Global Scientific JOURNALS
GSJ: Volume 12, Issue 1, January 2024, Online: ISSN 2320-9186
www.globalscientificjournal.com

EVALUATION OF NUTRIENT COMPOSITION AND ORGANOLEPTIC PROPERTIES OF BISCUITS PRODUCED FROM WHEAT AND AFRICAN BREADFRUIT (*TRECULIA AFRICANA*) FLOURS

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Abstract
This study was aimed at evaluating the nutrient composition and organoleptic properties of biscuits produced from wheat and African breadfruit composite flours. The wheat/ African breadfruit composite flours was mixed in the ratio of 100:0, 80:20, 60:40, 40:60, 20:80 and 50:50 respectively and used to produce biscuits. Proximate analysis, mineral composition and sensory evaluation were carried out on the biscuits samples using standard methods. Proximate analysis showed a significant increase ($P<0.05$) in moisture (7.49-8.01)%, Ash (1.41-2.07)%, crude fibre (4.67-5.19)%, Fat (4.69-5.19)%, Crude protein (8.18-17.22)% and significant decrease in carbohydrate content (73.62-62.30)% and energy value (366.51-365.09)kg/100g with increase in African bread fruit flour in the biscuits. In the mineral composition, there was significant increase ($p<0.05$) in calcium (22.86-50.02)%, magnesium (12.53-17.54)%, phosphorus (121.01-167.76)%, potassium (117.97-164.22)%, Iron (2.55-2.94)% and zinc (1.42-2.05)% with increase in African breadfruit flours. Sensory evaluation results shows significant decrease in colour (8.25-7.75)%, flavor (7.90-7.30)% and overall acceptance (7.70-7.05)% and significant increase in the texture (6.85-7.05)%. It is seen that the biscuits produced from wheat and African breadfruit flours have a good keeping quality because the moisture content is less than the maximum of 14%.

Introduction
Biscuits are regarded as a form of confectionery dried to a very low moisture content. According to (Aloba, 2011), biscuit is defined as a small thin crisp cake made from unleavened dough. (Ekundayo, 2000) described the production of biscuits as a mixture of flour and water but may contain fat, sugar and other ingredients mixed together into dough which is rested for a period and then passed between rollers to make a sheet (Olaoye, 2007). 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 batters (Enwere, 2008). The nutritional content however varies with the type of flour used. Soft wheat flour is the suitable flour for biscuits. This is due to its content of gliadin (a prolamin) and glutamine (glutelin) which undergoes hydration in the prescence of water, salt and sugar. This protein forms a viscoelastic matrix known as gluten, being responsible for the rising nature of dough or permit substantial increase in the volume of baked product of dough and its gas retention capability (Akpapunam and Darbe,2004).

Nigeria being one of the tropical countries cannot grow wheat in commercial quantity due to the country's climatic condition. Only three percent of the country's total consumption of this grain can be produced locally, therefore the industry can only survive by the utilization of this availability of local grain which can either partially or completely substitute wheat in the product without adversely affecting the quality of such product (Kulkarni,2007).

African breadfruit can be used as a substitute to wheat in varying ratio for biscuit baking as local alternative flour for biscuit production. Past research has been carried out on biscuit production using breadfruit and some have confirmed the nutritive value of breadfruit which is high in protein (Khan and Zeb, 2007). African breadfruit (*Treculia Africana*) belong to the mulberry family, *Moracceae*, it is of African origin and is now being grown in the most tropical and sub-tropical countries. The breadfruit seeds are found in the Eastern and Northern parts of Nigeria that is among the Igbos, Hausas and Igalas and is a popular food in these areas. It is known as *"Ukwa"* in Igbo and *"Barafuta"* in Hausa while among the Yorubas it is known as *"Jaloke (Ife)"*. It can also be found in other parts of the continent (Yagci and Fahrettin, 2009). An African breadfruit is not a fruit as the name implies but seed in the fruit. It is seldom eaten raw. It is rather baked, boiled, roasted, fried and ground into flour and tastes like wheat bread. It is a staple food of the South Pacific, (Akpapunam and Darbe, 2004).

