DEVELOPMENT AND QUALITY EVALUATION OF BISCUITS FORMULATED FROM FLOUR BLENDS OF WHEAT, BAMBARA NUT AND AERIAL YAM

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Abstract
Flour blends were produced using wheat, bambara nut, and Aerial yam. The flour samples were processed into biscuits in the following ratios (wheat : bambara nut : aerial yam): 100:0:0 (WTF), 0:100:0 (BNF), 0:0:100 (AYF), 40:30:30 (WBA), 30:30:40 (BAW), and 50:40:10 (ABW). Physical, chemical and sensory properties of the biscuit samples were determined. Physical properties showed that in diameter, values ranged from 7.11 to 12.01 cm, weight ranged from 11.30 to 11.99 g, spread ratio ranged from 1.80 to 3.00, spread factor ranged from 59.25 to 100 and height ranged from 4.01 to 5.01cm. Chemical qualities showed protein (7.90-17.08%), ash (1.96-4.96%), fat (1.20-5.20%), fibre (4.20-6.30%), and moisture (3.80-5.80%). Sensory scores showed that appearance ranged from 6.60 to 7.70, Aroma ranged from 6.60 to 8.02, taste ranged from 7.33 to 8.50, Crispness 7.12 to 7.21, and overall acceptance 6.81 to 8.32.There was a significant difference ($p<0.05$) among samples. However, all biscuit samples were generally accepted but sample with 100% wheat flour (WTF) was most preferred and sample WBA (40% wheat + 30% bambara nut + 30% aerial yam) was moderately accepted by panelists. Findings showed that good and acceptable biscuits can be produced using wheat, bambara nut and aerial yam flours at ratio of 4:3:3 substitutions. The results obtained showed the feasibility of producing quality biscuits from wheat, bambara nut and aerial yam flour blends.

Keywords: Physical properties, chemical properties, biscuit, bambaranut, aerial yam

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1. INTRODUCTION

A biscuit is a small flat, crisp cake made from flour. It emerged as an ideal food for travelling as they remain fresh for a longer time. Biscuits are ready to eat, cheap and convenient product that is consumed among all age groups in many countries (Hussein *et al*., 2006).The main ingredient generally used for biscuit production is wheat flour and other ingredients such as margarine, sugar, leavening agents, eggs, milk, salt (Wade, 2002). Wheat flour as the major source of raw material for the production of baked products is very expensive. Therefore, the formation of composite or flour blends using legumes and even roots can lead to lowering cost of production and increased protein level as well as other nutrients, which may be lacking in wheat flour. Bambara nut is known as "*okpa*" in Igbo land (Eastern Nigeria), *gurjiya* in Hausa (Northern Nigeria), while in Yoruba land it is *ekpakota* (Western Nigeria). The seeds are used for food and beverages because of its protein content and for digestive system applications. The entire plant is known for soil improvement because of nitrogen fixation. In West Africa, the nuts are eaten as snacks, roasted and salted or as a boiled meal (FAO, 1986). It can be eaten fresh or boiled after drying. Due to its high protein value, it is a very important crop for poorer people in Africa who cannot afford expensive animal protein. Although it has a very high nutritional value, it is still neglected and under-utilized in Nigeria. Aerial yam also known as air potato is an aggressive, herbaceous vine that can attain lengths of 19.81 M in a single growing season. Underground tubers may be present or absent. Aerial yam has been discovered to be of nutritional and medicinal importance. It is rich in protein, fibre and mineral. They are very good for traditional folk medicine (Onwueme, 1978; Walter, 2010). Aerial yam has been discovered to be rich in protein, fibre and minerals yet it is not a stable food, and it is not relevant in food industries. This has led to underutilization and wastages.

