

Quality assessment of biscuits produced from wheat-aerial yam-plantain flour blends

Ojinnaka MC¹, Okolie PI², Idorenyin BA³

^{1,3} Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria

² Department of Food Science and Technology, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria

Abstract

The suitability of biscuit production from six flour blends of wheat, plantain, and aerial yam was investigated. The biscuit samples from the composite flour blends were subjected to proximate, minerals, anti-nutrient and functional properties determination. Data obtained were subjected to analysis of variance, and mean values were separated using Duncan's multiple range test. The results obtained indicated that for proximate composition, the product ranged from 7.24% to 10.65% moisture, 1.43% to 2.61% ash, 2.21% to 3.56% fat, 1.74% to 2.12% fiber, 10.26% to 12.02% protein and 70.49% to 75.23% carbohydrate. Mineral content of the samples ranging from 4.46mg/100g to 5.96mg/100g iron, 360.50mg/100g to 400.50mg/100g potassium, 137.50mg/100g to 152.10mg/100g magnesium, and 3.21mg/100g to 6.57mg/100g sodium. Residual anti-nutrients in the biscuit samples ranged from 0.09 to 0.33mg/100g saponin, 0.06 to 1.14 mg/100g alkaloids, 0.24 to 0.47 mg/100g phenol, and 0.18 to 0.37 mg/100g tannin. The functional properties of the composite flour blends showed some significant ($p \leq 0.05$) difference when compared to wheat flour. The bulk density ($0.57 - 0.85\text{g/cm}^3$) of the composite flour blends increased as the rate of addition of plantain and aerial yam flour progressed.

Keywords: biscuit, plantain, aerial yam, wheat, flour

1. Introduction

Biscuits are convenient ready-to-eat baked snack consumed by all age groups in many countries (Adebowale *et al.*, 2012; Arise *et al.*, 2017) ^[1]. Wheat with other ingredients such as egg, fat, sugar, water, sweeteners as well as sensory qualities improvers are the main ingredients for the production of conventional biscuits (Adebowale *et al.*, 2012; Uchenna and Omolayo, 2017) ^[1, 3]. Wheat as the major raw material in pastry and bakery industries is rarely grown in Nigeria and very expensive to import (Oyeyinka *et al.*, 2014) ^[4]. The association of wheat consumption with such health problems as celiac disease makes it pertinent to utilize composite flour in biscuit manufacture (Kiin-Kabari and Giami, 2015^[5]; Adeola and Ohizua 2018^[6]) ^[5, 6].

Composite flour is a mixture of several flours obtained from roots, tubers, cereals and legumes with or with the addition of wheat flour (Julianti *et al.*, 2015; Arise *et al.*, 2017) ^[7, 2]. Composite flour utilization in the production of pastry and bakery products reduced the importation of wheat flour and brought about the use of underutilized indigenous crops through value addition (Arise *et al.*, 2016) ^[8]. Composite flour is desirable because it improves the nutritional value of bakery products, especially with the inclusion of legumes (Uchenna and Omolayo, 2017; Adeola and Ohizua 2018) ^[3, 6]. Successful efforts have been made in the use of composite flour from different crops in the production of bread and baked products (Edema, *et al.*, 2005; Hussein *et al.*, 2006; Adebowale *et al.*, 2012; Obasi, *et al.*, 2012; Adeola and Ohizua 2018) ^[10, 1, 11, 6].

Plantain (*Musa paradisiaca*) is grown in many tropical African countries like Nigeria. It is a good source of carbohydrate (32% of the fruit weight) and is rich in dietary fiber, iron, calcium, vitamin A, B6 and C (Adegunwa *et al.*, 2014; Arise *et al.*, 2017) ^[12, 21]. The use of plantain flour in

biscuits is desirable due to its high water absorption capacity (Oyeyinka *et al.*, 2014) ^[4].

Aerial yam (*Dioscorea bulbifera*) is an ostracized underutilized herbaceous twining edible tuber plant with distinctive flavor (Ojinnaka *et al.*, 2017) ^[13]. It has better nutritional value to most preferred yam species, but does not possess the same appeal compared to *D. alata* and *D. rotundata* (Ojinnaka *et al.*, 2016; Aathira and Siddhuraju, 2017) ^[14, 15]. Aerial yam is rich in protein, fiber and minerals (Uchenna and Omolayo, 2017) ^[3]. The use of aerial yam flour in the production of biscuits has been limited due to its small sizes which consume a lot of time to peel as well as the associated bitter taste.