Wheat is one of the most important crops grown around the world and it is considered as almost first amongst Cereals largely due to the fact that it's grain contains protein with unique chemical and physical properties, and other essential nutrient (Khan and Zeb, 2007). A huge increase in the demand for cereals is predicted if the food needs for the estimated world population is to be met. But there is great need to ensure these staple crops are nutritionally balanced and help mitigate the millions of cases of nutrition related deficiency issues globally. Over three billion people are micronutrient malnourished. This global crisis in nutritional health is the result of dysfunctional food systems that do not consistently supply enough of these essential nutrients to meet the nutritional requirements of high risk groups (Welch, 2005). It has been recommended that blending of cereal with legume or root crops with high level of protein in human diet will greatly improve the nutrient content of these staple crops. The use of composite flour is advantageous in the sense that the inherent deficiencies of essential amino acids in wheat flour (lysine, tryptophan and threonine) are supplied through their supplementation with wheat.

MATERIALS AND METHODS

Source of Raw Materials

Fresh African bread fruit (*Treculia africana*) seeds used in the study were purchased from New Market Enugu, Enugu State, Nigeria. Commercial wheat flour and the other ingredients (sugar, fat, salt, baking powder, eggs and flavouring) used for cookie production were also purchased from the same market.

Production of African Breadfruit Flour

The African breadfruit seeds were washed with water and parboiled in a stainless aluminum pot with a lid. The boiled seeds were drained in a basket for 12-15 minutes and allowed to cool at ambient temperature. Thereafter, the seeds were dehulled manually and left to dry indoors for 5 days to a minimum moisture content of about 9 - 11% moisture content. The dried kernels were sorted, milled using a milling machine and screened through a 40 - mesh sieve. The flour was stored in a screw capped container till needed.

Preparation of Biscuits

The different flours were weighed and mixed according to the formulation provided. Sugar and Margarine were creamed together using an infinity mixer until the consistency became fluffy. The dry ingredients such as salt and baking powder were mixed with the composite flour sample. The cream is further mixed with the dry ingredients until a soft dough is formed. The dough is then flattened using a rolling pin and cut into a round shape using a round cutter after which it is put into a baking tray and lined with a baking paper and then baked at 150°C for 45 minutes. It is then cooled and sealed in airtight zip-loc bags for storage prior to analysis.

Table 1: Recipe for preparation of composite biscuits samples from Wheat-African breadfruit flour:

Ingredients (g)	Quantity (g)
Flour	200
Margarine	115
Sugar	150
Egg	2
Salt	3
Baking Powder	4

Table 2: Formulation of Blends:

Wheat (%)	African Bread fruit (%)
100	0
80	20
60	40
40	60
20	80
50	50

Proximate Analysis

Determination of Moisture Content

The moisture content of the sample was determined according to standard procedure of AOAC (2010). The crucibles were washed and dried in an oven at 100°C for 1 hr. The weight was noted as w_1. About 2mL of each sample was separately weighed into the crucibles and their weights taken as (w_2) before and during drying at 100°C to a constant weight (w_3).

$$\% \text{ Moisture} = \frac{w_2 - w_3}{w_2 - w_1}$$

Where:

W_1 = weight of empty crucible
W_2 = weight of crucible and sample before drying
W_3 = weight of crucible + weight for sample after drying to a constant weight

Determination of Ash Content

The ash content of the samples was determined according to the standard method of AOAC (2010). A preheated and cooled crucible was weighed (w_1). Approximately 2mL of the sample was weighed into the crucible (w_2). The crucible was sent to the hot air oven to dry up the liquid content so as to avoid spurting. The sample was charred on a Bunsen flame inside a fume cupboard. The charred sample was placed in a muffle furnace set at 550°C for 2 hours until a white or light grey ash is obtained (w_3). The sample was removed, cooled in desiccators and weighed.

$$\text{Ash (\%) content} = \frac{w_2 - w_1}{w}$$

Where:

w = weight of sample used W_1 = weight of empty extracting flask weight of flask and extracted oil

Determination of Crude fibre content

Weende method described by Onwuka (2005) was used for the crude fibre determination. Exactly 2 g of the test sample was measured and defatted with petroleum ether. It was allowed to boil under reflux for 50 min with 200 mL of 1.25% of H_2S0_4 per 100 mL of solution. The hot acid solution was filtered and the residue poured into 200 ml boiling 1.25% NaOH and boiled for 30 min. It was filtered, progressively washed with boiling water, alcohol and petroleum ether after which the drained residue was transferred completely to a porcelain crucible and dried in an oven at 150°C to a constant weight. This was cooled, weighed and incinerated in a muffle furnace at 100°C for 2 h and reweighed after cooling in desiccators. The crude fiber content was calculated gravimetrically as:

$$\frac{w_2 - w_1}{w} \quad X \quad \frac{100}{1}$$

Where:

