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Production and Quality Evaluation of Short Bread Biscuit Using Wheat and Fermented Unripe Plantain Flour

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Authors' contributions

This work was carried out in collaboration among all authors. Authors JAA and ETO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MOA and OEO managed the analyses of the study. Author OEO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The utilization of plantain flour has increased in recent years as a result of its industrial potential and health benefits; hence the more quests for its application in food product development. In this study, short bread biscuit was formulated from wheat and plantain flours mixed in the ratios 90:10, 80:20, 70:30, 60:40, 50:50 and 100% wheat flour was indicated as control. The flours and the short bread biscuits were analyzed for their proximate, physico-chemical properties of the mixes and physical attributes and consumer acceptability of the short bread biscuit by sensory evaluation using standard methods. The result showed that the proximate composition values ranged from 12.41 to 14.54, 9.06 to 11.38, 1.11 to 1.51% for moisture, protein, fat, crude fibre, ash contents and carbohydrate respectively. The mineral ranged from 2.28 to 2.67 mg/100 g, 8.38 to 9.44 mg and 276 to 296.50 mg/100 g for iron, calcium and phosphorus respectively. The physiochemical properties ranged from 0.609 to 0.615 g/ml and 0.63 to 0.64 g/ml, 119.50 to 134.00 g/g, 15.25 to

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17.40 g/g for loose and packed bulk densities, water absorption capacity, swelling capacity respectively. The amylose and amylopectin value ranged from 24.05 to 31.55 and 68.45 to 75.95% respectively. The value for vitamin C and B1 ranged 3.04 to 3.58 and 0.22 to 0.24 µg/100 g respectively. The proximate content of the short bread biscuit ranged from 8.65 to 9.94, 6.93 to 7.73, 65.96 to 66.74, 1.02 to 1.75, 2.25 to 2.63 for moisture, protein, carbohydrate, crude fibre, ash and carbohydrate respectively. The sensory attribute shows that short bread biscuit produced from 90:10% was well accepted.

Keywords: Unripe plantain; wheat; fermentation; biscuits; composite flour.

1. INTRODUCTION

Biscuits may be regarded as a form of confectionery with very low moisture content. They are usually produced from cereal flours (mainly wheat) and consumed extensively all over the world. They are also ideal for nutrient availability, palatability, compactness and convenience. They differ from other baked products like bread and cakes because of low moisture content, comparative freedom from microbial spoilage and long shelf-life [1]. Biscuits may be classified either by the degree of enrichment and processing or by the method adopted in shaping them. Based on the enrichment criterion, biscuits may be produced from hard dough, soft dough or from batter [2].

Nigeria, a tropical country, cannot grow wheat in commercial quantity due to its hot climatic condition. Therefore, for the survival of biscuits and other confectionery products, the use of locally available grains, legumes or some edible insect to substitute wheat flour is essential. Series of studies involving the use of non-wheat flour from various cereals, legumes, roots and tubers have been carried out to substitute wheat in baked products [3].

Plantain is the common name for herbaceous plants of the genus *Musa.* Plantains are classified formally as *Musa acuminate* and *Musa balbisiana* depending on their genomic constitution. It provides more than 25% of the carbohydrate requirements for over 70 million people and tends to be firmer and low in sugar content. Plantains are commonly cooked or otherwise processed and are used either when green or unripe (starchy) or over ripe (sweet) [4]. An average plantain has about 220 calories and is a good source of potassium and dietary fiber [5]. It is rich in carbohydrate, dietary fiber, iron, vitamins and minerals. It is ideal for diabetic, children and pregnant woman and can also be a good supplement for marasmus patients. It also helps to cure anemia and maintain a healthy heart [6]. The development of food products using composite flour has increased and is attracting much attention from researchers, especially in the production of bakery products and pastries. The blending of wheat flour with various tubers, legumes, cereals and fruit flour in different percentages has been found suitable to produce variety of food products. It was found that composite flour used to produce food products is still able to maintain similar characteristics to products made from full-wheat flour [7,8,9]. The positive effects of the use of composite flour can be seen in the final product related to the functional and physicochemical properties and health benefits of raw blended flour along with percentage blending. Composite flour is a good new approach to utilizing uncommon food products as the application of composite flour produced products with different characteristics and quality, depending on the types and percentage of wheat flour used in the formulation [9].