This study is focused at evaluating some quality attributes of biscuits made from wheat, plantain and aerial yam composite flour with a view to increasing the utilization of aerial yam.

2. Materials and Methods

2.1 Source of Materials

Aerial yam (*Dioscorea bulbifera*) used in this study were obtained from National Root Crop Research Institute Umudike, Abia state Nigeria. Whole wheat grain (*Graminea triticum*) and unripe plantain were purchased from Umuahia main market Ubani Ibeku Umuahia North. These main food materials were identified by the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

2.2 Preparation of Flour

2.2.1 Wheat flour

The wheat grain were sorted, winnowed, washed and dried in thermo-regulated oven (Gallen, BS model 0v-160) at a temperature of 60°C for 13h. The dried grains were milled

with hammer mill into flour and then sieved with 250µm particle size sieve. The flour samples were sealed in cellophane bag and stored at room temperature at 26°C until needed for blend formulation (Olaoye *et al.*, 2006)^[16].

2.2.2 Aerial Yam flour

The Aerial yam tubers were peeled, soaked in water with 0.25% Sodium bisulfite, thoroughly washed, chopped then dried in thermo-regulated oven (Gallen, BS model 0v-160) at a temperature of 65°C for 12h. After which they were milled with hammer mill into flour and then sieved with 250µm particle size sieve. The flour was sealed in cellophane bag and stored at room temperature (24°C) until needed for blend formulation (Nwosu, 2014)^[17].

2.2.3 Plantain flour

The plantain were peeled, sliced, soaked in water with 0.25% Sodium bisulfite, and dried with thermo-regulated oven (Gallen, BS model 0v-160) at a temperature of 60°C for 13h. The dried materials were milled with hammer mill into flour and then sieved with 250µm particle size sieve. The flour samples were packed in cellophane bag and stored at room temperature (24°C) for analysis (Olaoye *et al.*, 2006)^[16].

2.2.4 Formulation of composite flour

Six different composite flour blends of wheat, Aerial yam and plantain were formulated as shown in Table 1. The flour blends were thoroughly mixed to obtain homogeneous blends and were stored in airtight containers at room temperature until when needed for biscuit production.

2.3 Biscuit Production

The biscuit samples were prepared using the method described by Oyeyinka *et al.* (2014)^[4] with slight modifications. Sugar (150g), baking fat (190g) and salt (5g) were mixed together manually in a bowl. Flour blends (500g) mixed baking powder (2.5g), and vanilla (5g) were then added and thoroughly mixed into batter. Measured amount of water (125ml) was gradually added to form slightly firm dough. The dough was kneaded, shaped using the stamp cutter and baked on a greased tray in an oven at 180°C for 10-20 minutes.

2.4 Analytical methods

2.4.1 Determination of chemical properties of the biscuit samples

Proximate compositions (moisture, ash, crude fiber, protein (N*6.25) and crude fat) of biscuits produced from the composite flour from wheat, aerial yam and plantain were analyzed, determined in duplicate using the standard procedures of Association of Official Analytical Chemists (AOAC, 2010)^[18]. Carbohydrate was determined by difference.

Atomic absorption spectrophotometer (Thermo Electron Cooperation, S4 AA System, GE712354) was used to determine iron, potassium, sodium and magnesium minerals from the biscuit samples following dry ashing sample procedure (Ohizua *et al.* 2017)^[19].

2.4.2 Determination of antinutrients of the biscuit samples

Tannin, phenol, alkaloid and saponin anti-nutrients were determined as described by Igbokwe *et al.* (2016)^[20].

2.4.3 Determination of functional properties of the composite flour blends

Bulk density, water absorption capacity, oil absorption capacity, wettability were determined as described by Onwuka (2005)^[21].

2.5 Statistical Analysis

Data were subjected to analysis of variances using SPSS 21.0 software. Mean with standard deviation was determined and means with significant difference were separated by applying Duncan's multiple range test at 95% confidence level.

