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Nutritional and Sensory Evaluation of High Fiber Biscuits Produced from Blends of African Breadfruit, Maize and Coconut Flours

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ABSTRACT

High fiber biscuits were produced from a blend of African Breadfruit flour, Maize flour and Coconut grits. Flour blend of ratio Whole breadfruit seeds: Maize: Coconut of 70:20:10 was used for Sample A; 60:30:10 for Sample B; 45:45:10 for Sample C; 30: 60:10 for Sample D and 20: 70: 10 for Sample E. Sample F was obtained from blend of flours of Hulled breadfruit seeds: Maize: Coconut on a ratio 45:45:10, while Sample G (control) was produced from 100% Wheat flour. The samples were subjected to nutritional and sensory evaluation. Proximate composition of the samples showed that Dry matter (Dm) ranged from 95.10 - 95.49%, Moisture 4.51 to 4.90%, Protein 8.45 to 10.85%, Fat 9.01 to 16.68%, Crude fiber 1.56 to 9.32%, Carbohydrate 59.36 to 71.54% and Ash 2.01 to 2.88%.The samples made from flour blends were significantly ($p<0.05$) higher in Moisture, Fat, Crude fiber and Ash, while the sample made of wheat flour (control) was significantly higher in Carbohydrate and Energy value. The wheat flour biscuit was significantly ($p<0.05$) higher in protein than samples containing whole breadfruit flour, but significantly ($p<0.05$) lower than the sample containing hulled breadfruit flour. The blended flour samples were significantly ($p<0.05$) higher in Dietary fiber, while the wheat flour biscuit was significantly higher in all the sensory attributes considered. Overall, the high fiber biscuits produced from the flour blends compared favorably with the sample obtained from the conventional wheat flour, thus showing prospects for industrial application of the flour blends.

Keywords: High fiber, Flours, Blend, Nutritional, Sensory.

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1 INTRODUCTION

Diets based on whole grains are increasing day by day due to various health benefits associated with them as they are good sources of dietary fiber, antioxidants, vitamins, minerals etc. In fact, there has been a trend to incorporate bran from high protein fiber sources into cereal products. Increasing dietary fiber intake was one objective of the 2010 Dietary Guidelines for Americans (Hegazy and Ibrahim, 2009).

High fiber diet has been shown time and again to reduce heart disease, regulate blood sugar (reduce type 2 diabetes risk), improve digestive function, increase satiety (aids in achieving healthy weight) and helps to prevent certain cancers (O'Conor *et al*., 2003).

Dietary fiber comes from the portion of plants that is not digested by enzymes in the intestinal tract. Part of it, however, may be metabolized by bacteria in the lower gut. Good sources include: whole grains, legumes, nuts, fruits and vegetables. The Institute of Medicine Food and Nutrition Board (IOM) (2005) recommends that adults consume 20 – 35 g of dietary fiber per day, but most people fall short of the recommended daily requirement, averaging on 15 g per day (Slavin, 2008). Rapid urbanization and change in life style have led to an increase in the demand for ready to eat convenience foods, most of which are wheat based. Wheat is a cereal grain made up of 1.68% minerals, 61.7% carbohydrate, 12.2% moisture, 10.4% protein and 1.56% fat (Pamplona and George, 2004). Wheat has a poor essential amino acid (lysine and tryptophan) pattern (Okoh, 1998), and is also implicated in celiac disease (intolerance to wheat gluten).

The production of wheat in Nigeria is far below the domestic requirement. Many developing countries including Nigeria spend their hard earned foreign exchange on importation of wheat leading to underutilization of indigenous cereals, with a resultant detrimental effect on agricultural and technological development.

There is need to develop an adequate substitute for wheat from locally grown crops with comparable or better nutritional quality and adequate levels of dietary fiber.

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The need for development and use of inexpensive local resources in the production of popular foods such as cookies has been recognized by organizations such as Food and Agricultural Organization (FAO/WHO, 1994). Non wheat-based composite flour have been used to produce cookies with high nutritional and sensory properties (Chinma and Gernah, 2007; Agariga and Iwe, 2009; Okpala and Okoli, 2011).

This research work is aimed at developing high fiber snack from non-wheat flour blends of whole and hulled African breadfruit seeds, Maize and Coconut grits. Apart from the likely nutritional and sensory appeal of resultant products, this will add value to these agricultural materials.

2 MATERIALS AND METHOD

2.1 Source of raw materials

Mature whole seeds of African breadfruit (*Treculia africana)*, Maize (*Zea mays)* and husked Coconut (*Cocos nucifera)* were purchased from Umuahia main market in Abia state, Nigeria. The samples were authenticated at the Department of Plant Science, Michael Okpara University of Agricuture, Umudike, Abia State, Nigeria. Other materials purchased from the market include sugar, margarine, eggs, sodium bicarbonate, vanilla and milk.