The aim of this project was to produce and evaluate the quality attribute of short bread biscuit from wheat and fermented plantain composite flour with the objectives of evaluating the proximate and physico-chemical properties of the mixes and determining the physical attribute and acceptability of short bread biscuit by sensory evaluation.

2. MATERIALS AND METHODS

2.1 Materials

Unripe plantain was purchased at from an open market in Ogbomoso, Oyo State, Nigeria. Also, other materials of known quantity such as wheat flour, margarine, sugar, whole eggs, vanilla flavour, baking powder, salt, Nut meg, was used to improve the overall quality of the biscuits; these ingredients were also be purchased from the same market.

2.2 Methods

2.2.1 Production of fermented unripe plantain flour

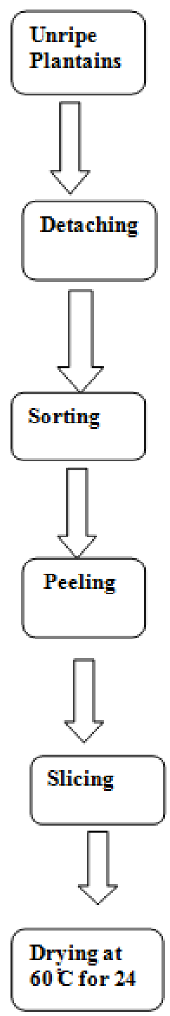
The unripe plantain was oven dried using methods described by Falade and Olugbuyi [10]. The fingers were carefully detached from the bunch, sorted, cleaned, peeled and sliced to about 5 mm thickness. The sliced plantains were oven dried at 60ºC for 24 hours [11]. The dried chips were milled using a hammer mill and sieved (300-400 µm). The flour was made to slurry by mixing with distilled water in a ratio of 10; 3w/v and allowed to ferment for 24 hr. The fermented slurry was oven dried at 60ºC for 24 hours. The dried flour was milled, sieved and sealed in polythene bags (100 µm) until needed for baking (Fig. 1).

2.3 Preparation of the Various Flours Blends

The wheat flour was blend with unripe plantain flour in line with the maximum acceptable blend in the early work [12]. Six blends containing varying proportions of plantain flour (0, 5, 10, 20, 30, 40 and 50%) together with wheat flour was prepared by mixing required amounts of respective flours.

2.4 Production of Short Bread Biscuit

The biscuits were prepared using each ratio of mixed wheat flour and unripe plantain flour. 100% wheat flour was used as control. Formulation for all samples of biscuits is as shown in Table 1.



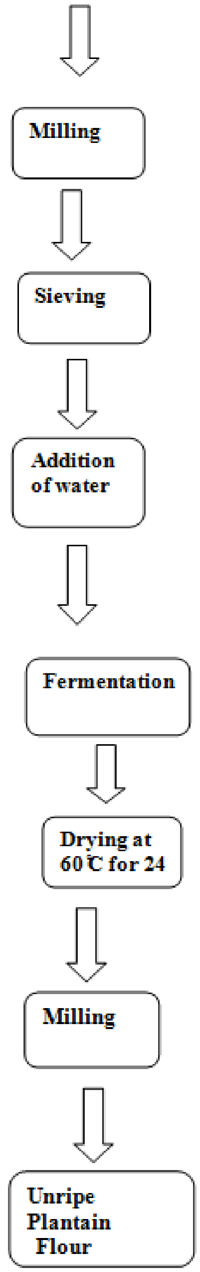


Fig. 1. Production of unripe fermented plantain flour
Source: (Falade and Olugbuyi, [10])

The Oyewole et al. [13] and Ayo and Nkama [12] methods of biscuit production was adopted. The sugar and fat was mixed using a mixer at medium speed until fluffy. The liquid milk was added and mixed for 30 min. The wheat-unripe composite flour baking powder and salt were slowly added into the mixture and mixed until a uniform smooth paste was obtained. The paste was rolled on a flat rolling board sprinkled with the same flour to a uniform thickness of 0.4 cm using a wooden rolling pin. Rectangular biscuits of 4.0 cm diameter was cut (using a biscuit-cutter), placed on a greased baking tray and baked at 160°C for 15 min (BCH- Rotary oven, Great Britain). The biscuit was allowed to cool down and hermetically sealed.

