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Quality Evaluation of Biscuit Produced from Blend of Wheat Toasted White Bean Flour and Banana Puree

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ABSTRACT
In this study, the suitability of wheat, toasted white bean flour and banana puree in the development of biscuit was investigated. Wheat, white bean flour and banana puree were blended into various proportions of flour mixes and used to produce biscuits. The biscuits were evaluated for proximate, minerals composition, sensory and anti-nutrients, while the flour were evaluated for its functional properties. The proximate composition of the biscuit varied from 7.85-9.71%, 12.34-14.01%, 1.15-1.86%, 1.21-1.49%, 1.65-1.92% and 70.01-76.11% for moisture, protein, fat, crude fiber, ash and carbohydrate content of the biscuit, respectively. The mineral content ranged from 10.11-13.12 mg/100 g, 52.65-61.76 mg/100 g, 130.71-211.76 mg/100 g, 111.97-130.84 mg/100 g and 14.81-20.43 mg/100 g for calcium, magnesium, potassium, phosphorus and sodium, respectively. The functional properties ranged from 0.76-0.80 g/cm3; 86.65-188.11 g/g; 94.30-197.23 g/g; 569.23-699.54%; 5.68-6.44%; 61.50-125.50 sec, 73.75-75.25% for bulk density, water absorption capacity, oil absorption capacity, swelling capacity, solubility, wettability and dispersiblity respectively. The anti-nutritional properties ranged from 37.67 to 46.73 mg/100 g, 5.27 to 5.57 mg/100 g and 32.91 to 35.10 mg/100 g for oxalate, phytate and tannin, respectively. The physical properties values ranged from 6.11-8.20 mm, 38.46-39.30 mm, 37.83-38.23 mm, 4.79-5.85, 5.35-7.49 g and 1.72-1.90 kg for thickness, diameter, height, spread ratio, weight and break strength respectively. biscuit from composite flours were not significantly ($p>0.05$) different from the control in overall acceptability. This shows the possibility of producing nutritious biscuit with desirable organoleptic qualities from wheat, white bean flour and banana puree.
Key word; wheat, biscuit, nutrition, fortification

INTRODUCTION
Biscuits may be regarded as a form of confectionery dried to a very low moisture content which is made from unleavened dough (Obi and Nwakalor, 2015). They are ready-to-eat, convenient and inexpensive food products, containing digestive and dietary principles of vital importance. Biscuits are nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in the oven (Olaoye *et al.*, 2017). In Nigeria, the

consumption of ready-to-eat baked products is continually growing and there has been an increase in reliance on imported wheat (Akpapunam *et al.,* 2017).

Moreover, the major ingredients for production of biscuits are flour, fat, sugar, salt and water, which are mixed together with other minor ingredients, such as baking powder, skimmed milk, emulsifier and sodium meta-bisulphite to form dough containing a gluten network (Oyedele *et al.,* 2017). According to Nwakalor (2014), the dough is rested for a period and passed between rollers to make a sheet. These sheets are however, transformed into appetizing product through the application of heat in the oven. Alebiosu *et al.,* (2020) reported that biscuits constitute valuable amount of iron, calcium, protein, calorie, fibre and some of the B-vitamins and they are classified based on the ingredient composition and processing techniques.

Wheat, botanically known as *Triticum aestivum* is one of the most useful and valuable crops grown around the world and it is considered as almost first among cereal largely due to the fact that its grain contains protein with unique chemical and physical properties, and other vital nutrients. Studies have shown that blending of legume with root crops or cereals could help to improve the overall nutrition in the diet. Wheat flour is the major nutritious plant foods available, offering an array of minerals and critical nutrients. Wheat flour is a powder made from the grinding of wheat used for human consumption. Efforts has been made to promote the use of composite flour in which locally grown crops with high protein values replaces a portion of wheat flour (Sanchez *et al.,* 2016)

White Beans (*Phaseolus vulgaris*) are rich in protein as well as complex carbohydrates. Beans have a low glycemic index. This makes them an ideal food for the management of insulin resistance, diabetes, and hyperlipidaemia. (Foster-Powell, 2022; Rizdalla, 2023). Toasted beans floor contains between 22-25 % proteins and make a significant contribution to the protein and energy requirement of many Nigeria. They are also rich in niacin, thiamine and riboflavin (Sarthe *et al.,* 2014). They are said to contain high levels of potassium, phosphorus, calcium and iron (Osagie *et al.,* 2016). The role of bean flour as a source of protein is however affected by several factors including low protein digestibility, flatulence and the presence of numerous anti-nutritional constituents which made up the most important single factor affecting its utilization. (Aletor and Fetuga, 2014),

Banana (*Musa spp*) is among the leading fruit crops in the economic value in the world. It is ranked the fifth in the world trade (Guylene *et al.,* 2018). It stands out among other crops for having a high range of minerals and vitamins present in it. Banana Puree refers to bananas that have been processed into a soft paste or thick liquid. The processing can be done using a potato masher, blender or simply by pressing the bananas (ripe would be easier to press) through a strainer. Banana puree have various health benefits and excellent nutritional status. They are rich in potassium compounds as they are a good source of antioxidants (Someya *et al.,* 2022). Potassium-rich banana puree adds creaminess to other fruit purees, and it adds sweetness to biscuit (Someya *et al.,* 2020). This research was carried out to effectively evaluate biscuits produced from wheat, toasted beans four and banana puree.