2.2 Preparation of whole breadfruit flour

Approximately 5kg of whole African breadfruit seeds were sorted to remove spoilt seeds and stones, washed in a basin of tap water till they were freed from slimy materials, dust and other foreign matters. The cleaned seeds were allowed to drain in a plastic basket and subsequently oven dried in Gallenkemp 300 Plus, England at 60ºC for 7 h. The seeds were then roasted at 120ºC for 15 min in a 60 cm wide shallow pan using gas cooker, cooled to room temperature (29±2ºC) before milling in a commercial disc attrition mill (7hp, China). The flour was sieved using a 75 µm screen and stored in an air tight container at room temperature until use.

2.3 Preparation of hulled breadfruit seeds flour

The method described by Samaila and Nwabueze (2013) for the production of breadfruit flour was slightly modified. African breadfruit seeds (6 kg) were sorted to remove spoilt seeds, washed in a basin of tap water till they were freed from slimy materials, dust and other foreign bodies. The cleaned seeds were blanched in hot water at 100ºC for 15 min in an aluminum pot, poured into a plastic basket to drain and air dried for 15 min. The seeds were cracked in a commercial attrition mill (7hp China) and the hulls winnowed manually. The hulled seeds were dried in an oven (Gallenkemp 300 Plus, England) at 60^oC for 7 h, cooled to 37°C, milled in a commercial disc attrition mill (7hp, China) to pass through a 75 µm mesh sieve and stored in an air-tight container at room temperature until use.

2.4 Production of maize flour

Approximately (5 kg) of dry maize were sorted to remove spoilt grains , stone and other extraneous materials, before milling in a disc attrition mill (7hp China), sifted through a 75 µm mesh sieve and stored in an air-tight container at room temperature until use.

2.5 Production of partially defatted coconut grits

The method of Okafor and Ugwu (2014) was used. The husked coconuts weighing 6 kg were manually cracked and the endocarp recovered using kitchen knife, followed by removal of the outer brown skin. This was subsequently grated, homogenized in boiling water in the ratio of 6:1, filtered through a clean muslin cloth and pressed to obtain the defatted coconut. This was further rinsed with hot water (70ºC) to ensure that most of the fat was extracted. The defatted coconut was then dried to constant weight in the hot air oven at 60^oC, cooled, and stored in an air tight container.

2.6 Preparation of flour blends and biscuits

Seven samples were obtained by blending whole breadfruit flour, maize flour and coconut grit on 70 : 20 : 10, 60 :30 : 10, 45 : 45 : 10, 30 : 60 : 10, 20 : 70 : 10 proportion; and hulled breadfruit: maize flour: coconut grit on 45:45:10, while 100% wheat flour served as control. Production of biscuits followed the method of Kure *et al*. (1998). Exactly 150g of each flour sample was mixed with 40g of sugar, 30g of margarine at medium speed using Master Chef Mixer (model MC-HM6630) until fluffy. To this was added 10g of egg, 10g of milk, 1.5g of baking powder, 0.5g of vanilla and 90ml of water. Each sample was mixed until a uniform smooth paste or dough is obtained. This was then rolled to a sheet of about 0.25 cm thickness on a board using a rolling pin. Cookie cutters were used to cut the sheet into desired shapes and sizes which were subsequently baked in an oven at about 150ºC for 20 min, allowed to cool, packed and stored at ambient conditions.

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2.8 Proximate analysis of samples

2.8.1 Moisture content determination

Moisture content of the samples was determined according to the gravimetric methods of AOAC (1995). Exactly 5g of test sample was measured into crucibles that have been earlier washed, dried in an oven at a temperature of 70-80°C for 2 h and weighed. The samples were dried in the oven at 105°C for 4 h. This was cooled in desiccators and weighed. It was returned to the oven for further drying, cooling and weighing at 30 min intervals repeatedly until a constant weight is obtained. The weight of the moisture loss was calculated and expressed as percentage weight:

$$\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \ldots \ldots\ldots \ldots\ldots\ldots \ldots\ldots\ldots (1)$$

Where,

W_1 = initial weight of empty crucible

W_2 = weight of crucible + sample before drying

W_3 = weight of crucible + sample after drying.

2.8.2 Fat content determination

Fat content of the test samples was determined by the continuous solvent extraction method using a soxhlet extractor as described by James (1995). Clean boiling flask (250 ml) was dried in an oven at 105°C-110°C for 30 min, allowed to cool in desiccators, and weighed. The flask was filled with 300 ml of petroleum ether. Five grams of the test sample was measured into a fat-free extraction thimble which has been dried in an oven and weighed. The extraction thimble was plugged with cotton wool and the weight taken again. The soxhlet apparatus was assembled and allowed to reflux for 6 h. The thimble was removed and the flask kept briefly for escape of petroleum ether before drying at 105°C-110°C for 1 h. The flask was allowed to cool in desiccators and then the weight taken. The fat content was calculated as:

$$\% \text{ Fat} = \frac{W_2 - W_3}{W_1} \times 100 \ldots\ldots\ldots \ldots\ldots\ldots (2)$$

Where:

W_3 = weight of empty extraction flask

W_2 = weight of flask and oil extract

W_1 = weight of sample used

2.8.3 Crude fiber determination

Weende method described by Onwuka, (2005) was used for the crude fiber 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% NaOHand 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;

$$\% \text{ Crude fiber} = \frac{W_2 - W_3}{\text{Weight of sample}} \times \frac{100}{1} \ldots\ldots\ldots\ldots\ldots (3)$$

Where:

W_2 = weight of crucible + boiled dried sample

W_3 = Weight of crucible + ash

2.8.4 Ash content determination

Ash content of the test samples was determined by the method described by Onwuka, (2005). Exactly 2 g of the test sample was weighed into a previously weighed porcelain crucible and heated in a muffle furnace at 550°C for 2 h during which the sample has completely turned to ash. This was cooled in desiccators and re-weighed.