Table 1. Formulation of wheat and fermented plantain flour mixes used for short-bread biscuit

Ingredients	Samples					
	A	B	C	D	E	F
Wheat flour (g)	10	90	80	70	60	50
Plantain flour (g)	0	10	20	30	40	50
Sugar (g)	40	40	40	40	40	40
Margarine (g)	40	40	40	40	40	40
Vanilla Flavour (g	5	5	5	5	5	5
Egg (g)	25	25	25	25	25	25
Baking powder (g)	5	5	5	5	5	5
Nutmeg (g)	0.5	0.5	0.5	0.5	0.5	0.5
Powder preservatives	0.5	0.5	0.5	0.5	0.5	0.5

Key notes: A =100:0; B = 90:10; C=80:20; D=70:30: E=60:40; F=50:50 of Wheat: Unripe plantain flour

2.5 Chemical Analyses

Proximate composition: The moisture content of the flour was determined in triplicate by drying at 120°C to constant dry weight in a hot-air oven. The total nitrogen content was determined by Kjeldahl nitrogen analysis, according to AOAC [14]. The percentage of crude protein was estimated by multiplying the total nitrogen content by a factor of 6.25. The total fat content was determined by extraction of 2.0-2.5 g of dry ground sample for 12 h in a Soxhlet with petroleum ether and removed the solvent by rotary evaporator then dried the sample in hot air oven at 100°C for about 1 h to allow the ether evaporate [14]. The crude fiber and ash contents were determined according to AOAC methods [14]. Finally, the total carbohydrate content was calculated by subtracting the total percentage of all the other above components from 100.

Vitamin analysis: Vitamin C and B_1 were determined according to AOAC [14].

Mineral content: The mineral content was determined using the method of AOAC [14]. One gram of the sample was digested with ntric/perchloric/sulfuric acid mixture in the ratio 9:2:1, respectively and filtered. The filtrate was made up to the mark in 5-ml volumetric flask. The filtrate was loded in an Atomic Absorption Spectrophotometer (Model 703, Perkin Elmes, Norwalk, CT). While potassium content was determined using flame photometer (Sherwood, U.K.) using NaCl and KCl as the standard.

Functional properties: Bulk density of the samples was determined using the method described by Kinsella [15]. Water absorption capacity was determined by the method described by Sosulski, Garrant, and Slinkard [16]. Emulsion capacity was determined using the method described by Yasumatsu et al. [17]. The foaming capacity was determined according to the method described by Narayana and Narasinga [18]. Swelling capacity and solubility index were determined according to procedures described by Akpata and Miachi [19]. Pasting characteristics of blends were evaluated using a Brabender viscoamylograph (Newport Scientific Pty Ltd. Warrie-wood NSW, Australia). Flour slurry, containing 12% solids, was heated from 30 to 95°C at a rate of 2.5°C/min, held at 95°C for 15 min, and cooled at the same rate to 50°C [20].

Sugar: The sugar (amylose and amylopectin) content was detrmined by the method as described by [21] as modified by [22].

Sensory evaluation: Sensory evaluation of the biscuit was carried out using using 20 untrained panelist who are biscuit consumers and familiar with its quality selection based on their interest and availability. It was rated on a 9 point hedonic scale with 1 representing the least score (dislike extremely) and 9 the highest score (like extremely) for different parameters such as colour, flavour, taste, crispness and overall acceptability.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Wheat-Unripe Plantain Flour

The proximate composition of the flour is shown in Table 2. The moisture of the flour varied from 12.41 to 14.54% with sample with 100% wheat flour having the lowest value and sample with 50% each of wheat and plantain flour having the highest value. There was notable increase in the moisture content of the flour has unripe plantain flour is added. The decrease in moisture content with increase in the added coconut flour could have a positive effect on the shelf life stability, as moisture could lead to product spoilage due to oxidation reaction [18]. A similar trend of decrease in moisture content was observed by [23,24] who reported decrease in moisture in products from composite flours of cereals and legumes. There is significant difference (P<0.05) between the samples.