In Nigeria, wheat flour is the major flour used in the baking industries, neglecting other sources of flour like Aerial yam flour, Bambara

flour which are common and rich in nutrients. Aerial yam is gradually going into extinction because many people see it as a poor man's food, while others avoid Aerial yam due to its small sizes which consume a lot of time in peeling and its bitter taste. This work is aimed at evaluating the physical, chemical and sensory of biscuits made from wheat, bambara nut and aerial yam composite flour with a view to increasing the utilization of bambara nut and aerial yam.

2. MATERIAL AND METHODS

2.1 Sources of raw materials

Bambara nut and wheat flour were obtained from Eke Market in Afikpo, Ebonyi State Nigeria while Aerial yams were bought in Asaga Ohafia in Abia State in Nigeria. They were cleaned and processed into flour.

2.2 Preparation of aerial yam flour

Aerial yams were sorted, peeled and immersed in sodium metabisulfite solution to reduce browning of the yams. Peeled yams were washed thoroughly to remove dirt and sliced into 2 mm thickness. The slices were blanched at 80 ^{o}C for 5 min. This was followed by drying at 50 ^{o}C using cabinet drier. After which, it was milled into flour using hammer mill and then sieved through a 212 µm sieve (Fig. 1).

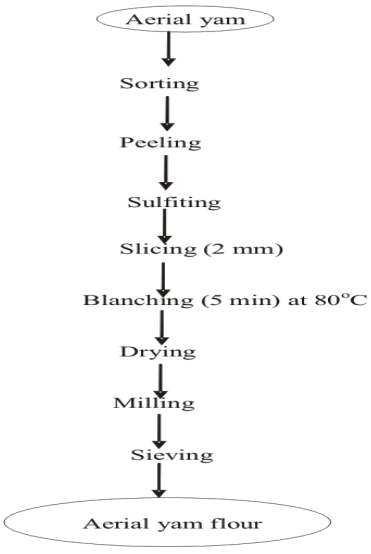

Fig. 1: Flow Chart for the Production of Aerial Yam Flour

2.3 Preparation of bambara nut flour

Bambara nuts were sorted to remove foreign materials, washed and soaked in water for 2 days. Nuts were dehulled and dried at 50 ^{o}C using cabinet drier. After which, it was milled into flour using hammer mill and then sieved through a 212 µm sieve (Fig. 2).

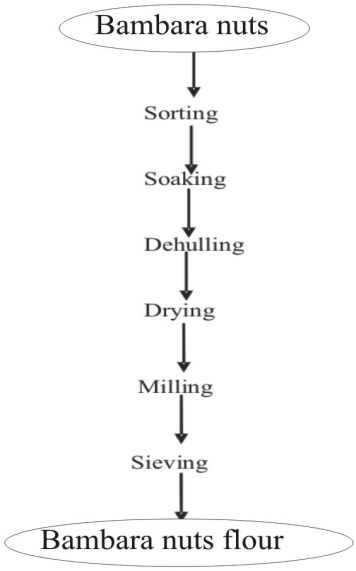

Figure 2: Flow Chart for the Production of Bambara nut Flour

2.4 Blend formulation

Six blends were formulated by mixing wheat, aerial yam and bambara nut flours as shown in Table 1.

Table 1: Blend formulation for biscuit making

Wheat	Bambara nut	Aerial Yam
100	-	-
-	100	-
-	-	100
40	30	30
30	30	40
50	40	10

2.5 Biscuit production

Biscuits were made using each of the formulated flour blends using the method described by Kure *et al.* (1998). The proportions of the ingredients are shown in Table 2. The flow chart for the production of biscuits is shown in Fig. 3. The biscuit samples

were packaged in polyethylene bag and stored for further analyses.