The percentage ash was calculated as:

$$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where;

W_1 = weight of empty crucible

W_2 = weight of crucible + sample

W_3 = weight of crucible + ash

2.8.5 Crude protein determination

The crude protein content of the test sample was determined by Kjeldahl method as reported by Onwuka (2005). Exactly 2 g of the test samples was weighed into a micro-kjeldahlflask containing a metallic catalyst and 5 ml of concentrated H_2SO_4 added. The same treatment was given to another 5 ml sample. The sample was digested at red hot temperature in a fume cupboard for 2 h and the digest transferred into a volumetric flask each. A clear solution is an indication of complete digestion after 2 h. Each of the transferred digest was diluted to 50 ml with distilled water. Then, 10 ml 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.

$$\%N = \frac{100 \times N \times 14 \times V_t \times T - B}{W} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

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

2.8.6 Carbohydrate determination

The carbohydrate content of dried test sample was estimated using the arithmetic difference method as described by Onwuka, (2005). This means that when other proximate components have been determined as percentage, the sum of these determinations was subtracted from 100 to give the carbohydrate contents.
% carbohydrate = 100 - (% moisture + % ash + % crude protein + % fat +% crude fiber).

2.9 Dietary fiber determination

The enzymatic gravimetric method (AOAC, 1995) was used. A measured weight of 5g each was heated in 100ml of distilled water to gelatinize the starch. The gelatinized sample was treated with 2.0ml of heat stable α-amylase enzyme and kept at 90^{o}C in an electric water bath with shaker for 15 min. The partially hydrolyzed gelatinized sample was allowed to cool to 60^{0}C in a preset water bath and 2ml of amyloglucosidase enzyme solution was added to it. It was allowed to stay for 30 min at that temperature. Following this, 2.0ml of protease enzyme (pepsin) with tris buffer solution, pH 7.5 was added to it and allowed to stand for another 30 minutes.

The triple deposited sample digest was filtered through Whatman No. 1 filter paper. The filtrate (which contained soluble fiber), was recovered in a conical flask while the residue (which contained the insoluble dietary fiber) was washed with two portions of 15ml 78% ethanol and 95% ethanol, respectively and finally with 50ml of acetone to defat. The washed residue was transferred quantitatively into a weighted crucible and dried in the oven at 100^{o}C for an hour. It was cooled in desiccators and weighed.

Meanwhile, the soluble fiber was precipitated by treating it with 15ml of drop wise addition of 95% ethanol at 60^{o}C. The filter precipitates was recovered by filtration. The precipitate with filter paper was washed with 50mls of acetone, dried in the oven at 100^{o}C for 1 hour and reweighed. The weight of fibers in each case was calculated by difference using the formula below;

Weight of Dietary fiber = $W_2 – W_1$…………………………………… (6)

Where:
W_1 = Weight of empty crucible
W_2 = Weight of crucible and fiber

Corrections were made for ash in which the fiber in the crucible was burnt completely leaving grey ash. The weight of ash was taken after cooling in desiccators. It was given by the formula;

$W_3 – W_1$ = Weight of ash

Where:
W_1 = Weight of empty crucible
W_3 = Weight of crucible and ash.

The corrected dietary fiber content was obtained by subtracting the ash weight from the initial fiber weight.
The net weights of soluble and insoluble fibers were added to obtain the total dietary fiber content.
TDF = SDF + IDF

2.10 Sensory evaluation

The biscuit samples were subjected to sensory evaluation using a 30-member semi trained panel. Each sample was presented in coded white plastic plate in a randomized order. Potable water was provided to rinse the mouth after each evaluation. The panelists were instructed to score the coded samples for aroma, taste, color, texture 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).

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2.11 Statistical analysis

Statistical analysis was performed using SPSS version 17.0 to conduct analysis of variance (ANOVA) on the mean values, and significance difference is determined using Duncan Multiple Range Test.

3.0 RESULTS AND DISCUSSION

3.1 Proximate composition

The result of the proximate composition of biscuits samples is as shown in Table 1. There was significant difference (p<0.05) in dry matter content of the biscuit samples, with the highest values recorded for Sample D (Whole Breadfruit: Maize: Coconut; 30:60:10 blend). There was no significant difference (p>0.05) in the 95.50% of Sample D and 95.49% of Sample G (100% Wheat). The high dry matter observed in the two samples may be attributed to high fiber content of wheat, maize and whole breadfruit kernels. The contributory effect of the maize and the breadfruit can be effective at certain proportional levels, hence there was no significant difference (p.0.05) in Samples A and B, and also in Samples C and E. The lowest value of 95.10% of Sample F is an indication that the hull of most grains is rich sources of fiber. However, the values recorded for all the samples fall within dry matter range of 95.19 to 97.00% for cassava –pigeon pea biscuit reported by Ashaye*et al*., (2015). Certain ingredients used in formulation may equally contribute to difference in dry matter content of biscuits.