The protein contents of the flour varied from 9.06 to 11.38% with sample with 50% each of wheat and plantain flour having the lowest value and sample with 100% wheat flour having the highest value. There was notable decrease in the protein content of the flour with unripe plantain flour substitution. The decrease in the protein content is has a low protein content of unripe flour. The result is similar to the report of [25] and [26] when plantain flour was substituted to wheat flour for cake production but lower than the values reported by [27] and [28]. Similar losses of crude protein by the application of heat have been reported [29,30,31]. There is significant difference (P<0.05) between the samples.

The fat content of the flour varied from 1.11 to 1.51% with sample F having the lowest value and sample A having the highest value. There was slight increase in the fat content of the flour with unripe plantain flour substitution, this is as a result of low level of fat in plantain flour as reported by [32] and [27] – 0.34% and 1.47% respectively is an indication that fat do not contribute much to the energy content. It also gives a higher probability of a longer shelf life in terms of the onset of rancidity [33]. There is significantly different (P < 0.05) between samples.

The crude fibre content of the flours varied from 1.11 to 2.68% with sample A having the lowest value and sample F having the highest value. There was notable increase in the fat content of the flour with unripe plantain flour substitution. This shows that the composite blends are good sources of fiber and can be used in the preparation of functional food products. Consumption of high fiber food products has been linked to reduction in hermorrhoids, diabetes, high blood pressure, and obesity [34]. Fibre also has biochemical effect on the absorption and reabsorption of bile acid and consequently the absorption of dirty fats and cholesterol [35]. The work of [36] also reported that plantain is rich in dietary fibre (8.82%), resistant starch (16.2%), and low in protein and fat. There is significantly different (P < 0.05) between samples. The ash contents of the flours varied from 1.58 to 2.34% with sample A having the lowest value and sample F having the highest value. There is increase in the ash content of the flour with unripe plantain flour inclusion.

The carbohydrate content of the flours ranges from 70.28 to 72.02% with sample A having the lowest value and sample F having the highest value. There was notable decrease in the fat content of the flour with unripe plantain flour substitution. This may be because these flours contain high amount of starch and sugar content [37,38]. The energy content was between 346.89 kcal/g and 372.75 kcal/g. This high-energy content of the composite flour may be advantageous for formulation of breakfast cereal and complementary foods [39]. Carbohydrate is a source of energy for human daily activities. The bulk carbohydrate of unripe plantain is made up of starch and it is this bulk starch that gave plantain edged over other carbohydrate foods to be used as a diabetic food [40]. The bulk carbohydrate of unripe plantain is made up of starch and it is this bulk starch that gave plantain edged over other carbohydrate foods to be used as a diabetic food [40]. There is no significantly different (P > 0.05) between samples A and B.

Table 2. Proximate composition wheat –unripe plantain flour mixes (%)

Sample	Moisture	Crude protein	Crude fat	Crude fibre	Ash	Carbohydrate
100:0	12.41±0.035 ^{a}	11.38±0.014 ^{f}	1.51±0.028 ^{e}	1.11±0.091 ^{a}	1.58±0.000 ^{a}	72.02±0.169 ^{e}
90:10	13.85±0.014 ^{b}	9.87±0.007 ^{e}	1.33±0.007 ^{d}	1.98±0.021 ^{b}	1.65±0.021 ^{b}	71.34±0.014 ^{d}
80:20	13.94±0.014 ^{c}	9.56±0.028 ^{d}	1.28±0.000 ^{c}	2.24±0.014 ^{c}	1.78±0.014 ^{c}	71.20±0.042 ^{cd}
70:30	14.08±0.021 ^{d}	9.39±0.014 ^{c}	1.26±0.021 ^{c}	2.41±0.028 ^{d}	1.81±0.014 ^{c}	71.06±0.071 ^{bc}
60:40	14.14±0.035 ^{d}	9.32±0.035 ^{b}	1.18±0.014 ^{b}	2.47±0.014 ^{d}	1.96±0.028 ^{d}	70.94±0.098 ^{b}
50:50	14.54±0.056 ^{e}	9.06±0.014 ^{a}	1.11±0.014 ^{a}	2.68±0.014 ^{e}	2.34±0.035 ^{e}	70.28±0.035 ^{a}