MATERIALS AND METHODS

Sample collection

Fresh samples of whole wheat grain (*Triticum aestivum*), white bean (*Phaseolus vulgaris*) and banana (*Musa spp*) was obtained from Anyigba central market. Other raw materials and ingredients such as baking powder, flavour, sugar, eggs and butter was also obtained from Anyigba Market and taken to Prince Abubakar Audu University, Anyigba, Kogi State.

Sample Preparation

Production of Wheat flour, Toasted white Beans flour and banana Puree

Whole Wheat Flour

The method of whole wheat flour as described by Ndife *et al.,* (2014). The whole wheat grains was first sorted out, cleaned and washed in water. It was then oven-dried for 15mins at 60°C. Disc attrition mill was later used to fine mill the whole wheat grains and sieved using a 2mm

Whole Wheat Grains

↓

Sorting/ Cleaning

↓

Washing

↓

Oven Drying

↓

Fine Milling

↓

Sieving

↓

Whole Wheat Flour

Flow Chart for Whole Wheat Flour

Source: Ndife *et al.,* (2014)

Toasted White Beans flour

The method of white beans flour is similar to that of whole wheat flour as described by Ndife *et al.,* (2014). The white beans (*Phaseolus vulgaris*) was first sorted, cleaned and washed using clean water gently so as not to affect the cotyledon of the legume. The washed beans (*Phaseolus vulgaris*) was then toasted, decorticated, milled (using a disc attrition mill) and sieved using a 2mm sieve.

White Beans

↓

Sorting/Cleaning

↓

Washing

↓

Toasting

↓

Decortication/Winnowing

↓

Fine Milling

↓

Sieving

↓

Toasted White Bean Flour

Flow Chart for Toasted White Bean Flour

Source: Ndife *et al.,* (2014)

Banana Puree

The method of banana puree as described by Igbabul *et al,* (2015). The banana was first sorted and cleaned, then peeled and sliced into smaller pieces. The sliced banana was crushed to form banana puree.

Matured Green Banana

↓

Sorting/Cleaning

↓

Peeling

↓

Slicing

↓

Crushing

Banana Puree
Flow Chart for Banana Puree
Source: Igbabul *et al.*, 2015)

Experimental Design

The whole wheat flour was weighed according to their varying inclusions of 0, 5, 10, 15 and 20% of the toasted white beans flour and banana puree and was labeled as samples AAA, BBB, CCC, DDD and EEE respectively. Sample AAA serves as the control as seen in the formulation table below:

Sample Formulation Table

Sample Code	Raw Materials		
	Wheat (%)	**Toasted White Bean (%)**	**Banana Puree (%)**
AAA(Control)	100	—	—
BBB	85	5	10
CCC	80	10	10
DDD	75	15	10
EEE	70	20	10

KEY:
AAA (Control) = 100% Wheat Flour
BBB = 85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree
CCC = 80% Wheat Flour + 10% white bean flour + 10% Banana puree
DDD = 75% Wheat Flour + 15% white bean flour + 10 % Banana Puree
EEE = 70% wheat Flour + 20% white bean flour + 10% Banana Puree

Table 3.2.5 Ingredients Table

Ingredients	Quantity
Flour Samples	450g
Salt	5.4g
Fat	27g
Sugar	27.0g
Water	Variable

Source : (Uzoukwu *et al.*, 2015)

Biscuit

Biscuit production followed the method described by Ndife *et al.,* (2014). The whole wheat flour was weighed. The dry component was first mixed together (composite flour, sugar, baking powder) then the wet components will be mixed also (eggs, butter, milk, flavor). The wet components will be added to the dried one and kneaded for about 12mins into consistent dough. The resulting dough will be cut into uniform sizes and passed through a series of molding, shaping and stamping. The stamped dough will be baked in the oven for 45 min at 260°C, the products will be allowed to cool and will be subsequently packaged with a cellophane wrapper. All the enriched biscuits will be stored at room temperature, during the period of analytical investigation. The process flow diagram is as shown below:

WEIGHING

↓

INGREEDIENTS MIXING

↓

KNEADING (for 12mins)

↓

SHAPING/MOULDING

↓

STAMPING

↓

BAKING (45mins at 260°C)

↓

COOLING

↓

PACKAGING

FLOW CHART FOR BISCUIT PRODUCTION

Source: Ndife *et al.,* (2014)

Analysis

Proximate Analysis of Biscuit Samples

Moisture Content Determination

The moisture content was determined as described by AOAC (2010). 2g of the samples was weighed accurately into a weighed dry-cleaned dish with an easily removable lid. The uncovered dish containing the sample with its lid will be placed in a well-insulated oven at 103°C for 3 hours. Then removed and transferred into desiccators at room temperature to cool. After cooling, the sample was weighed and replaced in the oven for another 1 hour. After this, the dish containing the sample was removed and cooled in a desiccator and re- weighed. The procedure was repeated until a constant weight is obtained. The loss in weight was reported as moisture content and calculated as:

% MC = M1 – M2 × 100% M1 – M0

where;

M0 = weight of dish and lid (g)

M1 = weight of dish and sample after drying (g)

M2 = weight of dish and sample before drying (g)

M1 – M0 = weight of sample prepared for drying (g)

% dry matter content = 100% moisture content.