There was significant difference (p<0.05) in moisture content with the highest value of 4.90% in Sample F and lowest value of 4.51% in Sample D. There was no significant difference (p<0.05) in the 4.61% of Sample C and 4.62% of Sample E. 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 *et al*. (1998) that moisture content of baked samples could be attributed to the baking process the products were subjected. Also, the hulling of the breadfruit seeds will increase the protein value of the flour and might contribute to higher moisture content of biscuit. Mustafa *et al*. (1986) reported an increase in moisture content of bakery products with increase in protein content The moisture content of the snacks containing whole breadfruit (Samples A to E) increased with increase in whole breadfruit flour addition. This agrees with the report of Bose and Shams-Ud-Din, (2010) for cracker biscuits containing chick pea husk, indicating that the larger particles of husk have more water holding capacity than the smaller particles of wheat flour.

According to AAAC, (2000) the maximum limit for moisture content is14% which is far in excess of the values obtained in all the samples. The considerable low moisture in the samples is an indication of good keeping quality of the products when properly packaged and stored (Temple *et al*., 1996), since high moisture content in food has been shown to encourage microbial growth.

Table 1: Proximate composition of biscuits samples

Sample	Dry matter (DM) %	Moisture %	Crude Protein %	Crude Fat %	Crude Fiber %	Carbohydrate %	Ash %	Energy Kcal
A	95.19^{c} ±0.01	4.81^{b} ±0.01	10.62^{c} ±0.01	13.01^{a} ±0.01	9.32^{a} +0.02	59.36^{f} ±0.02	2.88^{a} ±0.01	396.99^{d} ±0.13
B	95.19^{c} ±0.00	4.70^{c} ±0.00	10.55^{d} ±0.00	10.64^{b} ±0.01	8.05^{b} ±0.09	63.25^{e} ±0.08	2.80^{b} ±0.00	391.00^{g} ±0.43
C	95.30^{b} ±0.0	4.61^{d} ±0.01	9.37^{e} ±0.01	10.56^{c} ±0.01	7.32^{c} ±0.01	65.39^{d} ±0.02	2.76^{c} ±0.01	394.10^{f} ±0.12
D	95.50^{a} ±0.02	4.51^{e} ±0.01	8.87^{f} ±0.02	9.93^{f} ±0.02	5.32^{d} ±0.02	69.77^{c} ±0.02	2.50^{d} ±0.00	395.80^{e} ±0.12
E	95.38^{b} ±0.02	4.62^{d} ±0.02	8.45^{g} ±0.02	9.01^{f} ±0.01	4.66^{e} ±0.02	70.98^{b}±0.01	2.31^{e} ±0.01	398.7^{c} ±0.05
F	95.10^{e} ±0.00	4.90^{a} ±0.00	11.18^{a} ±0.00	9.68^{d} ±0.01	2.42^{f} ±0.01	69.74^{c} ±0.01	2.09^{f} ±0.01	410.80^{b} ±0.10
G	95.49^{a} ±0.01	4.51^{e}e±0.01	10.85^{b} ±0.01	9.45^{e} ±0.01	1.56^{g} ±0.02	71.54^{a} ±0.04	2.01^{g} ±0.01	415.23^{a} ±0.03

Means within a column with different superscripts are significantly different (P<0.05).
A = WBF:MF:DCG (70: 20: 10) B = WBF:MF:DCG (60: 30: 10) C = WBF:MF:DCG (45: 45: 10) D = WBF:MF:DCG (30: 60: 10) E = WBF:MF:DCG (20: 70: 10) F = HBF:MF:DCG (45: 45: 10) G = 100% WF (Control)
*WBF = Whole Breadfruit Flour, HBF = Hulled Breadfruit Flour, MF = Maize Flour
DCG = Defatted Coconut Grits and WF = Wheat Flour

There was significant ($p<0.05$) difference in crude protein content of the biscuit samples with Sample F coming tops with 11.18% followed by 10.85% of Sample G. This supports earlier suggestion that hulling might have increased protein value of breadfruit seeds. This conforms to the report of Arawande*et al*. (2009) that protein is more concentrated in hulled seeds.

The crude protein content of 8.45 to 10.62% of the whole breadfruit seed samples agrees with the 8.92 to 9.72% reported by Bose and Shans Ud-Udin (2010) for whole fiber snack, but lower than the 13.45 to 15.90% reported by Okafor and Ugwu (2014). The protein content of samples decreased with increase in maize substitution, which may be attributed to lower protein content in maize flour. Supplementation with diverse protein sources guarantees amino acid balance in high fiber snack (Opeoluwa, *et al*., 2015).

There was significant ($p<0.05$) difference in fat content of the samples with Sample A recording the highest value of 13.01%, while Sample E with 9.01% has the least. The least fat content in sample E could be attributed to the high substitution of maize flour. There is generally low fat content in maize since maize is mainly a starchy food.

