 \times dilution\ factor \times 100}{Weight\ of\ sample}$$

Sensory Evaluation

Twenty (20) semi-trained panelists were selected randomly from the students of the Food, Nutrition and Home Sciences to assess the bread samples for texture, mouth feel, flavour, colour, and overall acceptance using a preference method as described by Iwe (2002). The evaluation was carried out using a nine (9) point hedonic scale. The bread samples were presented in different ratio. The order in which the samples were presented was randomize. Clean water was provided for the panelist to rinse their mouths in between each evaluation.

Statistical Analysis

All data collected were evaluated using analysis of variance (ANOVA) and performed using SPSS version 23 to obtained significant differences at

$p<0.05$. Duncan Multiple Range Test (DMRT) was used in separating the means.

RESULTS AND DISCUSSION

Physical properties of bread samples produced from wheat, unripe plantain and watermelon seed flour blends

Table 4.1 shows the results for the physical properties of bread produced from wheat, unripe plantain and watermelon seed flour blends.

The loaf volume and the specific volume ranged from 430 - 780cm^3 and 2.71 - 3.51cm^3/g. There was significant ($p<0.05$) difference in the loaf volume and specific volume of the bread samples. The loaf volume and the specific volume decreased significantly with increased substitution of unripe plantain and watermelon seed flour. Sample AAA with 100% wheat flour recorded the highest values of 780cm^3 and 3.51cm^3/g for the loaf volume and specific volume while sample EEE had the lowest values of 430cm^3 and 2.71cm^3/g for loaf volume and specific volume respectively. This could be attributed to the decrease in structure forming proteins in wheat which lowered the ability of the dough to rise during proofing leading to reduction in the bread volume. Similar result was reported by Olaoye*et al.* (2006) in bread production from different composite flours.

The weight of the samples ranged from 18 – 281g. There was significant ($p<0.05$) difference in the samples. Sample EEE with 20% substitution of the composite flour recorded the highest weight and this implies that weight increase with increased levels of unripe plantain and watermelon seed flour. Onuegbu*et al.* (2013) also reported an increase in weight in bread production from different composite flours.

Table 4.1: Physical properties of bread samples produced from wheat, unripe plantain and watermelon seed flour blends

Samples	Loaf volume (cm^3)	Loaf weight (g)	Specific loaf volume (cm^3/g)
AAA	$780.00^a \pm 0.00$	$221.87^a \pm 1.41$	$3.51^a \pm 0.01$
BBB	$690.00^a \pm 1.14$	$205.94^b \pm 1.01$	$3.35^b \pm 0.04$
CCC	$610.00^b \pm 0.14$	$189.16^c \pm 1.40$	$3.22^c \pm 0.06$
DDD	$525.00^c \pm 1.22$	$177.04^d \pm 2.03$	$2.96^d \pm 003$
EEE	$430.00^d \pm 2.14$	$158.13^e \pm 2.12$	$2.71^e \pm 0.06$

Values are mean ± standard deviation (n=2). Values with the same superscript in the same column are not significantly different (p>0.05)

AAA= 100% wheat flour

BBB = 90% wheat flour +5% Unripe plantain flour +5% Watermelon seed flour

CCC= 80% wheat flour +10% Unripe plantain flour +10% Watermelon seed flour

DDD = 70% wheat flour +15% Unripe plantain flour +15% Watermelon seed flour

EEE = 60% wheat flour +20% Unripe plantain flour +20% Watermelon seed flour

Proximate composition of bread produced from wheat, unripe plantain and dried watermelon seed

Table 4.2 shows the results of the proximate composition of bread made from wheat-unripe plantain-dried watermelon seed flour blends. The moisture level of the whole wheat bread and the supplemented bread samples ranged from 28.35 to 32.46%. Sample AAA (100% wheat flour) had the lowest percentage of moisture (28.35%), while sample EEE (60% wheat, 20% unripe plantain and 20% watermelon seed) recorded the highest percentage of moisture (32.46%). It was observed that increased in composite flour blends resulted in a corresponding increased in the moisture contents of the composite bread samples. These findings are inconsistent with those of Udeme *et al*. (2014), who discovered that bread made from wheat potato flour blends showed an increasing tendency as supplementation levels increased. There were significant differences in all of the bread samples ($p<0.05$).