Values are mean ± Standard deviation of triplicate determinations. Means with different superscripts are significantly different (P < 0.05)

3.2 Mineral Composition of Wheat-Unripe Plantain Flour Mixes

The mineral content of the flour is shown in Table 3. The value ranged from 2.28 to 2.67 mg/100 g, 8.38 to 9.44 mg/100 g and 276 to 296.50 mg/100 g for iron, calcium and phosphorus respectively with, sample A having the lowest value and sample F having the highest value. There was increase in the mineral content of the flour with the inclusion of unripe plantain flour, this is has a result of addition of addition of unripe plantain which is rich in iron and calcium [41]. Minerals are essential for the maintenance of the overall mental physical wellbeing and are important constituents for the development and maintenance of bones, teeth, tissues, muscles, blood, and nerve cells. They aid acid base balance, response of the nerves to physiological stimulation and blood clotting [42] and also it play a key role in various physiological functions of the body, especially in the building and regulation processes. Fruits are considered as a good source of dietary minerals [43].

3.3 Physiochemical Properties of Wheat–Unripe Plantain Flour Mixes

The physiochemical properties of the flour are shown in Table 4. The loose and packed bulk densities of the flour varied from 0.609 to 0.615 (g/ml) and 0.63 to 0.64 (g/ml) with sample A having the lowest value and sample F having the highest value. There was notable increase in the loose and packed bulk densities of the flour with unriped plantain flour substitution. The increase in the loose and packed bulk densities of the flour suggest that the requirements for packaging these flours will not change significantly, but rather it will allow the use of a more economical package [44]. The bulk density is generally affected by the particle size and the density of the flour and it is very important in determining the packaging requirement, material handling and application in wet processing in the food industry, indicating a lesse package requirement with increase in soy flour substitution [45]. The bulk density is affected by the particle size and the density of the flour which is very important in determining the packaging requirements, material hand-ling and the application in wet processing in food industry [45]. Generally, higher bulk density is desirable for it great ease of dispersibility and reduction of paste thickness which is an important factor in convalescent child feeding [46].

The water absorption capacity of the flou ranged from 119.50 to 134.00 (g/g) with sample A having the lowest value and sample F having the highest value. There was notable increase in the water absorption capacity of the flour with unriped plantain flour substitution. The difference in WAC could be due to difference in the granule size of the various formulations which may enhance the ability of the flours to absorb water [47]. WAI measures the volume occupied by the starch granule or starch polymer after swelling in excess water which can be used as an index of gelatinization [48]. Water absorption characteristics represent the ability of a product to associate with water under conditions where water is limited [49]. The swelling capacity of the flour ranged from 15.25 to 17.40 g/g with sample A having the lowest value and sample F having the highest value with sample A having the lowest value There was increase in the swelling power has plantain is substituted, Increase in the swelling power of flours with increasing time was attributed to the increasing heat [50].

3.4 Pasting Properties of Wheat–Unripe Plantain Flour Mixes

The pasting properties of the flour ranged are shown in Table 5. Gelatinization and pasting are properties of flour that are significant in the food industry, because they tend to affect the texture, uses and digestibility of starchy foods [45]. It values ranged 271.58 to 276.34; 215.74 to 218.07; 40.03 to 41.74; 305.72 to 317.87; 84.92 to 87.94; 5.97 to 7.94; 73.55 to 81.48 for peak viscosity, through viscosity, break down viscosity, final viscosity, set back, peak time and pasting temperature. Peak viscosity is the ability of the starch to swell freely before its physical breakdown [51]. The results of pasting properties of the samples indicates that the substitution of breadfruit flour reduced the peak viscosity. The relatively low peak viscosity effect by breadfruit flour addition is an indication that the flour can be used for the production of products that require low gel strength and elasticity [45]. The breakdown viscosity of the samples indicates an index for the stability of the starch [52]. Breakdown viscosity measures the ability of paste to withstand breakdown during cooling. Large values indicate little breakdown of sample starches. The final viscosity indicates the ability of the flour to form a gel or viscous paste after cooking and cooling as well as the resistance of the viscous paste to shear stress during stirring [45]. The final viscosity of the samples decreased with an increase in unripe plantain substitution.