Fat plays a significant role in the shelf life of food products and as such relatively high fat content could be undesirable in baked food products (Ejiofor *et al*., 1988). The fat content of the samples were low compared to 18.20% reported by Agunbiade and Ojezele (2010) for instant breakfast meal. Fats in food products are flavor retainer and increases mouth feel of the products (Etudaiye *et al*., 2008).

There was significant ($p<0.05$) difference in the crude fiber content of all the samples, with values ranging from 1.56 to 9.32%. The high fiber content of Sample A of 9.32% could be attributed to 70% inclusion of whole breadfruit flour in the biscuit. The substantial fiber content of the samples might be due to addition of coconut to the products as coconut is reported to be high in fiber (Okafor and Ugwu, 2014). Trinidad *et al*. (2006) reported that coconut flour contains 60.9% total dietary fiber consisting of 56.8% insoluble and 3.8% soluble, which are fermentable and produced short chain fatty acids. In a relative sense, the samples containing whole breadfruit flour, maize flour and coconut will be preferable with respect to their higher fiber content since crude fiber is known to aid the digestive system of human (Amusa *et al*., 2002).

There was significant ($p<0.05$) difference in carbohydrate content of samples with Sample G (wheat flour biscuit) recording the highest value of 71.54%. The samples containing whole breadfruit flour are remarkably lower in carbohydrate. However, there range of values (59.36 to 70.98%) correlates with the 60.24 to 76.45% reported by Akubor and Badifu (2004) for breadfruit blend and the 43.68 to 61.60% of Bose and ShansUd-Udin (2010) for chick pea husk substituted biscuits. The higher value of Sample F compared to most of the blended flour samples may be attributed to the hulling process, with the expected rise in carbohydrate composition. The only exception is in Sample E where high substitution with maize flour might have led to remarkable increase in carbohydrate. The higher value of Sample G (100% wheat flour) is understandable since wheat is a good source of carbohydrate. Conversely, the carbohydrate content of samples containing whole breadfruit flours decreased as substitution level increased, as evidenced in Sample A with the least value of 59.36%. This further suggests that wheat and maize, which are typical cereals, are better sources of carbohydrate than breadfruit. The high carbohydrate content of the samples is justifiable since the biscuits were made from mainly carbohydrate rich materials, which are wheat, breadfruit and maize (Olaoye*et al*., 2007).

There was significant ($p<0.05$) difference in the ash content of the samples with Sample A which has highest substitution of whole breadfruit flour coming tops with 2.88%. It is equally noteworthy that Samples A to E containing whole breadfruit flour were higher in ash, suggesting that the breadfruit hull may have contributed to the high ash content. The ash content of Sample F of 2.09% containing hulled breadfruit flour was significantly ($p<0.05$) higher than the 2.01% Sample G obtained from wheat flour. This corroborates the report of Ragone (1997) that breadfruit contains comparatively higher ash than wheat. The ash content values were in agreement with the 1.10 to 2.44% of Agunbiade and Ojezele (2010). It can be inferred that incorporation of breadfruit flour in biscuit manufacture will enhance mineral intake since sufficient ash is indicative of rich mineral elements in a food sample (Olaoye *et al*., 2007; Eke *et al*., 2007). Ash is a non-organic compound containing mineral and nutritionally aids in the metabolism of other organic compounds such as fat and carbohydrate (Ojinnaka *et al*., 2013).

There was significant ($p<0.05$) difference in energy value of biscuit samples with the wheat flour (control) recording the highest value of 415.23Kcal and Sample B the least value of 391.00Kcal. The highest energy value of the wheat flour was an attestation to the fact that carbohydrate is a veritable energy supplier. This is verifiable from the fact that Sample G (wheat flour biscuit) recorded the highest carbohydrate content. The comparatively high energy value of Sample E and F might be attributed to substantial addition of maize flour on one hand, and hulling of breadfruit seeds on the other. Whereas maize is a good source of carbohydrate, hulling will generally lead to increase in proximate values of seeds. The energy values of the samples are considerable since snacks are intended to hold forth for the main meal.

3.2 Dietary fiber content of biscuits

From Table 2 it can seen that there was significant ($p<0.05$) difference in total dietary fiber (TDF) of the biscuit samples, with Sample A exceeding the rest with a value of 10.86 g/100g. This concurs with the highest crude fiber value recorded by the sample previously. Like in the crude fiber analysis, the dietary fiber also depreciated with decrease in whole breadfruit flour substitution, suggesting that the breadfruit hull is not only high in fiber, but also a good source of dietary fiber. There was no significant ($p>0.05$) difference in dietary fiber content of Samples F and G, and their very low fiber contents of 1.30 and 1.24 g/100g respectively, which lend credence to the proposition that the breadfruit hull might have contributed to the high fiber of Samples A to E. The values obtained in Samples A to E compared with the 3.12 to 8.64 g/100g for snacks produced from corn/soy residue,

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the 3.12 to 9.11g/100g for corn/defatted soy residue (Trongpanich *et al*., 2000) and the 7.7g/100g in the baked bread made with baker's patent flour substituted with 5% corn bran (Sosulski and Wu, 1998). They also reported a range of 5.9 to 13.3g/100g and 7.7 to 19.1 g/100g of TDF by replacing baker's patent flour with various proportions of wheat bran and field pea hulls respectively in baked bread. Total dietary fiber is widely recognized as essential element of good nutrition (Teresita *et al*., 2013). According to European Food Safety Authority (EFSA, 2010), a food can be referred to as a good "source of fiber" if it contains at least 3g/100g of dietary fiber, and "high in fiber" if it contains at least 6g/100g of dietary fiber. It follows that all the samples containing whole breadfruit flour can be classified as high fiber biscuits.