Fat content of the various bread samples ranged from 9.39 to 14.20% with sample EEE (60% wheat, 20% unripe plantain and 20% watermelon seed) having the highest percentage of fat (14.20%) followed by bread sample DDD (70% wheat, 15% unripe plantain and 15% watermelon seed) with (13.62%). The lowest fat was recorded by the control sample AAA (100% wheat flour) with 9.39%. When the amount of unripe plantain and watermelon seed flour was increased, the fat levels increased. There were significant differences between the control bread sample and the composite samples ($p<0.05$). Fat gives flavour and soft texture to foods; nevertheless, high levels of fat are undesirable in food products because they could lead to rancidity in foods (Racheal and Margaret, 2016). Furthermore, eating foods rich in trans fats present in bakery fats create inflammation, which is linked to heart disease, stroke, diabetes, and other chronic health conditions (http://www.health.harvard.edu).

All bread samples had crude fibre content ranging from 0.79 to 1.24%, with the composite bread sample EEE (60% wheat, 20% unripe plantain and 20% watermelon seed) having the highest fibre content (1.24%). The fibre content of the 100% wheat flour bread was lowest (0.79%), which contrasts with that discovered by Kayode *et al.* (2015) in 100% wheat flour bread. The rise in unripe plantain flour could be linked to the higher crude fibre content. This result is consistent with Oluwalana and Oluwamukomi (2011) findings. Fibre has several health benefits (Rehinan *et al*., 2014). The crude fibre content of plantain flour, according to Rehinan *et al*.

(2014), indicates that when added to a human diet, they can help lower serum cholesterol, reduce the risk of heart attack, colon cancer, obesity, blood pressure, appendicitis, and many other disorders. The fibre contents of the bread samples were within the recommended range of not more than 5g dietary fibre / 100g of dry matter (FAO/WHO, 2014).Dietary fibre has a protective action against various disorders such as diabetes mellitus, cardiovascular diseases, constipation, appendicitis, hemorrhoids, and colon cancer (Mervat, 2011; Bhawna *et al*., 2013).

The ash level of the bread increased with the proportion of substitution, with values ranging from 0.93 to 1.37 %.Composite bread sample EEE (60% wheat, 20% unripe plantain and 20% watermelon seed) had the highest value (1.37%), whereas control sample AAA (100% wheat flour) recorded the lowest ash content (0.93%). The ash content of the composite bread samples increased as the quantity of unripe plantain and watermelon seed flour in the samples increased. There were significant changes at $p<0.05$. This result showed increase in ash with higher substitution and could be attributed to addition of watermelon seed. Similar result was obtained by Ubbor and Akobundu (2009) from cookies produced from composite flour blends of watermelon seed flour/ wheat flour. The bread samples had a protein composition that ranged from 11.37 to 18.24 %. The bread sample with the highest protein content was made with 60% wheat, 20% unripe plantain and 20% watermelon seed flour blends. The protein level of the composite bread samples was higher than the protein content of bread made with 100% wheat flour. The protein value of the composite bread rises when the percentage of unripe plantain and watermelon seed flour in the bread is increased.

The carbohydrate content of the bread samples ranged from 32.48 to 49.99 %, with the control bread sample recording the highest mean value of 49.99 % while the lowest was found in bread sample EEE (60% wheat, 20% unripe plantain and 20% watermelon seed) with 32.48 %. The carbohydrate content in the composite bread samples reduced drastically, from 49.99 to 32.48 % when unripe plantain and watermelon seed flour blends increased. The drop could be related to the reduction in wheat flour in the composite bread samples. Dabels *et al*. (2016) found similar results in their composite cookies. The carbohydrate value differed significantly ($p<0.05$) between the bread samples. Previous researchers obtained a similar result of carbohydrate contents of cookies made flour blends of cardaba banana being lower in carbohydrate than cookies from 100%

wheat flour (Ayo-Omogie and Adekunle (2015). Ubbor *et al*. (2022) also reported a similar result of increase in carbohydrate content of cookies as the proportion of acha and orange fleshed sweet potato increased.