3. Results and Discussion

3.1 Determination of chemical properties of biscuit

The proximate composition of the biscuit produced from the composite flour from wheat, plantain and aerial yam are as shown in Table 2. The value of the moisture content ranged from 7.24% to 10.65%. The values were lower to the values reported by Adebawale *et al.* (2012)^[1] for sorghum-wheat biscuits but higher than the ranges reported by Uchenna and Omolayo (2017)^[3] for wheat-aerial yam-bambara nut biscuit and Arise *et al.* (2017) for wheat-plantain-bambara nut biscuit. Low moisture content of biscuit entails greater shelf stability (Sanni *et al.*, 2006; Adebawale *et al.*, 2012)^[22, 1]. The moisture content values obtained from this work were within the range reported to have no adverse effect on the quality attributes of the product (Kure *et al.*, 1998)^[23].

The values of protein content obtained in the study were within the ranged reported by Uchenna and Omolayo, (2017)^[3] for wheat-aerial yam-bambara nut biscuit. The protein values ranged from 10.26% to 12.02% with sample 50:25:25 having the highest mean value of 12.02%. Sample 50:25:25 had the highest protein content compared to sample 100:0:0 (Control: 100%wheat flour). Protein is necessary for proper body maintenance and growth. It also serves as enzymes and hormones; it maintains acid-base balance and strong immune system (Mahan and Escott-Stump, 2008)^[24].

The value for the ash content of the biscuit ranged from 1.43% to 2.57%. The ash content of the biscuit samples increased with increase in the composite flour up to 20%. The ash content gives an indication of the amount of total mineral content of a food material. The values for the ash content from this study were slightly above the range obtained by Adebawale *et al.*, (2012)^[1] on sorghum-wheat biscuit by 0.21% but were greatly below the values reported by Uchenna and Omolayo, (2017)^[3] for wheat-aerial yam-bambara nut biscuit. Similar results were reported by Nwosu (2014)^[17].

The fat content of the sample ranged from 2.21% to 3.56%. Sample 80:10:10 with the mean value of 3.56% had the highest fat content while sample 100:0:0 (control: 100% wheat flour) had the lowest fat content value of 2.12%. The samples were significantly different at (P<0.05) and the fat content was generally low. The fat contents of the biscuit samples were similar to those reported by other researchers (Giwa and Ikujenlola, 2010; Adebawale *et al.*, 2012; Silky and Tiwari, 2014; Uchenna and Omolayo, 2017)^[25, 1, 26, 3] who produced biscuits from different composite flour blends containing different proportions of sorghum, plantain, bambara nut, millet, wheat, and tiger nut. The fat content of the biscuits did not appear to vary as the same quantities of fat were added.

The crude fiber content of the biscuits were higher compared to the biscuit from 100% wheat flour. The crude fiber content ranged from 1.74% to 2.12%. These values were higher than the values reported by Oluwamukomi *et al.*, (2011) for cassava-wheat biscuit (0.24% - 0.64%) and Adebawale *et al.*, (2012) [1] for Sorghum-wheat biscuit (1.66% - 1.95%). However, the value reported in this study were lower to the findings of Bolarinwa *et al.*, (2016) [28] and Arise *et al.*, (2017) [2] for biscuits produced from malted sorghum-soy and wheat-plantain-bambara nut composite flour blends respectively. Fiber plays a vital role in aiding food digestion as it absorbs water, provides roughage for the bowels and assisting intestinal movement.

The carbohydrate content of the biscuit samples from this study ranged from 70.49% to 75.23%. Sample 100:0:0 (control: 100% wheat flour) had the highest carbohydrate compared to other samples. Khan and Zeb (2007) [29] reported that wheat is a rich source of carbohydrate.

3.2 Mineral composition of the samples

The results of the mineral composition of the biscuits produced from composite flour of wheat, aerial yam and plantain showed significantly difference ($p < 0.05$) exist among the samples (Table 3). The sodium, potassium, iron, and magnesium contents of the biscuits ranged, respectively, from 3.21-6.57, 360.50 - 400.50, 04.46 - 5.96, and 137.50 – 152.10 mg/100g. Magnesium is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation (Adeola and Ohizua, 2018) [6]. Generally, it was observed that the sodium, potassium, iron, and magnesium contents of the biscuits increased as the percentage inclusion level of plantain and aerial yam flours increased.