Table 2: Ingredients and quantities

Ingredients	Quantity (%)
Flour blend	100
Margarine	40
Sugar	45
Milk	4
Salt	2
Egg	30
Baking powder	1

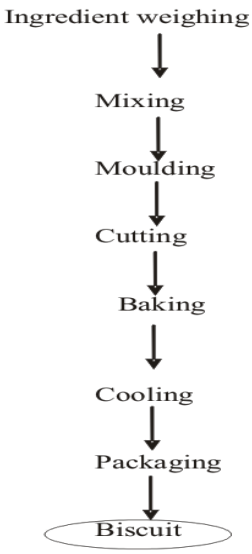

Fig 3: Flow chart for biscuit production

2.8 Chemical analysis

Moisture, fat, ash, fibre, and protein contents were determined as described by AOAC (2000).

2.9 Statistical analysis

Data were obtained in triplicate. Analysis of variance (ANOVA) was conducted using SPSS 17.0 for determining significant difference among means, statistical significant difference ($P<0.05$) among means were separated using Tukey HSD test

3. RESULTS AND DISCUSSION

3.1 Physical properties

The physical properties of biscuits prepared from the flour blends were presented in Table 3. The values for diameter ranged from 7.11 to 12.01 cm. Sample WTF (100% wheat) had the highest value while sample ABW (50% wheat + 40% Bambara nut + 10% aerial yam) had the lowest value. The above variations may be due to gluten content present in the flour.

The weight of the samples also showed a significant different ($P<0.05$) among the samples. The value ranged from 9.04 to 12.30 g. Sample BAW (30% wheat + 30% bambara nut + 40% aerial yam) had the highest value while sample AYF (100% aerial yam) had the lowest value. In terms of spread ratio, the values ranged from 1.64 to 3.00. Sample WTF (100% wheat) had the highest value 3.00, which was significantly different ($p<0.05$) from others. This can be as a result of the composition of flour used (100% wheat).

The spread factor showed a range of 54.67 to 100. Sample WTF (100% wheat) had the highest value while sample WBA (40% wheat + 30% bambara nut + 30% aerial yam) had the lowest value showing a significant difference ($p<0.05$) among all other samples. Spread factor is a ratio that depends on the thickness and diameter of the biscuits.

Low spread factor shows that starch polymer molecules are bound with granules and swelling is limited when heated. On cooling the starch forms rigid gel with capacity characteristics of large molecular aggregates.

The difference in spread ratio may be due to the difference in the level of substitution of flour blends. Moreover, the height ranged from 4.01 to 5.01cm. Sample WBA (40% wheat + 30% bambara nut + 30% aerial yam) had the highest value while sample WTF (100% wheat), AYF (100% aerial yam) and ABW (50% wheat + 40% bambara nut + 10% aerial yam) had the lowest value. These differences may be attributed to variations in chemical components of samples.

The physical parameters of baked products diameter, weight and spread factor depend on the gluten content. The gluten content of the flour enables it to entrap the gas produced, yielding higher volume and weight.

Table 3: Physical Properties of Biscuits

Sample	Diameter (cm)	Weight (g)	Spread Ratio	Spread Factor (%)	Height (cm)
WTF	12.01±0.01[a]	11.99±0.01[b]	3.00±0.01[a]	100±0.00[a]	4.01±0.01[c]
BNF	8.01±0.01[d]	10.73±0.01[d]	1.97±0.03[c]	65.50±0.07[c]	4.10±0.06[c]
AYF	7.53±0.04[e]	9.04±0.01[f]	1.89±0.01[d]	63.01±0.01[a]	4.01±0.01[c]
WBA	8.22±0.02[c]	10.10±0.01[e]	1.64±0.01[f]	54.67±0.54[c]	5.01±0.01[a]
BAW	9.21±0.01[b]	12.30±0.01[a]	2.03±0.01[b]	67.67±0.54[b]	4.53±0.04[b]
ABW	7.11±0.01[e]	11.30±0.01[c]	1.80±0.01[e]	59.25±0.23[b]	4.01±0.01[c]

Values are mean ± standard deviation of triplicate determinations. Means in column with different superscript are significantly different (p<0.05).