Table 4.2: Proximate composition of bread produced from wheat, unripe plantain and watermelon seed flour blends

Sample	Moisture content (%)	Ash content (%)	Crude fibre content (%)	Fat content (%)	Protein content (%)	Carbohydrates content (%)
AAA	28.35^{e}±0.07	0.93^{d}±.04	0.79^{e}±0.01	9.39^{e}±0.01	11.38^{e}±0.06	49.99^{a}±1.17
BBB	28.93^{d}±0.01	1.07^{c}±0.04	0.98^{d}±0.00	10.40^{d}±0.14	12.87^{d}±0.06	45.74^{b}±0.18
CCC	29.15^{c}±0.07	1.17^{b}±0.04	1.07^{c}±0.01	12.18^{c}±003	14.74^{c}±0.07	41.88^{c}±0.37
DDD	30.54^{b}±0.00	1.25^{b}±0.00	1.15^{b}±0.04	13.62^{b}±0.03	16.52^{b}±0.09	36.94^{c}±0.78
EEE	32.46^{a}±0.03	1.38^{a}±0.04	1.24^{a}±0.03	14.20^{a}±0.00	18.24^{a}±0.00	32.48^{e}±0.04

Values are means ±SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different ($p<0.05$)

Keys

AAA (control) = 100% Wheat flour

BBB = 90% wheat flour +5% Unripe plantain flour +5% Watermelon seed flour

CCC= 80% wheat flour +10% Unripe plantain flour +10% Watermelon seed flour

DDD = 70% wheat flour +15% Unripe plantain flour +15% Watermelon seed flour

EEE = 60% wheat flour +20% Unripe plantain flour +20% Watermelon seed flour

Mineral composition of bread produced from wheat, unripe plantain and watermelon seed flour blends

The result of the mineral composition of bread produced from wheat, unripe plantain and watermelon seed flour blends is shown in Table 4.3. The result showed significant (P<0.05) difference among all samples in terms of mineral composition. Generally, the mineral contents of the bread samples increased as the proportion of unripe plantain and watermelon seed flour increased in the bread samples (Table 4.3). Calcium is an important constituent of bone and teeth, and it is actively involved in the regulation of nerve and muscle functions (Abdel-Hameed *et al*., 2023). The calcium content of bread ranged from 180.75 to 310.10 mg/100g with sample AAA (100% wheat flour) having the least calcium content while sample EEE had the highest value. Adebayo-Oyetoro *et al*. (2016) also reported higher calcium contents (21.00 - 24.20 mg/100g) for pawpaw fortified milk.

The potassium content of the bread increased as the proportion of unripe plantain and watermelon seed flour increases from 5% to 20% in the bread samples. The content ranged from 191.30 to 333.65 mg/100g. These findings are in agreement with the report of Bolarinwa *et al*. (2020) who reported increased in potassium content (272.5 – 327 mg/100 g) of moringa fortified bread as moringa concentration increased in the blends. Potassium works with sodium to maintain the body's water balance. The kidneys regulate the level of potassium in the body. It is known that high sodium intake may lead to hypertension. Consequentially, reduction in sodium helps lower blood pressure in all people with hypertension (A diet low in potassium and high in sodium may be a factor in high blood pressure). High potassium has been reported to have a protective effect against excessive sodium intake. Racheal and Margaret (2016), suggested that a ratio of sodium ion to potassium ion less than one ($Na^+ / K^+ < 1$) would be suitable for reducing high blood pressure. Potassium is also involved in nerve function, muscle control and blood pressure.