Ash Content Determination

The ash content is the amount of mineral constituent of a food material as described by AOAC 2010. The crucible was weighed and dried in the oven and cooled in the desiccators, and weighed again. 3g of the grinded sample was weighed in an empty porcelain crucible, which was placed in a muffle furnace and maintained at 550°C for 45 minutes after which the crucible was then transferred into the desiccators, cooled and weighed. The percentage ash content was determined using this method.

% Ash = weight of crucible + ash – weight of empty crucible × 100 %
Weight of sample

Crude Fibre Determination

29g of the sample was weighed into 600ml long beaker. 100ml of hot 1.25% H_2SO_4 Will be added (heated), boiled and reflux for 30 minutes. It was then filtered through whatman filter paper; the beaker was then rinsed with distilled water until the filter becomes neutral. The residue was then be transferred into another beaker and 100ml of 1.25% NaOH was added. The digestion process was repeated by boiling and refluxed for 30 minutes. It was then filtered, and the beaker rinsed with distilled water. The residue was then washed with distilled water until the filtrate becomes neutral. The residue was then be transferred into the oven to dry. After drying, it was then coded in a decanter and weighed (weight A). The sample was then put in the furnace at 600°C for 6 hours, then cooled and reweighed (weight B). The losses in weight during incineration represent the weight of crude fibre in the sample (AOAC, 2010).

% crude fibre = weight A – weight B × 100 % Sample weight

Protein Content Determination

Protein content was determined as described by AOAC (2010). 1g of the sample was weighed into a digestion flask and 7 kjeidahl tablets were added to it. 20ml of concentrated H_2SO_4 will be added and digested for 5 hours until a clear solution was obtained, the digest was then cooled, transferred into 100ml of volumetric flask and made up to mark with distilled water. 20 ml of boric acid will be dispensed into conical flask; while 5 drops of the indicator and 75ml of distilled water will be added to it. 10ml of the digest will be dispensed into Kjeidahl distillation flask. The conical flask and the distilled flask was fixed in place and 20% NaOH will be added through the gas funnel into the digest. The steam exist was closed and the time was taken when the solution of the boric acid and the indicator turned green. The distillation will be carried out for 15mins and distillate titrated with 0.05M HCL.

% total nitrogen = 14.01× (sample titre – blank titre) × N 10 × sample weight

Fat Determination

The fat content was determined using the method described by AOAC (2010). The sample (10g) was weighed on a chemical balance and wrapped up in a filter paper. It was then placed in the extraction thimble. Fat extraction unit was cleaned, dried in an oven and cooled in the desiccator before weighing. Petroleum ether (25ml) was measured into the flask and the fat extracted with solvent. After extraction, the solvent was evaporated by drying in the oven. The flask and the content was then cooled in a dessicator and weighed. The fat content was calculated as follows:

% fat content = X – Y / Z

where;

X= weighed of fat + flask

Y= weight of flask

Z= weight of sample

Carbohydrate Determination

Total carbohydrate was determined by differences between 100 and total sum of the percentage of fat, moisture, ash, crude fiber and protein content.

Mineral analysis

The biscuit samples wasdigested by the wet ashing method prior to mineral content determination using atomic absorption spectrophotometer for Ca, and Fe and Corning 400 flame photometer for K and Na (Abduladeet *et al,* 2017). While the phosphorus (P) content was determined calorimetrically with spectrophotometer using the method described by Iwuoha, and Ike, (2016).

Physical Properties of Biscuits

The weight and of the biscuit samples were determined by weighing on a weighing balance (Santual Electronic Weighing Balance) and measuring with a calibrated ruler, respectively (AOAC, 2012). The length and bredth were determined according to the method of Giami *et al.* (2018). The thickness of the biscuits was determined using the method of Akpapunam *et al.,* (2017).

Functional Properties of the Composite Flour

Water Absorption

To 1g of the sample, 15ml of distilled water was added in a 25ml centrifuge tube and agitated on a vortex mixer for 2 minutes. It was centrifuged at 4000rpm revolutions per minutes for 20minutes. The supernatant was decanted and discarded. The adhering drops of water was removed and the tube reweighed again (Akpapunam *et al.,* 2017).