3.3 Antinutrient composition of the biscuit samples

Antinutrients are substances that impart negatively on bioavailability, digestibility, and utilization of nutrients of food. Table 4 shows the antinutrient composition of the biscuits produced from composite flour of wheat, aerial yam and plantain. There was a significant difference ($p < .05$) in the tannin, saponin, phenol, and alkaloid contents of the biscuit samples. Tannins are polyhydric phenols which are present in virtually all parts of plants and have been found to inhibit trypsin, chymotrypsin, amylase, and lipase activities (Inyang and Ekop, 2015) [30]. The tannin content of the biscuits was highest in sample 50:25:25 (0.37 mg/100g). The values of the tannin content recorded in this study were lower than that reported by Okpala and Okoli (2011) [31] for cookies produced from pigeon pea, cocoyam, and sorghum flour blends (0.36 to 0.51 mg/100g). Adeola and Ohizua, (2018) [6] reported values of 11.55 to 40.19 mg/100g for biscuits prepared from flour blends of unripe cooking banana, pigeon pea, and sweet potato. Tannins complexes

with proteins and slows down food digestibility (Uzeochina, 2007) [32]. Onwuka (2015) [21] reported that the presence of tannin can cause browning or other pigmentation problems in both fresh food and processed products.

The saponin level in the biscuit samples ranged from 0.09 mg/100g to 0.33 mg/100g. Sample 50:25:25 had the highest mean value for saponin content (0.33mg/100g). The saponin contents of the cookies were very low suggesting that in this regard, they pose no threat to human consumption. Saponins have been reported to lower plasma cholesterol concentrations (Okpala and Chinyelu, 2011) [33]. The alkaloid content of the sample increased as the percentage wheat flour content in the sample decreased. Sample 100:0:0 (100% wheat) had the highest level of alkaloid content of 1.14mg/100g while sample 90:5:5 had the lowest value of 0.06mg/100g. The phenols content in this study ranged from 0.24mg/100g for sample 100:0:0 (control 100% wt) to 90:5:5 being the lowest with mean value (0.47mg/100g).

3.4 Functional properties of composite Flour blends

The functional properties of the composite flour blends are shown in Table 5. The functional properties of food highlights on the complex interactions between the compositions, structures, conformation as well as the physiochemical properties of food material during processing (Kohnhorst *et al.*, 1990) [34]. Water absorption capacity of the samples ranged from 16.10 – 20.30g/g and this indicated that sample 100:0:0 had an ability to hold water compared to other samples. They were significantly ($P \leq 0.05$) different from each other with the lowest water absorption capacity mean value of (16.10ml/g) shown by sample 50:25:25. High water absorption flour has been found to be suitable for baking (Kohnhorst *et al.*, 1990) [34]. Sample 50:25:25 had the highest mean value of 12.20g/g oil absorption capacity while sample 80:20:20 had the least mean value of 11.00g/g. Oil absorption capacity shows the ability of the sample to absorb oil. High oil absorption flour is an indication of improvement in flavour and mouth feel of baked foods. Wettability values of the samples were in the range 1.00 – 4.50 secs with sample 50:25:25 having the highest wettability value of 4.50secs. Wettability is the ability of food sample to become completely wet in water (Onwuka, 2005) [21].

Table 1: Mix Blend formulation used in the production of the biscuit samples (%)

Sample	Wheat	Plantain	Aerial yam
100:0:0	100	0	0
90:5:5	90	5	5
80:10:10	80	10	10
70:15:15	70	15	15
60:20:20	60	20	20
50:25:25	50	25	25

Table 2: Proximate composition of the biscuit samples (%)

Samples Wheat: Plantain: Aerial yam	Moisture	Ash	Fat	Crude Fibre	Crude Protein	Carbohydrate
100:0:0	8.32 ^c ± 0.02	1.43 ± 0.01	2.21 ^f ± 0.01	1.74 ^d ± 0.01	11.04 ^c ± 0.01	75.23 ^a ± 0.08
90:5:5	7.62 ^d ± 0.02	2.41 ^d ± 0.01	2.72 ^e ± 0.01	1.97 ^b ± 0.01	11.47 ^b ± 0.02	73.82 ^d ± 0.04
80:10:10	7.24 ^f ± 0.01	2.51 ^c ± 0.01	3.56 ^a ± 0.01	2.02 ^b ± 0.04	10.42 ^d ± 0.01	74.20 ^c ± 0.01
70:15:15	7.53 ^e ± 0.01	2.57 ^b ± 0.01	2.81 ^d ± 0.01	1.83 ^c ± 0.01	10.40 ^d ± 0.01	74.90 ^b ± 0.01
60:20:20	8.43 ^b ± 0.01	2.61 ^a ± 0.01	2.85 ^b ± 0.01	2.12 ^a ± 0.01	10.26 ^e ± 0.01	73.73 ^d ± 0.07
50:25:25	10.65 ^a ± 0.1	1.50 ^e ± 0.01	3.28 ^a ± 0.03	2.02 ^a ± 0.02	12.02 ^a ± 0.02	70.49 ^e ± 0.20

* Values with different superscript in the same column are significantly different ($P \leq 0.05$).