The magnesium content of bread samples ranged from 88.50 to 199.50 mg/100g. Sample AAA had the lowest value while sample EEE had the highest value. Similar trend as other mineral contents was observed for the magnesium contents of the bread. There was significant (P<0.05) difference among all samples. The magnesium content increase progressively as the proportion of brown rice flour increases. Magnesium is an essential constituent of all cells and is necessary for the functioning of enzymes involved in energy utilization and it is present in the bone (Ndife *et al*., 2014). Deficiency of magnesium is rare and results from excessive loss in diarrhea rather than from low intakes. The iron content of bread samples ranged from 11.10 to 20.55 mg/100. Sample AAA had the lowest value (11.10 mg/100g) while sample EEE had the highest significant (P<0.05) value (20.50 mg/100g). There was progressive increase in the iron content of bread samples as the proportion of unripe plantain and watermelon seed flour increase in the composite flour. Iron is an essential mineral required in the diet of pregnant women, nursing mothers, infant, convoluting patients and elderly people. It is also important for the prevention of anaemia (Olumide *et al*., 2023).

Table 4.3: Mineral composition of bread produced from wheat, unripe plantain and watermelon seed flour blends

Samples	Potassium (mg/100g)	Magnesium (mg/100g)	Calcium (mg/100g)	Iron (mg/100g)
AAA	$191.30^{e}\pm0.14$	$88.50^{e}\pm0.00$	$180.75^{e}\pm0.07$	$11.10^{e}\pm0.00$
BBB	$211.50^{d}\pm0.00$	$103.20^{d}\pm0.14$	$217.40^{d}\pm0.14$	$12.25^{d}\pm0.07$
CCC	$243.20^{c}\pm0.14$	$123.25^{c}\pm0.35$	$239.20^{c}\pm0.00$	$15.60^{c}\pm0.00$
DDD	$286.10^{b}\pm0.00$	$158.70^{b}\pm0.14$	$268.90^{b}\pm2.26$	$18.30^{b}\pm0.14$
EEE	$333.65^{a}\pm0.21$	$199.50^{a}\pm0.14$	$310.10^{a}\pm0.00$	$20.55^{a}\pm0.07$

Values are means ±SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different (p<0.05)

Keys

AAA (control) = 100% Wheat flour

BBB = 90% wheat flour +5% Unripe plantain flour +5% Watermelon seed flour

CCC= 80% wheat flour +10% Unripe plantain flour +10% Watermelon seed flour

DDD = 70% wheat flour +15% Unripe plantain flour +15% Watermelon seed flour

EEE = 60% wheat flour +20% Unripe plantain flour +20% Watermelon seed flour

Anti-nutrient properties of bread produced from wheat, unripe plantain and watermelon seed flour blends

The result of the anti-nutrient properties of bread produced from wheat, unripe plantain and watermelon seed flour blends is shown in Table 4.4. The result indicated that there was significant (P<0.05) difference among all bread samples in terms of phytate, oxalate, tannin, saponin and alkaloid contents. The phytate content of samples ranged from 3.87 to 8.02 mg/100g. Sample EEE had the highest value (8.02 mg/100g) while sample AAA had the lowest value (3.87 mg/100g). The phytate content of the bread samples were significantly (P<0.05) different. It was observed that inclusion of unripe plantain and watermelon seed flour brought about increase in the phytic acid of the flour blends. Comparing the phytate contents of bread samples with reported literatures, it was lower compared to the value reported for wheat-peanut bread (10.36%) by Ndjouenkeu *et al*. (2016) and the value reported for dehulled and whole soybeans chinchin (1.07 – 6.5%) (Okafor and Ujor 2014). Considering the processing effect on the phytate content of bread, addition of unripe plantain and watermelon seed flour as well as fermentation during proofing has increased it. This is in line with the work of Idowu *et al*. (2013) who reported 31.1% addition in phytic acid content of kenkey. It is also in agreement with the result of Ngodi *et al*. (2015).