WAC = Weight tube + sediment - weight of empty tube Weight of sample

Swelling Power

1g of the sample was weighed into 50ml plastic centrifuge tube. 50ml of distilled water was then added to the sample and mixed gently. The slurry was heated in a water bath at 60, 70, 80, 90, 100°C respectively for 10 minutes. The solution was gently shaken during heating to prevent clumping of the starch and the solution will be centrifuge at 3000rpm for 10 minutes. Then the supernatant was decanted and dried to determine the amount of soluble solid and dissolved and was used to calculate the solubility. The weight of the sediment was recorded and moisture content of the sediment gel would be determined (Takashi and sieb, 2018).

Swelling power = Weight of the wet mass of seed/Weight of dry matter in the gel

Bulk Density

A known amount of samples was weighed into 50mls graduated measuring cylinder. The sample was packed by gently tapping the cylinder on the bench top 10 times from a height of 5cm. The volume of the sample was recorded (Akpapunam *et al.,* 2017)

Bulk density (g/ml or g/cm3) = Weight of sample / Volume of sample after tapping

Oil absorption Capacity

10g of flour samples was weighed into 100ml measuring cylinder and distilled water was added to reach a volume of 100ml, the set up was stirred vigorously and allowed to settle for 3hrs. The absorption of settled particles was recorded and subtracted from 100. The difference was reported as % absorption (Akpapunam *et al.,* 2017).

Sensory Analysis

Sensory evaluation of the composite biscuit samples was carried out by 25 panelists on a 9-point hedonic scale for different parameters such as colour, aroma, taste, texture, crunchiness and overall acceptability as described by Iwuoha and Ike, (2016).

Antinutritional Analysis
Tannin, Phenol, Alkaloids and saponin antinutrient was determined by a method described by AOAC (2012).

Statistical Analysis
The data obtained were statistically analyzed using the analysis of variance (ANOVA) using SPSS and the Duncan Multiple range test with significance level at p<0.05.

RESULTS AND DISCUSSION
Proximate Composition of Biscuits
Table 4.1: Proximate Composition of Biscuits

Sample Code	Moisture (%)	Ash (%)	Crude Fiber (%)	Crude Fat (%)	Protein (%)	Carbohydrate (%)
AAA (Control)	8.37 ± 0.00^{c}	0.65 ± 0.05^{d}	0.49 ± 0.01^{d}	8.64 ± 0.02^{a}	11.07 ± 0.04^{e}	70.78 ± 0.01^{a}
BBB	8.50 ± 0.05^{c}	0.83 ± 0.02^{c}	0.62 ± 0.02^{c}	8.49 ± 0.01^{b}	13.32 ± 0.02^{d}	67.89 ± 0.06^{b}
CCC	7.90 ± 0.00^{d}	1.05 ± 0.00^{b}	0.90 ± 0.02^{b}	7.86 ± 0.04^{c}	15.79 ± 0.00^{c}	66.50 ± 0.02^{c}
DDD	9.15 ± 0.02^{b}	1.08 ± 0.03^{b}	0.98 ± 0.00^{b}	7.50 ± 0.00^{d}	17.22 ± 0.60^{b}	64.08 ± 0.01^{d}
EEE	10.32 ± 0.02^{a}	1.23 ± 0.03^{a}	1.07 ± 0.01^{a}	7.15 ± 0.03^{e}	19.91 ± 0.04^{a}	60.33 ± 0.02^{e}

Values are mean ± standard deviation (SD) of duplicate determination. Values with different superscript within a column are significantly different from each other at p≤0.05.

AAA (Control) = 100% Wheat Flour
BBB = 85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree
CCC = 80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree
DDD = 75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree
EEE = 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree

Moisture Content
From Table 4.1, the moisture content ranged from 7.90 to 10.32%. Biscuits sample containing 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) had the highest significant value

in moisture content (10.32) followed by that produced from 75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree (DDD). The least moisture content was recorded in the samples containing 80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree (CCC). The value obtained is within the range of values recommended by the USDA, (2017) which reported 1-15% as safe moisture content for storage of cereal product. The moisture content is an indicator of shelf-life ability. The moisture content below 14% is recommended for long period of storage, hence a good potential during storage.

Ash Content

The ash content ranged from 0.65 to 1.23%. No significant difference was recorded between sample CCC and DDD in the ash content. However, the highest Ash content was recorded in the sample containing 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) While the Control (100% Wheat Flour) recorded the lowest. Ash contents are an indication of minerals that are contained in the flours. Flours reported in this study are comparable with the work of Odenigbo *et al.* (2013).

Crude Fiber

The crude fiber of the biscuit's samples ranged from 0.49 to 1.07%. Samples with 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) had the highest crude fiber content while samples with 100% Wheat Flour (Control Sample) had the lowest crude fiber content. Meanwhile, no significant difference was observed between sample CCC and DDD. The fiber content recorded in this study was higher than what Oladele *et al.* (2019) reported in their findings. It is well known that soluble fiber generally increases transit time through the gut, slow emptying of the stomach and slow glucose absorption (Chukwuma *et al.*, 2020).