Table 3: Mineral composition of the biscuit samples (mg/100g)

Samples Wheat:Plantain:Aerial yam	Fe	K	Mg	Na
100:0:0	4.46 ^f ± 0.02	360.50 ^d ±0.71	137.50 ^f ±0.71	3.21 ^d ± 0.01
90:5:5	4.68 ^e ± 0.01	363.30 ^d ±0.14	141.00 ^e ±1.41	5.13 ^c ± 0.01
80:10:10	4.81 ^d ± 0.01	367.60 ^c ±0.28	144.50 ^d ±0.71	5.28 ^{bc} ± 0.01
70:15:15	4.86 ^c ± 0.01	369.50 ^c ±0.71	146.90 ^c ±0.14	6.11 ^b ± 0.01
60:20:20	5.11 ^b ± 0.01	373.15 ^b ±0.01	149.55 ^b ±0.07	6.57 ^a ± 0.01
50:25:25	5.96 ^a ± 0.02	400.50 ^a ±2.12	152.10 ^a ±1.27	6.54 ^a ± 0.36

*Values with different superscript in the same columns are significantly different ($p \leq 0.05$).

Table 4: Anti-nutrient composition of the biscuit samples (mg/100g)

Samples Wheat:Plantain:Aerial yam	Saponin	Alkaloid	Phenol	Tannin
100:0:0	0.09 ^b ± 0.01	1.14 ^a ±0.01	0.47 ^a ±0.01	0.18 ^c ± 0.01
90:5:5	0.24 ^c ± 0.01	0.06 ^e ±0.01	0.24 ^c ±0.01	0.23 ^b ± 0.01
80:10:10	0.28 ^a ± 0.01	0.14 ^d ±0.01	0.28 ^c ±0.01	0.26 ^b ± 0.01
70:15:15	0.29 ^a ± 0.01	0.15 ^d ±0.01	0.29 ^c ±0.01	0.27 ^b ± 0.01
60:20:20	0.30 ^a ± 0.01	0.18 ^c ±0.01	0.30 ^c ±0.10	0.33 ^a ± 0.01
50:25:25	0.33 ^a ±0.02	0.20 ^b ± 0.01	0.33 ^b ± 0.10	0.37 ^a ± 0.03

*Values with different superscript in the same columns are significantly different ($p \leq 0.05$).

Table 5: Functional properties of wheat-aerial yam-plantain composite flour blends

Samples Wheat:Plantain:Aerial yam	Bulk Density (g/cm ³)	Oil Absorption Capacity (g/g)	Water Absorption Capacity (g/g)	Wettability (secs)
100:0:0	0.57 ^c ± 0.01	11.20 ^c ±0.21	20.30 ^a ±0.01	1.00 ^e ± 0.01
90:5:5	0.77 ^b ± 0.01	11.60 ^b ± 0.14	18.20 ^b ± 0.07	3.30 ^b ± 0.01
80:10:10	0.76 ^b ± 0.01	11.00 ^c ± 0.00	17.90 ^c ± 0.07	1.09 ^d ± 0.01
70:15:15	0.83 ^a ± 0.01	11.70 ^b ± 0.14	16.80 ^d ± 0.07	1.30 ^c ± 0.01
60:20:20	0.84 ^a ± 0.03	12.10 ^a ±0.07	16.44 ^e ±0.07	1.02 ^e ± 0.01
50:25:25	0.85 ^a ± 0.01	12.20 ^a ±0.01	16.10 ^f ±0.07	4.5 ^a ± 0.01

*Values with different superscript in the same column are significantly different ($P \leq 0.05$).

4. Conclusion

This study covered the quality characteristics of biscuit produced from flour blends of wheat, plantain, and aerial yam. It was generally observed in this study that the antinutritional content of the products were low and within tolerable levels. Also acceptable biscuits can be produced from 50% wheat, 25% plantain and 25% aerial yam flour blends.

Conflict of interests

The authors declare that there is no conflict of interests.

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