W2 = weight of crucible + boiled dried sample

W3 = Weight of crucible + ash
W = weight of sample

Determination of Fat Content

The fat content of the sample was determined using the standard AOAC (2010) method. A soxhlet extractor with a reflux condenser and a 500ml round bottom flask was set up. About 300mL of petroleum ether will be paired into the round bottom flask. The sample (2ml) was weighed into labeled thimble and sealed with cotton wool, then fitted into the extraction tube of the soxhlet extractor. The soxhlet extractor after assembly was allowed to reflux for about 6 hrs, after which the thimble was removed with care and the petroleum ether (40-60 C) collected on top and drained into a container for re-use. The flask and its content was dried between 50-60°C in a hot air oven. It was removed from the oven and cooled in a desiccators and weighed. The fat content was calculated as follows:

$$\text{Fat content } \% = \frac{w_3 - w_1}{w}$$

Where:

w = weight of sample used
w_1 - weight of empty extracting flask
W_3 = weight of flask and extracted oil

Determination of Crude protein

The crude protein content of the test sample was determined by micro Kjeldahl method as reported by Onwuka (2005). Exactly 2g of the test samples was weighed into a micro-kjeldahl flask containing a metallic catalyst and 5 mL of concentrated H2SO4 added. The same treatment was given to another 5mL sample. The sample was digested at red hot temperature in a fume cupboard for 2h and the digest transferred into a volumetric flask each. A clear solution is an indication of complete digestion after 2h. Each of the transferred digest was diluted to 50 ml with distilled water. Then, 10mL of each dilution was pipetted into "markham" apparatus with gradual introduction of 10 mL, 40% NaOH and distilled. Exactly 10ml of 4% Boric acid solution containing 3 drops of mixed indicator was used to collect the distillate and 50 mL of distillate from each duplicate titrated with 0.02N H_2SO_4 to a pink color. Percentage protein is calculated by multiplying percentage Nitrogen by a factor, 6.25.

$$\%N = \frac{100 \times n \times 14 \times V_t \times T\text{-}B}{W} \times 100$$

Where:

T = Titre value of the sample
B = Blank titre value
Vt = Total volume of digest
N = Normality of acid used
W = weight of sample
% crude protein (cp) = % N x 6.25
Note: The total Nitrogen content is calculated using the relationship 1ml of H_2SO_4 =14mg of H_2SO_4.

Determination of Carbohydrate Content

The carbohydrate content was calculated by difference as illustrated by AOAC (2010). The sum of all other proximate analysis test (% moisture, % ash, % protein, crude fibre and % fat) were calculated and total subtracted from 100.
% carbohydrate = 100 — (% moisture + % ash + % protein + % fat + crude fibre)

Sensory evaluation

The biscuit samples were subjected to sensory evaluation using a 15-member semi trained panelists. Each sample was presented in coded white plastic plate in a randomized order. Portable water was provided to rinse their mouth after each evaluation. The panelists were instructed to score the coded samples for colour, texture, flavour and overall acceptability. Each sensory attribute was rated on a 9-point Hedonic scale with 1 representing the least score (Dislike extremely) and 9 the highest score (Like extremely) (Iwe, 2014).

Statistical Analysis

Analysis of Variance (ANOVA) was performed on the data to determine differences, while the least significant test was used to detect significant differences among the mean