Table 3. Mineral composition of wheat–unripe plantain flour mixes

Sample	Fe (mg/100 g)	Ca (mg/100 g)	P (mg/100 g)
100:0	2.28±0.014 [a]	8.38±0.014 [a]	276.00±1.014 [a]
90:10	2.35±0.212 [b]	8.91±0.014 [b]	280.00±1.014 [a]
80:20	2.48±0.212 [c]	8.97±0.014 [c]	287.00±1.014 [b]
70:30	2.50±0.014 [c]	9.30±0.121 [d]	290.50±0.121 [bc]
60:40	2.56±0.014 [d]	9.36±0.121 [e]	293.50±0.121 [cd]
50:50	2.67±0.212 [e]	9.44±0.121 [f]	296.50±0.121 [d]

Values are mean ± Standard deviation of triplicate determinations. Means with different superscripts are significantly different (P < 0.05)

Table 4. Physiochemical properties of wheat–unripe plantain flour mixes

Sample	Loose bulk density (g/ml)	Parked bulk density (g/ml)	Water absorption capacity (g/g)	Swelling capacity (g/g)
100:0	0.609±0.000 [a]	0.63±0.000 [a]	119.50±2.121 [a]	15.25±2.212 [a]
90:10	0.612±0.000 [b]	0.63±0.000 [b]	122.50±2.121 [ab]	15.65±2.212 [ab]
80:20	0.613±0.000 [c]	0.63±0.000 [b]	124.50±2.121 [abc]	16.00±2.282 [bc]
70:30	0.614±0.000 [d]	0.63±0.000 [c]	126.50±2.121 [bc]	16.35±2.212 [cd]
60:40	0.615±0.000 [e]	0.64±0.000 [d]	129.50±2.121 [cd]	16.80±2.141 [d]
50:50	0.615 ±0.000 [f]	0.64±0.000 [e]	134.00±1.414 [d]	17.40±2.141 [e]

Values are mean ± Standard deviation of triplicate determinations. Means with different superscripts are significantly different (P < 0.05)

Table 5. Pasting properties of wheat-unripe plantain flour mixes

Sample	Peak 1 (RVU)	Through 1 (RVU)	Break-down (RVU)	Final viscosity (RVU)	Set back (RVU)	Peak time (Min)	Pasting Temp. °C
100:0	276.34 [f]	218.07 [f]	40.03 [a]	317.87 [f]	87.94 [f]	5.97 [a]	73.55 [a]
90:10	275.73 [e]	217.57 [e]	41.74 [d]	315.84 [e]	86.52 [e]	6.71 [b]	74.80 [b]
80:20	275.21 [d]	217.03 [d]	41.06 [c]	313.37 [d]	88.41 [d]	6.97 [c]	76.71 [c]
70:30	274.76 [c]	216.74 [c]	40.74 [b]	310.79 [c]	86.85 [c]	7.28 [d]	77.89 [d]
60:40	272.99 [b]	216.03 [b]	42.35 [e]	307.58 [b]	85.00 [b]	7.82 [e]	79.05 [e]
50:50	271.58 [a]	215.74 [a]	41.74 [d]	305.72 [a]	84.92 [a]	7.94 [f]	81.48 [f]

Values are mean ± Standard deviation of triplicate determinations. Means with different superscripts are significantly different (P < 0.05)

The final viscosity is the change in the viscosity after holding cooked starch at 50°C. It is one of the most common parameter used to define the quality of a particular starch-based sample, as it indicates the ability of the flour to form a viscous paste or gel after cooking and cooling as well as the resistance of the paste to shear force during stirring [53,54]. Final viscosity (indicates the ability of the material to form a viscous paste) have been reported as the most commonly used parameter to determine the ability of starch-based materials to form a viscous paste or gel after cooking and cooling as well as the resistance of the paste to shear force during stirring [45,55].