Fat Content

The fat content of the samples were significantly different at $P \leq 0.05$. The Control Sample Containing 100% wheat flour had the highest fat content of 8.64% while the sample containing 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) recorded the lowest fat content (7.15). The fat content of the flour blends in this study is similar to those reported by Egbebi and Bademosi (2021) and Odenigbo *et al.* (2019). The lower fat gave a higher probability of a longer shelf-life in terms of the onset of rancidity (Ihekoronye and Ngoddy, 2015).

Protein Content

The protein content of the biscuit's samples ranged from 13.32 to 19.91% with noticeable significant difference in all the samples. Biscuits produced from 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) recorded the highest protein content (19.91) followed by the samples containing 75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree (DDD) (17.22%) while the Control Sample (AAA containing 100% wheat flour) recorded the least (13.32%). The highest protein content of biscuit sample (EEE) could be attributed to the ratio of toasted white bean percentage (20/100 g) in the flour component since bean is a good source of protein.

Carbohydrate

The carbohydrate content of the flour ranged from 60.63 to 70.78% with the Control sample (100% wheat flour) having the highest value (70.78%) while Sample EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) recorded the lowest (60.63%). The carbohydrate contents of these samples are an indication that the products are good sources of energy. Carbohydrates are good sources of energy and that a high concentration of it is desirable in breakfast meals and weaning formulas. In this regard, therefore, the high carbohydrates content of the wheat flour would make it provide required energy in breakfast formulations (Butt *et al.,* 2018). This study agrees with the findings of Adebowale *et al.,* (2018).

Mineral Composition of Biscuits

Table 4.2: mineral Composition of Biscuits

Sample Code	Na (Mg/Kg)	K (Mg/Kg)	Ca (Mg/Kg)	Fe (Mg/Kg)
AAA (Control)	30.41±0.1^{e}	173.3±0.3^{e}	160.15±0.05^{e}	9.35±0.05^{e}
BBB	49.30±0.00^{d}	203.6±0.2^{d}	180.70±0.00^{d}	9.85±0.05^{d}
CCC	75.10±0.00^{c}	238.4±0.1^{c}	209.15±0.05^{c}	10.60±0.1^{c}
DDD	98.75±0.05^{b}	270.7±0.1^{b}	229.60±0.2^{b}	11.65±0.15^{b}
EEE	125.50±0.3^{a}	298.2±0.2^{a}	258.4±0.3^{a}	12.20±0.00^{a}

Values are mean ± standard deviation (SD) of duplicate determination. Values with different superscript within a column are significantly different from each other at p≤0.05.

AAA (Control) = 100% Wheat Flour

BBB = 85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree

CCC = 80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree

DDD = 75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree

EEE = 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree

Sodium (Na)

The mineral content of the different biscuit samples is shown in table 4.2 above. The sodium content ranged from 30.41 to 125.5 Mg/kg. Biscuit samples containing 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) recorded the highest value (125.5mg/kg) while the control sample (100% Wheat) recorded the lowest (30.41mg/kg). Minerals are essential for health and as such are part of all aspect of cellular function and they are required for building structural components of human beings. This finding agrees with the research work of Aremu *et al.,* (2017).

Potassium (K)

The potassium content was significantly different within samples at P≤0.05. Samples containing 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) recorded the highest potassium content (298.2 mg/kg) while the control (100% wheat) recorded the lowest (173.3 mg/kg). Potassium is very useful in food addictives and in the industry. Potassium also contains medicinal properties which makes the element therapeutic in nature. The high potassium content in sample EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) could be due to the high percentage of protein. The value obtained from this study correlates with the findings of Ayo *et al.*, (2017).

Calcium (Ca)

The calcium content showed that the biscuit samples containing 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) recorded the highest (258.4Mg/kg) while the control sample (100% wheat) recorded the lowest (160.15mg/kg). The calcium content is responsible for building of strong bones and teeth in the body. Biscuit Samples EEE could be suggested for strong bones. The calcium result obtained is higher than the findings of Day, (2023) who recorded between 10.11 to 13.10 mg/kg.

Iron (Fe)

The iron content ranged between 9.35 to 12.20 Mg/Kg. Significant difference was shown in all the biscuit samples as sample EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) had the highest value (12.20 Mg/Kg.) while the control samples (100% Wheat flour) recorded the lowest value (9.35 mg/kg). The value of Zinc was found to be generally low throughout the biscuit samples compared to other essential minerals. This implies that the biscuit samples produced in this study contains more major minerals than trace minerals. Conclusively, Minerals are vital for normal growth, maintenance, effective immune system and prevention of cell damage (Kassa and Hailay, 2014). The results from the mineral analysis showed that the biscuit would contribute substantially to the recommended dietary requirement for minerals. This result agrees with the finding of Iwuoha and Eke, (2016).