RESULTS AND DISCUSSION

Proximate composition

There was significant difference ($p<0.05$) in moisture content with the highest value of 8.01% in Sample F and lowest value of 7.49% in Sample A. The highest moisture value of Sample F may be attributed to the hulling of the breadfruit seeds prior to flour production, which might have led to moisture gain. This corroborates the report of Kure, Bahayo and Daniel (1998) that moisture content of baked samples could be attributed to the baking process the products were subjected to. There was significant difference ($p<0.05$) in ash content with the highest value of 2.07% in Sample F and lowest value of 1.41% in Sample A. The breadfruit hull may have contributed to the high ash content (Obasi and Ifediba, 2018). There was significant difference ($p<0.05$) in crude fibre content with the highest value of 5.19% in Sample F and lowest value of 4.67% in Sample A. This may be attributed to inclusion of high quantity of breadfruit flour in the biscuit. There was significant difference ($p<0.05$) in fat content with the highest value of 5.19% in Sample F and lowest value of 4.65% in Sample A. The least fat content in sample A could be attributed to the high substitution of wheat flour. There is generally low fat content in wheat since wheat is mainly a starchy food. There was significant difference ($p<0.05$) in crude protein content with the highest value of 17.22% in Sample F and lowest value of 8.18% in Sample A, this may be attributed to hulling which might have increased protein value of breadfruit seeds. There was significant difference ($p<0.05$) in carbohydrate content with the highest value of 73.62% in Sample A and lowest value of 62.30% in Sample F. There was significant difference ($p<0.05$) in energy content with the highest value of 368.38% in Sample B and lowest value of 365.09% in Sample F. There was no significant difference ($p<0.05$) in energy content between Samples A and E which recorded 366%. Also, there was no significant difference ($p<0.05$) in energy content between samples C and D which recorded 368%.

Table 3: Proximate composition (%) of Wheat-African Breadfruit Composite Biscuit

Moisture	Ash	Crude Fibre	Fat	Crude Protein	Carbohydrate	Energy
7.49' ±0.007	1.4l'± 0.007	4.67^{f}± 0.014	4.65^{f} ± 0.014	8.18^{f} ± 0.007	73.62^{a}± 0.007	366.51^{d}± 3.669
7.53^{e}± 0.007	1.56^{E}± 0.007	4.75^{e}± 0.007	4.75^{e}±0.007	9.43^{e}± 0.007	72.02^{b}± 0.007	368.38^{a}± 0.063
7.67^{d}± 0.014	$l,62^{d}$± 0.007	4.89^{d}± 0.007	4.89^{d}± 0.004	10.68^{d}± 0.007	70.ir±0.141	367.65^{b}± 0.530
7.75^{C}±0.007	1.75^{C}± 0.007	5.02^{C}± 0.007	5.02^{C}± 0.007	12.25^{C}± 0,007	68. 16^{d}± 0.021	367.46^0.007
7.89^{b}± 0.007	1.89^{b}± 0.007	5.12^{b}±0.007	5.12^{b}±0.007	15.14^{b}±0.007	64.81^{e}±0.007	366.34° ±0.063
$8,01^{a}$± 0.014	2.07^{a}± 0.007	5.19^{a}± 0.007	5.19^{a}±0.007	1 7.22" ±0.007	62.30^{f}± 0.000	365.09^{f}± 0.035

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

Keys:

Sample A: 100% whole wheat flour

Sample B: 80% wheat flour and 20% African breadfruit flour

Sample C: 60% wheat flour and 40% African breadfruit flour

Sample D: 40% wheat flour and 60% African breadfruit flour

Sample E: 20% wheat flour and 80% African breadfruit flour

Sample F: 50% wheat flour and 50% African breadfruit flour

Mineral Composition

The calcium content of the biscuits ranged from 22.86% in Sample A to 50.02% in sample F. With the highest value recorded in Sample F the result implied that calcium was highest when the biscuit samples were made from 50% of wheat and African breadfruit respectively. The magnesium content of the biscuits ranged from 12.53% in Sample A to 17.54% in Sample F. With the highest value recorded in Sample F the result implied that magnesium was highest when the biscuit samples were made from 50% of wheat and African breadfruit respectively. The phosphorous content of the biscuits ranged from 121.01% in Sample A to 167.76% in Sample F. With the highest value recorded in Sample F the result implied that phosphorous was highest when the biscuit samples were made from 50% of wheat and African breadfruit respectively. The potassium content of the biscuits ranged from 117.97% in Sample A to 164.22% in Sample F. With the highest value recorded in Sample F the result implied that potassium was highest when the biscuit samples were made from 50% of wheat and African breadfruit respectively. The iron content of the biscuits ranged from 2.55% in Sample A to 2.94% in Sample F. With the highest value recorded in. Sample F the result implied that iron was highest when the biscuit samples were made from 50% of wheat and African breadfruit respectively. The zinc content of the biscuits ranged from 1.42% in Sample A to 2.05% in Sample F. With the highest value recorded in Sample F the result implied that zinc was highest when the biscuit samples were made from 50% of wheat and African breadfruit respectively.