The setback value indicates that the higher the substitution level of unripe plantain flour, the more the retrogradation level during cooling and the more the staling of the products made from the flour [56]. The pasting temperature is an indication of the gelatinization time during processing. It is the temperature at which the first detectable increase in viscosity is noted and is an index associated with the initial change due to the swelling of the starch.

3.5 Vitamin Composition of Wheat-Unripe Plantain Flour Mixes

The vitamin contain of the flour is shown in Table 6. The value for vitamin C and B1 ranged 3.04 to 3.58 and 0.22 to 0.24 µg/100 g with sample A having the lowest value and sample F having the highest value. There was increase in the vitamin content of the flour has plantain flour is added. The increase observed in the vitamin B as the unripe plantain levels increased confirmed the claims of previous workers [57,58] that carrot powder has a good residual amount of carotenoids. Carotenoids have been implicated in the enhancement of immune system, decreased risk of degenerative diseases such as cancers, cardiovascular disease, prevention of muscular degeneration and cataract formation [59,60] and Vitamin C indicates that the product from the composite flour will be a good source of vitamin C for body normal metabolism, and can also be used in prevention of scurvy and in wound healing and tissues repair. There is significant difference (P<0.05) between the samples.

3.6 Starch Content of Wheat-Unripe Plantain Flour Mixes

The result of the amylose and amylopectin of the flour blends are presented in Table 7. the amylose and amylopectin value ranged from 24.05 to 31.55 and 68.45 to 75.95% respectively with increase in the amylose content and decrease amylopectin content of the flour has plantain flour is added. The results of amylose are lower to the study of [61] who reported amylose value ranging from 40 to 70% for different plantain cultivars. Thus, high value of amylose content detected may be due to level of plantain substitution. The ratio of amylose to amylopectin in carbohydrate has important implication on food quality, industrial application and health. Straight–chain amylose forms a solid bond so that it is not easily gelatinized, whereas amylopectin is highly branched, available for enzymatic digestion with open structure [62].

3.7 Proximate Composition of Short Bread Biscuit

The proximate composition of short bread biscuit is shown in Table 8. The moisture content of the short bread biscuit ranged from 22.98 to 4.88% with biscuit from 100% wheat flour having the lowest value and 50% wheat flour, 50% unripe plantain Flour having the highest value. There was increase in the moisture content of the short bread biscuit has unripe plantain Flour is added. The increase in moisture content with increase in the added unripe plantain flour could have a positive effect on the shelf life stability, as moisture could lead to product spoilage due to oxidation reaction [18]. A similar trend of decrease in moisture content was observed by [23,24] who reported decrease in moisture in products from composite flours of cereals and legumes. Biscuit produced from high percentage of unripe plantain Flour flour have the higher value to those from wheat flour; this may be due to high water absorbing capacity of coconut fiber.

3.8 Sensory Evaluation of Short Bread Biscuit

The sensory evaluations of the short bread biscuit are presented in Table 9. The colours of the biscuit samples were all acceptable to the panelists. However, all samples were most

Table 6. Vitamin composition of wheat-unripe plantain flour

Sample	Vitamin C µg/100 g	Vitamin B1 µg/100 g
100:0	3.04±0.212 [a]	0.22±0.002 [a]
90:10	3.15±0.218 [b]	0.22±0.001 [b]
80:20	3.25±0.014 [c]	0.23±0.000 [bc]
70:30	3.38±0.014 [d]	0.23±0.002 [c]
60:40	3.44±0.212 [e]	0.23±0.001 [d]
50:50	3.58±0.212 [f]	0.24±0.001 [e]

Values are mean ± Standard deviation of triplicate determinations. Means with different superscripts are significantly different (P < 0.05)