PHYSICAL PROPERTIES OF BISCUITS

Table 4.3 Physical Properties of Biscuits

Sample Code	Weight (g)	Length (mm)	Breadth (mm)	Thickness (mm)
AAA (Control)	4.84 ± 0.64^a	4.45 ± 0.04^b	3.18 ± 0.62^a	10.96 ± 0.75^c
BBB	2.19 ± 0.65^e	3.47 ± 0.73^d	2.26 ± 0.12^d	10.52 ± 1.60^d
CCC	5.71 ± 1.10^d	3.29 ± 0.05^e	2.78 ± 0.05^c	16.11 ± 0.05^a
DDD	4.68 ± 1.15^b	3.88 ± 0.64^c	2.78 ± 0.05^c	13.07 ± 0.02^b
EEE	4.04 ± 0.24^c	4.83 ± 0.05^a	2.82 ± 0.30^b	10.16 ± 1.50^e

Values are mean ± standard deviation (SD) of duplicate determination. Values with different superscript within a column are significantly different from each other at $p \leq 0.05$.

AAA (Control) = 100% Wheat Flour

BBB = 85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree

CCC = 80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree

DDD = 75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree

EEE = 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree

Weight

The weight of biscuit flours ranged from 2.19 to 5.71g. Significant differences were observed for all the biscuit samples under study at $P \leq 0.05$. Sample CCC (Wheat Flour + 10% Toasted white bean flour + 10% Banana puree) was found to be heavier (5.71g) than other samples while sample EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) was lightest in weight (2.19g). The values observed is in agreement with the values of Adeniyi *et al.,* (2017) who recorded between 4.2 to 6.7g of weight in his work on quality production of cookies from blends of wheat, acha and African yam bean flour.

Length

The length of biscuits ranged between 3.29 and 4.86mm with sample EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) having the highest value (4.83mm) while sample CCC (85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree) recorded the lowest value of 3.29mm. Significant differences at P≤0.05 were observed for all the samples involved in this study.

Breadth

From table 4.4 above, the breadth of the samples ranged from 3.29 to 4.83mm. The control sample (AAA) recorded the highest value (4.83mm) while no significant difference was found in samples CCC (80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree) and sample DDD (75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree). The result is however lower than the findings of Adeniyi *et al.,* (2017).

Thickness

The values for thickness of biscuit samples ranged between 10.16 to 16.111mm. The sample CCC (80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree) were found to be the thickest with a value of 16.11mm. While sample EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) recorded the lowest value for thickness at 10.16mm. The value for thickness recorded in this study is in line with the findings of Eltayeb *et al.,* 2021.

FUNCTIONAL PROPERTIES OF FLOUR

Table 4.4 Functional Properties of Flour

Flours	Water Absorption	Swelling Capacity	Bulk Density	Oil Absorption
Wheat Flour	1.80 ± 0.00^{a}	5.66 ± 0.00^{a}	0.56 ± 0.01^{b}	1.62 ± 0.91^{a}
Toasted White Bean Flour	1.70 ± 0.00^{b}	3.85 ± 0.00^{b}	0.60 ± 0.20^{a}	1.41 ± 0.00^{b}

Values are mean ± standard deviation (SD) of duplicate determination. Values with different superscript within a column are significantly different from each other at $p<0.05$.

Water Absorption Capacity

The water absorption capacity (WAC) for flours is given in Table 4.3. The WAC ranged between 1.70 to 1.80 g/ml for the flour. The WAC was observed to be highest in wheat flour and lowest in toasted bean flour. The result shows that the addition of bean flour and banana puree to wheat flour will have an effect on the amount of water absorption. This could be as a result of the molecular structure of the starch of the grain which prevented water absorption, as could be seen from the lower values of WAC. A similar observation was reported by Kaushal *et al.* (2022). High WAC of composite flours shows that the flours can be used in the preparation of some foods such as sausage, dough, processed cheese and bakery products.

Swelling Capacity

The swelling capacity of flour blends ranged between 3.85 and 5.66% with wheat flour recording the highest while toasted bean flour recorded the lowest value. The swelling capacity of flours depends on types of variety, size of particles and types of processing methods or unit operations.

Bulk Density

The bulk density ranged between 0.56 to 0.60g/ml. The highest bulk density was observed in the toasted bean flour and lowest was observed in the wheat flour. The observed value falls between the findings of the work of Iwuoha and Eke, (2016) who recorded between 0.45 and 0.70 in five varieties of cookies produced from different flour blends

Oil Absorption

The oil absorption capacity (OAC) of composite flour ranged from 1.41 to 1.62g/ml (Table 4.3). The highest OAC has observed in wheat flour while the lowest value in toasted white beam flour. The OAC of composite flour differed significantly ($p<0.05$). The presence of high-fat content in flours might have affected adversely the OAC of the composite flours. However, the flours in this study are potentially useful in the interaction of structural components in food most especially in flavour retention, improvement of palatability and extension of shelf life particularly in bakery or meat products where fat absorption is desired (Aremu *et al.*, 2017).