Key: WTF =100% wheat flour; BNF=100% Bambara nut flour; AYF= 100% Aerial yam flour; WBA= 40% Wheat flour + 30% Bambara nut flour + 30% Aerial yam flour; BAW=30% Wheat flour + 30% Bambara nut flour + 40% Aerial yam flour; ABW=50% Wheat flour + 40% Bambara nut flour + 10% Aerial yam flour.

3.2 Chemical composition

The chemical compositions of the formulated biscuits are shown in Table 4. The protein content of biscuit samples ranged from 7.90-17.08%. Significant difference (p<0.05) existed among samples. This was higher than the report of Oluwamukomi *et al.* (2011) that reported a range of 7.43-12.35% for cassava-wheat flour composite biscuits. Giwa and Ikujenlola (2010) reported a range of 10.86-11.56% for wheat-quality protein maize composite biscuits. The protein content of the produced biscuits decreased with increase in quantity of aerial yam flour used. This may be as a result of low protein content of aerial yam. 100% bambara nut biscuit had the highest protein content (17.08%) while 100% aerial yam biscuit had the least (8.69%). The ash content obtained for the biscuit samples ranged from 1.96 to 4.96%. 100% wheat biscuit had the highest ash content (4.96%) while the least value (1.96%) was recorded by 50% wheat + 40% bambara nut + 10 % aerial yam. The results obtained compared favourably to the report of Fasuan and Uche (2014) that reported range of 3.01-4.30%. Giwa and Ikujenlola reported a range of 2.95-3.56% for wheat-quality maize biscuit. The ash content decreased as the quantity of bambara nut decreased. The fat content ranged from 1.20-5.20%. The obtained values were similar to the report of Fasuan and Uche (2014) who obtained a range of 4.20-4.42%. Chima *et al.* (2014) reported a range of 1.25% -1.34%. The fibre ranged from 4.20-6.30%. Oluwamukanmi (2011) reported a range of 0.24-0.64% for cassava-wheat biscuit. Fasuan and Uche (2014) reported range of 2.65-3.21% for sorghum-wheat biscuits. Chima *et al.* (2014) reported a range of 2.12-3.38% for breadfruit-wheat biscuit. The moisture content ranged from 3.80-5.80%. This was similar to values reported by Chima *et al.* (2014) for breadfruit-wheat biscuit. The carbohydrate content increased with increase in the percentage of aerial yam flour.

3.3 Sensory evaluation

The sensory scores of the biscuit samples are shown in Table 5. In terms of appearance, Sample WTF (100% wheat) is the most preferred with the score of 7.70 while sample ABW (50% wheat + 40% bambara nut + 10% aerial yam) is the least preferred with a score of 6.60. The scores for aroma ranged from 8.02 to 5.51. Sample WTF (100% wheat) had the highest value (8.02) while sample BNF (100% bambara nut) had the least value (5.51). There was a significant different (p<0.05) among samples. In term of taste, sample WTF (100% wheat) is the most preferred with a score of 8.50 while sample BNF (100% bambara nut) is the least preferred with a score of 5.81. This variation may be due to the natural taste of the flour samples used for the biscuit production. Aerial yam has a slightly bitter taste while bambara nut has a characteristics taste. These may have contributed to the choice of the panelist. There were significant differences (P<0.05) between the samples in terms of crispness.

Table 4 Chemical composition of biscuits per 100 g

Sample	Moisture	Protein	Ash	Fibre	Fat	Carbohydrate
WTF	3.80±0.01^{d}	11.29±0.01^{c}	4.96±0.22^{a}	4.84±0.01^{c}	1.35±0.29^{e}	73.76± 0.28^{b}
BNF	3.60±0.11^{e}	17.08±0.24^{a}	3.40±0.00^{b}	4.20±0.05^{d}	5.20±0.42^{a}	63.52±1.02^{d}
AYF	4.69±0.31^{b}	7.90±0.00^{f}	3.51±0.01^{b}	6.30±0.00^{a}	1.20±0.00^{e}	76.40±1.07^{a}
WBA	3.82±0.03^{d}	10.49±0.01^{d}	4.76±0.29^{a}	5.03±0.01^{b}	3.33±0.20^{c}	72.57± 0.02^{c}
ABW	4.02±0.02^{c}	13.81±0.02^{b}	1.96±0.01^{c}	4.89± 0.04^{c}	4.01±0.01^{b}	72.31± 0.01^{c}
BAW	5.80±0.07^{a}	8.31±0.04^{e}	3.81±0.08^{b}	5.34±0.09^{b}	2.14±0.00^{d}	74.60±1.26^{b}