The oxalate content of samples ranged from 6.21 to 16.15 mg/100g. Sample EEE had the highest value (16.15 mg/100g) while sample AAA had the lowest value (6.21 mg/100g). The oxalate content of the bread samples were significantly (P<0.05) different. It was also observed that addition of unripe plantain and watermelon seed flour resulted into increase in oxalate content of bread samples. The oxalate is capable of chelating divalent cationic minerals like calcium, magnesium, iron and zinc thereby reducing biovailability of such minerals (Idowu *et al*., 2013). The tannin content of bread samples ranged from 5.82 to 8.27 mg/100g. Sample EEE had the highest value (8.27 mg/100g) while sample AAA had the lowest value (5.82 mg/100g). The tannin content of the bread samples were significantly (P<0.05) different. Tannins form complex with protein and thus precipitate proteins in the gut thereby reducing its digestibility, they can cause an astringent reaction in the mouth and make food unpalatable. Tannins can also interfere with dietary iron absorption (Braide *et al*., 2012). The saponin content of bread samples ranged from 5.84 to 13.74mg/100g. Sample EEE had the highest value (13.74mg/100g) while sample AAA had the lowest value (5.84mg/100g). The saponin content of the bread samples were significantly (P<0.05) different. The saponin value of composite bread is higher when compared with that of control, this increase may alter the organoleptic properties of the bread since saponins are a factors that contribute to undesirable organoleptic properties of some legume product (Okafor and Ujor, 2014). As reported by Ercan and El (2016), saponin is an anti-nutrient that may have possible health benefits in terms of reducing serum cholesterol. Alkaloid content of the bread sample also follows similar trend as other antinutrient properties and ranged from 0.18 to 0.54 mg/100g. Sample AAA had the lowest value (0.18 mg/100g) while sample EEE had the highest value (0.54 mg/100g). The alkaloid content were significantly (P<0.05) different among all samples. Substitution of wheat with unripe plantain and watermelon seed flour increase the alkaloid content of the bread samples. Alkaloids are important chemical compounds that serve as a rich reservoir for drug discovery. Several alkaloids isolated from natural herbs exhibit antiproliferation, antibacterial, antiviral, insecticidal, and antimetastatic effects on various types of cancers both in vitro and in vivo (Orji *et al.,* 2018). Alkaloids play an essential role in both human medicine and in an organism's natural defence.

Table 4.4: Anti-nutrient properties of bread produced from wheat, unripe plantain and watermelon seed flour blends

Samples	Phytate (mg/100g)	Oxalate (mg/100g)	Tannin (mg/100g)	Saponin (mg/100g)	Alkaloid (mg/100g)
AAA	$3.87^{e}\pm0.09$	$6.21^{e}\pm0.00$	$5.82^{e}\pm0.04$	$5.84^{e}\pm0.28$	$0.18^{e}\pm0.00$
BBB	$4.30^{d}\pm0.00$	$8.17^{d}\pm0.15$	$6.73^{d}\pm0.08$	$6.74^{d}\pm0.14$	$0.24^{d}\pm0.00$
CCC	$4.98^{c}\pm0.05$	$10.66^{c}\pm0.15$	$7.12^{c}\pm0.04$	$8.44^{c}\pm0.28$	$0.31^{c}\pm0.01$
DDD	$5.73^{b}\pm0.00$	$14.28^{b}\pm0.14$	$7.83^{b}\pm0.04$	$10.24^{b}\pm0.28$	$0.39^{b}\pm0.01$
EEE	$8.02^{a}\pm0.11$	$16.15^{a}\pm0.14$	$8.27^{a}\pm0.00$	$13.74^{a}\pm0.14$	$0.54^{a}\pm0.00$

Values are means ± SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different ($p<0.05$)

Keys

AAA (control) = 100% Wheat flour

BBB = 90% wheat flour +5% Unripe plantain flour +5% Watermelon seed flour

CCC= 80% wheat flour +10% Unripe plantain flour +10% Watermelon seed flour

DDD = 70% wheat flour +15% Unripe plantain flour +15% Watermelon seed flour

EEE = 60% wheat flour +20% Unripe plantain flour +20% Watermelon seed flour

Sensory properties of bread produced from wheat, unripe plantain and watermelon seed flour blends