SENSORY PROPERTIES OF BSICUITS

Table 4.5 Sensory Properties of Biscuits

Sample Code	Appearance/Colour	Flavour	Crispness	Taste	Mouthfeel	Overall acceptability
AAA (Control)	8.00 ± 0.00^{c}	8.60 ± 0.47^{a}	8.60 ± 0.47^{a}	8.60 ± 0.47^{a}	8.00 ± 0.00^{c}	8.30 ± 0.47^{b}
BBB	8.30 ± 0.47^{b}	8.30 ± 0.47^{b}	8.30 ± 0.47^{b}	8.60 ± 0.47^{a}	8.30 ± 0.47^{b}	8.30 ± 0.47^{b}
CCC	7.30 ± 0.47^{d}	8.30 ± 0.47^{b}	8.00 ± 0.00^{c}	8.00 ± 0.47^{b}	8.60 ± 0.47^{a}	8.30 ± 0.47^{b}
DDD	8.00 ± 0.00^{c}	8.00 ± 0.00^{c}	7.30 ± 0.47^{d}	8.00 ± 0.00^{b}	8.00 ± 0.00^{c}	8.00 ± 0.00^{c}
EEE	8.60 ± 0.47^{a}	8.00 ± 0.00^{c}	7.30 ± 0.47^{d}	8.60 ± 0.00^{a}	7.30 ± 0.47^{d}	8.60 ± 0.00^{a}

Values are mean ± standard deviation (SD) of duplicate determination. Values with different superscript within a column are significantly different from each other at $p\leq0.05$.

AAA (Control) = 100% Wheat Flour

BBB = 85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree

CCC = 80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree

DDD = 75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree

EEE = 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree

Appearance/Colour

The sensory evaluation shows that the appearance of biscuits ranged from 7.30 to 8.60. Biscuit samples with 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) was most preferred in appearance and differs significantly from others at $P\leq0.05$. The differences observed in the appearance could be as result of addition of other ingredients during biscuits production which impacted on the colour of the biscuits. This value obtained from this experiment is in alignment with the research work of Akinsanmi, *et al.*, (2015)

Flavour

The flavor of the biscuits produced ranged from 8.00 to 8.60. Biscuit produced from 100% wheat flour had the best significant ($P \leq 0.05$) flavor compared to others. The significant ($P \leq 0.05$) lesser preference of biscuits from 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) could be attributed to the low oil absorption properties of the bean flour. Absorption of oil by food products improve mouthfeel and flavor retention. Flavour is the combine sensation of smell and taste.

Crispness

The crispness observed in this study ranged from 7.30 to 8.60 with the control sample (100% wheat) having the highest value (8.60) while sample DDD (75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree) and EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) recorded the lowest value of 7.30. Significant differences were recorded in all samples except sample DDD and EEE.

Taste

The taste ranged from 7.30 to 8.60. The biscuit made from 70% wheat Flour + 20% toasted white bean flour + 10% Banana Puree (EEE) was preferred in taste and was not significantly different ($P \leq 0.05$) from the Control (100% wheat flour) and sample BBB (85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree). Pleasures from taste of food are the major determinant of food intake. Foods that satisfy taste may contribute not only to greater eating experience but also to a sense of satiation and satiety (Ayo, *et al.*, 2017).

MouthFeel

The mouthfeel ranged from 7.30 to 8.60 with sample CCC (80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree) having the highest value of 8.60 while sample EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree) had the lowest value of 7.30. The control sample containing 100% wheat flour was preferred in the mouthfeel compared to other samples. However, other samples were still rated high above average.

Overall Acceptability

From Table 4.3 above, the overall acceptability ranged from 8.0 to 8.6. Biscuit produced from 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) was the most accepted by the panel to others. All other samples were however rated above average by the judges. The significant difference ($P \leq 0.05$) could be attributed to the observed difference in taste, appearance and colour.

ANTINUTRITIONAL COMPOSITIONS OF BISCUITS

Table 4.6 Antinutritional Composition of Biscuits

Sample Code	Tannin (GAE/g)	Phenol (GAE/g)	Saponin (DE/g)	Alkaloids (%)
AAA (Control)	1.29 ± 0.01^{a}	1.00 ± 0.00^{e}	1.44 ± 0.02^{d}	0.05 ± 0.01^{b}
BBB	1.33 ± 0.00^{a}	1.59 ± 0.09^{d}	1.66 ± 0.00^{c}	0.08 ± 0.00^{b}
CCC	1.40 ± 0.01^{a}	2.08 ± 0.08^{b}	1.89 ± 0.01^{b}	0.12 ± 0.00^{a}
DDD	1.38 ± 0.00^{a}	2.50 ± 0.00^{a}	2.17 ± 0.01^{a}	0.14 ± 0.00^{a}
EEE	1.32 ± 0.00^{a}	1.83 ± 0.00^{c}	1.71 ± 0.01^{c}	0.10 ± 0.00^{a}

Values are mean ± standard deviation (SD) of duplicate determination. Values with different superscript within a column are significantly different from each other at $p \leq 0.05$.