Table 7. Starch content of flour mixes

Samples	Amylose %	Amylopectin %
100:0	24.05 [a]	75.95 [a]
90:10	25.89 [b]	74.11 [b]
80:20	30.27 [d]	69.73 [d]
70:30	32.55 [f]	67.45 [f]
60:40	29.38 [b]	70.62 [c]
50:50	31.55 [e]	68.45 [e]

Values are mean ± Standard deviation of triplicate determinations. Means with different superscripts are significantly different (P < 0.05)

Table 8. Proximate composition of short bread biscuit

Sample	Moisture (%)	Protein (%)	Fat (%)	Crude fibre (%)	Ash (%)	Carbohydrate (%)
100:0	2.98±0.000 [a]	4.56±0.040[f]	22.98±0.014 [a]	1.81±0.042 [a]	1.13±0.007 [a]	66.54±0.077 [e]
90:10	3.08±0.120 [a]	4.28±0.028 [e]	28.74±0.035 [b]	2.09±0.035 [b]	1.22±0.035 [b]	60.59±0.219 [d]
80:20	3.93±0.078 [b]	3.23±0.007 [d]	33.80±0.127 [c]	3.33±0.035 [c]	1.25±0.000 [b]	54.46±0.092 [d]
0:30	3.96±0.000 [B]	3.40±0.028 [c]	45.37±0.247 [e]	3.74±0.098 [d]	1.36±0.014 [c]	42.17±0.197 [b]
60:40	4.80±0.042 [c]	3.10±0.014 [b]	47.69±0.049 [d]	4.35±0.014 [e]	1.42±0.007 [d]	38.64±0.042 [a]
50:50	4.88±0.045	2.90±0.042 [a]	47.73±0.000	4.47±0.007	1.50±0.000	38.52±0.042 [a]

Values are mean ± Standard deviation of triplicate determinations. Means with different superscripts are significantly different (P < 0.05)

Table 9. Sensory evaluation of short bread biscuit from wheat-unripe plantain flour mixes

Sample	Colour	Aroma	Taste	Crispness	Overall acceptability
100	8.33±0.577 [a]	6.67±0.577 [a]	6.67±0.577 [b]	7.33±0.577 [b]	8.33±0.577 [b]
90:10	8.33±0.577 [a]	7.33±0.577 [ab]	6.33±0.577 [b]	6.67±0.577 [b]	6.67±0.577 [a]
80:20	8.33±0.577 [a]	7.67±0.577 [b]	6.00±0.000 [ab]	5.67±0.577 [a]	6.33±0.017 [a]
70:30	9.00±0.000[b]	8.00±0.000 [b]	5.33±0.577 [a]	5.00±0.000 [a]	5.67±0.577 [a]
60:40	9.04±0.020[b]	8.17±0.000 [b]	5.31±0.007 [a]	5.00±0.007[a]	5.54±0.000 [a]
50:50	9.06±0.001[b]	8.21±0.000 [c]	5.26±0.000 [a]	4.98±0.000 [a]	5.50±0.007 [a]

Values are expressed as mean ± standard deviation of duplicate determination. Mean with the same superscript along the same column are not significantly different (p>0.05)

preferred in terms of colour. The tastes of the samples were generally acceptable, but sample from100% wheat was most preferred. The result revealed that there was significant difference (P<0.05) among the samples with respect to all the sensory attributes evaluated except colour of the biscuits. This suggests that all the samples maintained a high level of acceptability by the panelists. This is comparable with the results obtained by some authors using non wheat composite flours for the production of biscuits [63].

4. CONCLUSION

The study showed that unripe plantain has a significant effect on nutritional (proximate, physiochemical, vitamin, mineral, starch anti-nutritional) properties of the flour. There was notable increase the nutritional composition of the flour with unripe plantain flour inclusion. The result indicated that development of value added short bread biscuits could be produced with unripe plantain flour. The inclusion of unripe plantain flour in the biscuits improved the fibre content. It is noteworthy to say that the organoleptic properties evaluation results showed that a highly acceptable biscuit could be obtained from the different up to 30% unripe plantain flour levels of inclusion. Such practices would promote the utilization of the crop and hence help in reducing post-harvest wastage of plantain and also enhance nutritional intake of consumers.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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