Table 4: Mineral composition (%) of Wheat-African Breadfruit composite

Samples	Calcium	Magnesium	Phosphorous	Potassium	Iron	Zinc
A	$22.86^{f}\pm 0.735$	$12.53^{f}\pm 0.021$	$121.01^{f}\pm 0.551$	$117.97^{f}\pm 0.975$	$2.55^{e}\pm 0.014$	$1.42^{e}\pm 0.014$
B	$28.54^{e}\pm 0.007$	$13.47^{e}\pm 0.014$	$128.71^{e}\pm 0.749$	$123.96^{e}\pm 0.593$	$2.63^{d}\pm 0.007$	$1.56^{d}\pm 0.014$
C	$32.9^{d}\pm 0.813$	$14.45^{d}\pm 0.014$	$136.24^{d}\pm 0.827$	$134.15^{d}\pm 0.438$	$2.73^{C}\pm 0.007$	$1.65^{C}\pm 0.007$
D	$36.97^{C}\pm 0.692$	$15.83^{C}\pm 0.014$	$143.38^{C}\pm 0.643$	$147.83^{c}\pm 1.569$	$2.78^{C}\pm 0.014$	$1.73^{b}\pm 0.007$
E	$43.\ 77^{b}\pm 0.685$	$16.67^{b}\pm 0.021$	$159.37^{b}\pm 0.572$	$152.79^{b}\pm 0.650$	$2.87^{b}\pm 0.007$	$1\ .77^{b}\pm 0.007$
F	$50.02^{a}\pm 0.226$	$17.54^{a}\pm 0.021$	$I67.76^{a}\pm 1.265$	$164.22^{a}\pm 1.322$	$2.94^{a}\pm 0.007$	$2.05^{a}\pm 0.007$

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

Keys:

Sample A: 100% whole wheat flour

Sample B: 80% wheat flour and 20% African breadfruit flour Sample C: 60% wheat flour and 40% African breadfruit flour Sample D: 40% wheat flour and 60% African breadfruit flour Sample E; 20% wheat flour and 80% African breadfruit flour Sample F: 50% wheat flour and 50% African breadfruit flour

Sensory properties

There was significant ($p<0.05$) difference in color of biscuit samples with Sample A recording the highest score of 8.25% and Sample D the lowest score of 7.20%. There was no significant ($p<0.05$) difference in texture of biscuit samples between Samples A and B and Samples C, E and F. There was significant ($p<0.05$) difference in flavour of biscuit samples with Sample A recording the highest score of 7.90% and Sample F the lowest score of 7.30%. There was significant (p<0,05) difference in overall acceptance of biscuit samples with Sample A recording the highest score of 7.70% and Sample F the lowest score of 7.05%.

Table 5: Sensory properties of Wheat-African Breadfruit composite

Samples	Colour	Texture	Flavour	Overall acceptance
A	8.25^{a}±0.910	6.85^{b}± 2.109	7.90^{a}±1.071	7.70^{a} ±1.525
B	7.80^{b}±0894	6.85^{b}± 1.871	7.80^{b}±1.056	7.55^{C}± 1.145
C	7.55^{e}±0.998	7.05^{a} ±1.669	7.75°±1.292	7.65^{b}± 1.136
D	7.20^{f} ± 1.281	6.50^{C}± 1.572	7.50^{e}±1.100	7.65^{b} ±1.348
E	7.60^{d}± 1.142	7.00^{a}± 1.891	7.65^{a}±1.424	7.40^{d}± 1.391
F	7.75^{C}± 1.802	7.05^{a}± 2.282	7.30^{f}± 1.490	7.05^{e}± 2.438

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

Keys:

Sample A: 100% whole wheat flour
Sample B: 80% wheat flour and 20% African breadfruit flour
Sample C: 60% wheat flour and 40% African breadfruit flour
Sample D: 40% wheat flour and 60% African breadfruit flour
Sample E: 20% wheat flour and 80% African breadfruit flour
Sample F: 50% wheat flour and 50% African breadfruit flour

Conclusion

The result of this research show that biscuit can be produced using flour blends from African Breadfruit and Wheat; all of which are obtainable from our immediate environment. Given that the moisture level content was less than the maximum of 14% it is seen that the considerable low moisture in the samples is an indication of good keeping quality of the products when properly packaged and stored.

The use of locally grown crops in flour production should be encouraged as this will help ensure food security. The combination has also been found more nutritious than wheat flour alone because breadfruit flour is richer than wheat flour in lysine and other essential amino acids.

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