Table 4.5 shows the results of the sensory qualities of bread samples. There were significant differences ($p\leq0.05$) among the bread samples in the parameters evaluated. Bread made from wheat flour (100%) were significantly different from the bread made from composite flour samples except in mouthfeel and texture. The inclusion of unripe plantain and watermelon seed in the recipe of composite flour samples affected the bread in taste, flavour, texture, mouthfeel and overall acceptability. No significant difference occurred among sample BBB, CCC and DDD in terms of flavor, texture and overall acceptability however, sample EEE was rated lowest in terms of all tasted sensory properties. This may be due to the increase in the proportion of unripe plantain and watermelon seed flour. Colour is an important sensory attribute of any food because of its influence on acceptability. The brown colour resulting from Maillard reaction is always associated with baked goods (Ubbor and Akobundu, 2009). Sample BBB was not significantly different from that of AAA, likewise sample CCC and DDD while SAMPLE EEE was significantly different ($p\leq0.05$) from the rest of the samples respectively. This result showed increase in brown colour with higher substitution with unripe plantain and watermelon seed flour and could obviously be attributed to brown colour effect of watermelon seed flour. The overall acceptability of the five bread samples as judged by the panel demonstrates that composite-based bread product BBB (90% wheat, 5% unripe plantain and 5% watermelon seed) were generally accepted and compared almost favourably as the 100% wheat flour (control). The acceptance rating for bread sample BBB was not statistically different ($p>0.05$) from the control. In contrast, samples with a replacement level of 5% were comparable to the control, indicating that this degree of substitution is best for bread production. This means that in bread bakery applications, up to 5% unripe plantain and watermelon seed flour blends can be replaced with wheat flour. Despite this finding, increasing the percentage of unripe plantain and watermelon seed flour in bread baking more than 5% reduced the preference rating marginally but were however accepted as none were rated below the mid-point of the Hedonic scale used.

Table 4.5: Mean sensory score of bread samples produced from wheat, unripe plantain and watermelon seed flour blends

Samples	Taste	Flavor	Crust/crumb colour	Texture	Mouthfeel	Overall acceptability
AAA	8.70^{a}±1.01	8.20^{a}±1.03	8.30^{a}±1.58	8.45^{a}+1.02	7.85^{a}±1.24	8.75^{a}±0.94
BBB	7.80^{b}±1.29	8.05^{ab}±0.97	8.10^{a}±0.50	7.90^{b}+1.09	7.75^{b}±1.28	7.95^{ab}±1.07
CCC	7.85^{b}±1.42	7.40^{b}±1.28	7.50^{b}±0.91	7.60^{b}±0.92	7.00^{bc}±0.95	7.80^{b}±1.72
DDD	7.70^{b}±1.82	7.50^{b}±1.53	7.45^{b}±0.80	7.85^{b}±0.73	7.65^{b}±1.28	7.60^{b}±1.30
EEE	7.65^{b}±1.59	7.05^{c}±1.70	7.00^{c}±0.62	7.00^{c}±1.05	6.95^{bc}±1.75	6.60^{c}±1.28

Values are means ± SD (n=20). Means differently superscripted along the vertical columns are significantly different ($p<0.05$)

Keys

AAA (control) = 100% Wheat flour

BBB = 90% wheat flour +5% Unripe plantain flour +5% Watermelon seed flour

CCC= 80% wheat flour +10% Unripe plantain flour +10% Watermelon seed flour

DDD = 70% wheat flour +15% Unripe plantain flour +15% Watermelon seed flour

EEE = 60% wheat flour +20% Unripe plantain flour +20% Watermelon seed flour

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

This study shows that nutrient-dense bread can be produced from the blends of wheat, unripe plantain and watermelon seed flour. The produced bread is rich in ash, protein and crude fibre as well as reduced carbohydrates content which makes it suitable for consumption by everyone including diabetic patients. Inclusion of unripe plantain and watermelon seed brought about increased in the mineral composition of the bread and as such also serve as good source of important mineral composition such as iron, calcium, potassium and magnesium.

The sensory result showed that inclusion of unripe plantain and watermelon seed resulted into the production of generally accepted bread sample with good organoleptic properties based on the recorded preference of the panelists. Based on the result of this present study it is therefore recommended that; Acceptable and nutritious bread can be produced from blends of wheat, unripe plantain and watermelon seed flour up to 20% inclusion level. Substitution level of 20% unripe plantain and 20% watermelon seed flour to wheat flour produced bread with highest ash, protein and crude fibre content.

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