The insoluble dietary fiber (IDF) of the samples were significantly ($p<0.05$) different with Sample A coming tops with 9.57g/100g. The values obtained for samples containing whole breadfruit flour correlates with the 8.01g/100g insoluble dietary fiber content of breadfruit (*Artocarpus altilis*) reported by Abena *et al*. (2014) Notably, there was no significant ($p>0.05$) difference in Sample F and G which were lowest with 0.27 and 0.23 g/100g respectively. The 0.27g/100g of Sample F which contained up to 45% of maize flour contrasts the 12.19 to 12.80 g/100g of maize kernel reported by Bressani *et al*, (1989), except for possible interplay in the flour blend. Insoluble dietary fiber includes cellulose, hemicelluloses and lignin, which are plant cell wall components that bind water as they pass through the digestive tract, making stools softer and bulkier. This helps in the treatment and prevention of constipation, hemorrhoids and diverticulitis. In addition, they absorb toxins and extra bile acids and facilitate their elimination from the body, thereby reducing the risk of some cancers, especially colon cancer (Arbab *et al*., 2007).

The soluble dietary fiber (SDF) content of Sample A was significantly ($p<0.05$) higher than other samples. There was no significant ($p>0.05$) difference in the soluble dietary fiber of Samples F and G, with lowest values of 1.03 and 1.01 g/100g, as in IDF. Soluble fiber includes pectin, gums and mucilage which become gummy when in contact with water. During digestion these viscous gels line along the walls of the intestine and reduce glucose and cholesterol absorption into the blood stream (Anderson *et al*., 2009; Toppy *et al*., 1986). This helps in controlling blood sugar and cholesterol levels which is most beneficial to diabetic and heart patients (Kritchevsky, 1986). The SDF values of the biscuit samples met the minimum 0.69g/100g required in order to make a health claim about fiber and coronary heart disease IOM (2002). Anderson *et al*. (2010) has noted that SDF intake is recommended in the treatment of obesity and diabetes.

Table 2: Dietary fiber content of biscuits samples

Sample	Dietary fiber (g/100g) Total	Insoluble	Soluble
A	$10.86^{a}\pm0.00$	$9.57^{a}\pm0.01$	$1.29^{a}\pm0.01$
B	$10.64^{b}\pm0.11$	$9.42^{ab}\pm0.11$	$1.22^{ab}\pm0.00$
C	$10.51^{bc}\pm0.10$	$9.35^{bc}\pm0.10$	$1.16^{b}\pm0.00$
D	$10.41^{cd}\pm0.14$	$9.22^{cd}\pm0.00$	$1.19^{b}\pm0.01$
E	$10.23^{d}\pm0.10$	$9.09^{d}\pm0.10$	$1.14^{b}\pm0.00$
F	$1.30^{e}\pm0.03$	$0.27^{e}\pm0.04$	$1.03^{c}\pm0.00$
G	$1.24^{e}\pm0.14$	$0.23^{e}\pm0.04$	$1.01^{c}\pm0.01$

Mean values down the columns with different superscripts are significantly ($P<0.05$) different.
Key: Samples A to G as defined in Table 1.

3.3 Sensory evaluation of biscuit samples

From Table 3 for the sensory attributes there was significant ($p<0.05$) difference in color of biscuit samples with Sample G obtained from wheat flour recording the highest score of 8.40, followed by the 7.73 of Sample F substituted with hulled breadfruit flour. Sample E with the least incorporation of whole breadfruit flour came third with 6.97. There was no significant ($p>0.05$) difference in the remaining samples, though Sample A with the highest amount of whole flour received the least score of 5.73. The observed decrease in color appeal with increase in the proportion of the whole breadfruit flour may be attributed to dulling effect of the breadfruit hull. Color is a very important tool in judging properly baked snacks, which not only reflect the suitable raw materials used for the preparation but also provides information about the formulation and quality of the product (Ojinnaka *et al*., 2013).

There were no significant ($p>0.05$) difference in the taste of samples A to E. There was also no significant difference in the taste of Samples F and G (control), though the later had the highest score of 8.40. The lower scores of samples containing whole breadfruit flour may be attributed to the objectionable taste of the hull. Moreover, the high fiber of the hull may absorb and reduce the availability of fat, sugar, and other ingredients likely to promote taste. There also appear to be an unpleasant interaction between the hull and the maize, hence the drop in score with increase in maize flour added.