AAA (Control) = 100% Wheat Flour

BBB = 85% Wheat Flour + 5% Toasted white bean flour + 10% Banana puree

CCC = 80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree

DDD = 75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree

EEE = 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree

The result of the anti-nutrient composition of flour blends is shown in Table 4.5 above. The presence of anti-nutrients in foods could hinder the efficient utilization, absorption or digestion of some nutrients and thus, reduce their bioavailability (Adeniji *et al.*, 2017).

Tannin

Tannin content ranged from 1.29 to 1.40 GAE/g. No significant differences was observed in the tannin content between all the biscuit samples under study. Popova and Mihaylova, (2019) defined tannins as a major group of antioxidant polyphenols found in food and beverages that attracts research interest with its multifunctional properties on human health. Tannins exhibit antinutritional properties by impairing the digestion of various nutrients and preventing the body from absorbing beneficial bioavailable substances (Agarwal, 2016). Other toxic effects of tannins can be categorized as: depression of food intake, inhibition of digestive enzymes, increased excretion of endogenous protein, digestive tract malfunctions and toxicity of absorbed tannin or its metabolites (Krupa, 2018). Tannin however, play a major potential role as protective factors against free radical mediated pathologies such as cancer and atherosclerosis in humans when present in small amounts. The observed values is in agreement with the findings of Agarwal, (2016)

Phenols

The phenol compounds ranged from 1.8 to 2.08 GAE/g with sample DDD (75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree) having the highest value (2.08) while the Control sample (100% wheat flour) had the lowest (1.8). This recorded value is in agreement with the work of Agarwal, (2016).the low phenolic content in the biscuits samples means that they contains some medical properties.

Saponin

The saponin values ranged from 1.44 to 2.17 DE/g. with sample DDD (75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree) having the highest value (2.17 DE/g) while the control sample (100% Wheat) recorded the lowest value (1.44 DE/g). Mihrete (2019) reported that high concentration of saponin in the diet can cause haemolysis of red blood cells. They can also interact with bio-membranes causing pores and holes in them leading to apoptosis (cell death). However, Saponin at low concentration can decrease blood lipids, lower cancer risks, and lower blood glucose (Agarwal, 2016). The findings presented in this study agrees with the work of Ndidi *et al.*, (2014) who recorded 0.148 mg/100g in their work on *Sphenostylis stenocarpa.*

Alkaloids

The alkaloid content ranged from 0.05 to 0.14% with sample DDD (75% Wheat Flour + 15% Toasted white bean flour + 10 % Banana Puree) having the highest value which is not significantly different (P≤0.05) from CCC (80% Wheat Flour + 10% Toasted white bean flour + 10% Banana puree) and EEE (70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree). Alkaloid play essential role in human medicine containing a lot of pharmacological properties. The mixture of wheat blend with toasted white bean flour and banana puree will increase the medicinal properties of the biscuit produced.

CONCLUSION AND RECOMMENDATION

This study determined the proximate, minerals, functional, physical, sensory and anti-nutritional properties of biscuits produced from blends of wheat, toasted white bean flour and banana puree. The biscuits produced increased in nutrient contents which are all desirable for good health and wellbeing. The study shows that supplementation of 70% wheat Flour + 20% Toasted white bean flour + 10% Banana Puree (EEE) produced biscuits that are rich in proteins and all major minerals. Therefore, the use of wheat flour, toasted white bean flour and banana puree in biscuit will go a long way in building up the immune system, enhancing nutrition, health and wellbeing of the consumers and reduce the dependence on wheat flour alone, thereby saving the huge foreign exchange used in importing wheat. It will also reduce food insecurity and diversify the use of white bean and banana puree. Finally, the biscuit produced from different blends of flour in this study possess medicinal properties and can help in blood glucose reduction, weight loss, improving the immune system and lowering the risk of cancer due to the low amount of antinutrient present in them.

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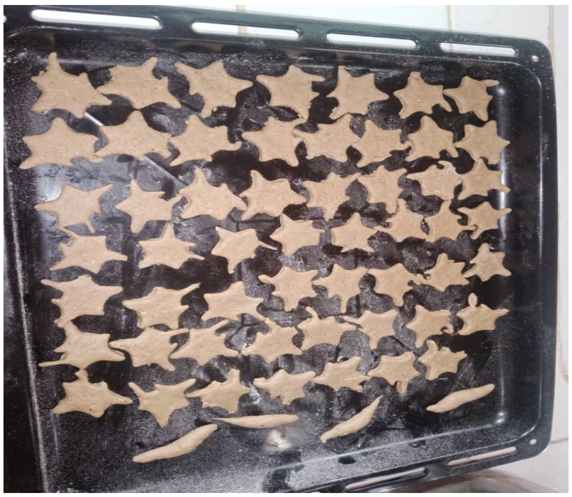

APPENDIX

Fig5: White Bean

Fig 6: Ripe Banana

Fig 7:Biscuit Samples Produced

Fig 8: Different biscuit samples packaged