Values are mean ± standard deviation of triplicate determinations. Means in column with different superscript are significantly different ($p<0.05$).

Key: WTF =100% wheat flour; BNF=100% Bambara nut flour; AYF= 100% Aerial yam flour; WBA= 40% Wheat flour + 30% Bambara nut flour + 30% Aerial yam flour; BAW=30% Wheat flour + 30% Bambara nut flour + 40% Aerial yam flour; ABW=50% Wheat flour + 40% Bambara nut flour + 10% Aerial yam flour.

Table 5: Sensory characteristic of biscuits

Samples	Taste	Aroma	Appearance	Crispness	Overall Accept.
WTF	8.50±0.10^{a}	8.02±0.02^{a}	7.70±0.13^{a}	7.21±0.01^{a}	8.32±0.03^{a}
BNF	5.81±0.01^{d}	5.51±o.o1^{e}	7.02±0.01^{b}	5.12±0.03^{e}	6.13±0.04^{f}
AYF	5.81±0.01^{d}	6.31±0.01^{d}	6.62±0.03^{c}	5.42±0.02^{d}	6.31±0.01^{e}
WBA	7.72±0.02^{b}	6.93±0.04^{b}	6.81±0.01^{c}	7.12±0.03^{b}	7.61±0.01^{b}
BAW	7.22±0.02^{c}	6.32±0.02^{d}	6.41±0.01^{d}	6.01±0.01^{c}	6.92±0.03^{c}
ABW	7.33±0.04^{c}	6.60±0.10^{c}	6.60±0.10^{d}	7.12±0.02^{b}	6.81±0.01^{d}

Values are mean ± standard deviation of triplicate. Means in column with different superscript are significantly different ($p<0.05$).

Key: WTF =100% wheat flour; BNF=100% Bambara nut flour; AYF= 100% Aerial yam flour;
WBA= 40% Wheat flour + 30% Bambara nut flour + 30% Aerial yam flour;
BAW=30% Wheat flour + 30% Bambara nut flour + 40% Aerial yam flour;
ABW=50% Wheat flour + 40% Bambara nut flour + 10% Aerial yam flour.

However, there was no significant difference between WBA (40% wheat + 30% bambara nut + 30% aerial yam) and ABW (50% wheat + 40% bambara nut + 10% aerial yam). In general acceptability, sample WTF (100% wheat flour) was most preferred while BNF (100% bambara nut flour) is least preferred. However, all the biscuit samples were all generally accepted. The overall result showed that the substitutions had minimal impact on the sensory properties at the levels used. Partial substitutions of wheat flour with non-wheat flours have been suggested by other authors (Akubor, 2004; Abu, 2007). Biscuit from composite flour WBA (40% wheat + 30% bambara nut + 30% aerial yam) was moderately accepted.

4. CONCLUSIONS

The sensory evaluation results showed that all the biscuit samples were generally accepted. Good and acceptable biscuits can be produced from the composite flour of Wheat, Bambara nut and Aerial yam flour. The results of the physical properties showed that all the biscuits produced were good. Biscuits made from WBA (40% wheat + 30% bambara nut + 30% aerial yam) competes favourably with that of wheat flour. Thus good and acceptable biscuits can be made using the composite flour of wheat, bambara nut, and aerial yam flour at a ratio of 4:3:3 respectively.

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