There was significant ($p<0.05$) difference in aroma of the biscuit samples with the control taking the lead with 7.83, closely followed by Sample F which recorded 7.50. There was no significant ($p>0.05$) difference in aroma of the samples containing whole breadfruit flour, except for the oddity of Sample D with the least score of 6.17. The lower scores of samples containing whole breadfruit flour may be attributed to the bland aroma of breadfruit hull. Nevertheless, the acceptable values may be attributed to the mild toasting of the retained hull, in added to the strong distinctive aroma of coconut (Poonam, 2013)

Table 3: Sensory attributes of the biscuits samples

Sample	Color	Taste	Aroma	Texture	Overall acceptability
A	5.73^{d}±1.10	6.53^{b}±1.50	6.50^{bc}±1.33	6.70^{b}±1.37	6.43^{c}±1.36
B	6.20^{cd}±2.28	6.43^{b}±1.63	6.50^{bc}±1.20	6.80^{b}±1.50	6.67^{c}±1.63
C	6.17^{cd}±1.74	6.43^{b}±1.68	6.63^{bc}±1.67	6.77^{b}±1.50	6.57^{c}±1.46
D	6.40^{cd}±1.83	6.07^{b}±2.02	6.17^{c}±1.72	6.57^{b}±161	6.37^{c}±1.79
E	6.97^{bc}±1.43	6.45^{b}±1.62	6.57^{bc}±1.48	7.13^{b}±1.41	6.87^{bc}±1.63
F	7.73^{ab}±1.17	7.50^{a}±1.41	7.17^{ab}±1.44	7.27^{b}±1.26	7.53^{b}±1.14
G	8.40^{a}±0.68	8.10^{a}±0.92	7.83^{a}±1.34	8.00^{a}±0.91	8.33^{a}±0.84

Mean values down the column with different superscript are significantly (P<0.05) different.
Key: Samples A to G as defined in Table 1.

There was no significant (p>0.05) difference in the texture of the samples made from flour blends, though the sample containing hulled breadfruit flour was rated better than others with whole breadfruit flour. The lower texture appeal of the biscuits containing whole breadfruit flour may be attributed to the hull particles, which retards homogenous distribution of fat in the dough, and consequently in the baked product. Sample G (control) was significantly (p<0.05) higher than other samples in texture, which may be due to the presence of gluten in wheat flour, leading to formation of an elastic smooth dough that will likely result to biscuits with better texture.

There was significant (p<0.05) difference in overall acceptability of the biscuit samples with Sample G (control) being the most acceptable. Sample F containing hulled breadfruit flour was significantly (p<0.05) higher than all samples containing whole breadfruit flour with a mean score of 7.53. There was no significant (p>0.05) difference in the acceptability of all samples containing whole breadfruit flour, though Sample E with the lowest proportion of whole breadfruit flour surpassed the rest with a score of 6.87, thus suggesting that high presence of hull particles might have been a setback to product acceptance. The highest score of 8.33 obtained by Sample G (control) was expected given that it excelled in other sensory attributes considered. However, it can be inferred that all the samples were generally acceptable since the sensorial scores were in excess of 5.0, which is considered the minimum acceptable score on a 9-point hedonic scale.

CONCLUSION

The result of this research show that high fiber biscuit can be produced using flour bends from African Breadfruit, maize and coconut; all of which are obtainable from our immediate environment. The comparative nutritional and sensorial credibility justify the need for further investigation into the use of various agricultural materials in the production of snacks that will promote both the nutritional and health needs of man. Attention should be paid towards attaining the fiber levels for digestion and health benefits without compromising the quality characteristics of products.

REFERENCES

1. Abena. A. B.; Faustina, D. W.; Jacob, K.A. and Ibok, O. (2014), Dietary Fibre, Ascorbic and Proximate Composition of Tropical Underutilized Fruits. *Africana Journal of Food Science*, 8 (6): 305-310.

2. Agriga, A.N. and M.O. Iwe (2009). Proximate Composition of Cookies Produced from Cassava Groundnut-corn starch blend, *Nigeria. Food Journal*, 27: 102-107.

3. Agunbiade, S. O. and Ojezele, M. O. (2010). Quality Evaluation of Instant Breakfast Meals Fabricated from Maize, Sorghum, Soybean and Yam Bean (Sphenostylisstenocarpa). *In World Journal. Dairy and Food Science.* 5(1):67-72.

4. Akubor P. I. and Badifu, G. I. O. (2004), Chemical Composition, Functional Properties and Baking Potential of African Breadfruit Kernel and Wheat Flour Blends. *International Journal of Food Science and Technology*, 39:223-229.

DOI: dx.doi.org/10.7324/IJASRE.2018.32634

5. American Associstion of Cereal Chemist (AACC), (2000). 10th Edition, The Association, St. Paul, MN. Method, 44-15A.

6. Amusa, N. A.; Kehinde, I. A. and Ashaye, O. A. (2002). Bio Deterioration of Breadfruit (Autoharps communist) in Storage and its Effects on the Nutrient Composition *African Journal of Biology Technology* Vol. 1 (2): 51-60.

7. Anderson, J. W.; Baird, P.; Davis Jr, R. H.; Ferreri, S.; Knudtson, M.; Koraym, A.; Waters, U. and Williams, C. L. (2009). Health Benefits of Dietary Fibre. *Nutrition. Revised*. 67(4):188-205.

8. Anderson, J.; Perryman, S.; Young, L. and Prior, S. (2010), “Dietary Fibre” http://www.ext.colostate.edu/pubs/foodnut/09333.html, accessed on 7th Nov, 2016.

9. AOAC (1995) International official methods of analysis: 10th edition. Association of Analytical Chemists International, Gaithersburg M.D.

10. Arawande, J. O.; Ajayi, I. O. and Adewumi, B. L. (2009), Nutritive Significant of Husked and dehusked Seeds of African Braedfruit and Characterization of its extracted oil. *Journal of Revised in National Development*. 7, 1:34-45.

11. Arbab, R. K.; Sahib, A.; Sajid, A.; Saiga, B.; Iqtidar, A. K.; (2007). Dietary Fibre Profile of Food Legumes. *Sarhad Journal of Agriculture*. 23(3): 23-26.

12. Ashaye, O.A., Olanipekun, O.T and Ojo, S.O. (2015). Chemical and Nutritional Evaluation of Biscuits processed from Cassava and Pigeon pea flow. *Journal of Food Processed Technology*, 6:521.

13. Betty, W. L.; Karen, W.; Andrew, I. and Pamela, R. P. (2002). Individual Sugars, Soluble, and Insoluble Dietary Fibre Contents of 70 High Consumption Foods. *Journal of Food Composition and Analysis*, 15:715-723.

14. Bose, D. and Shams-Lid-Din, M. (2010). The Effect of Chickpea (Cicerarietnium) Husk One the Properties of Cracker Biscuits. *Journal Bangladesh April, University*. 8(1): 147-152.

15. Chinma, C.E. and D.I. Gernah, (2007). Physicochemical and Sensory Properties of Cookies Produced from Cassava Soyabean/mango composite flours. *Journal Raw Material. Resvised*, 4: 32-43.

16. Ejiofor, M.A.N.; Obianuju, O. R. and Okafor, J. C. (1988). Diversifying of African Breadfruit as Food and Feeding Stuff. *International Tree Crop Journal* 5. Pp. 125-134.

17. Eke, J.; Sanni, S. A. and F. Awuno. (2007). Proximate and Sensory Properties of Banana Cakes. *Nigeria Food Journal*, 27(2):102-106.

18. Etudaiye, H. A. Oti, E. and Amed, C. (2008). Functional Properties of Wheat: Sweet Potato composite flour and sensory qualities of Confectioneries produced from the composites. *Nigeria Journal of Nutrition Science*.29(2) Pp.140-147.

19. European Food Safety Authority (EFSA) (2010): Scientific Opinion on Dietary Reference Values for carbohydrate and dietary Fibre by EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA), *EFSA Journal* 8(3):1462.

20. FAO/WHO/UNU Expert Cosultation (1994). Food Nutrients Requirements, Report of a joint FAO/WHO/UNU Expert Consultation, World Health Organization Technical Report Series 724. Genera: WHO.

21. Hegazy, A.I. and Ibrahim, N.I. (2009). Evaluation of the Protein Quality of Wheat Biscuits Supplemente4d by Fenugreek Seed Flour. *World .Journal Dairy Food Science*. 4: 129-135.

22. Institute of Medicine, Food and Nutrition Board (IOM) (2002). Dietary, Functional and Total Fiber in: Dietary Reference Intake for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesteros, Protein, and Amino Acids (Macronutrients). Washington, DC: National Academic Press.

23. Iwe, M.O. (2014). Current trends in sensory evaluation of foods. Rejoin Communication Services Ltd Uwani Enugu. pp. 142-145.

24. James, C.S. (1995). Analytical Chemistry of Food. Blackie Acadcemic& Professional, New York. Pp 34.

25. Kure, O.A., E.J. Bahayo and E.A. Daniel, (1998). Studies in the Proximate Composition and Effect of Flour Particle Size on Acceptability of Biscuit Produced from Blends of soya Beans and Plantain Flours. *Namida Tech-scope Journal*, 3: 17-21.

26. Kritchevsky, D. (1986). Dietary Fibre and atherosclerosis. N: Dietary fibre, basic and Clinical aspects. Vahouny, G.V. and Kritchevsy, Plenum Press, New York. Pp. 256-274.

27. Mustafa, A. I.; Alwessali, M. S.; Busha, S. I. and Al-Amia, R. H. (1986). Utilization of Cowpea Flour and Protein Isolate in Bakery Products. *Cereal Food World*, 31:756-759.

28. O'Connor CJ, Sun D., Smith B. G. and Nelton L.D. (2003). Inhibitory Effect of Brans and their Aqueous Estracts on the Lipolysis of Tributyrin. Catalysed by Calf Pregastric Lipase. *Journal of Food Science*, 68: 1818-1825.

29. Ojinnaka, M.C., Anyanwu, F.A., Ihemeje, A. (2013). Nutritional evaluation of Cookies Produced from African breadfruit (*Treculiaafricana*) starch and wheat flour. *International Journal Agriculture Food Science*, 3:95-99.

30. Okafor, G.I and Ugwu, F.C. (2014). Production and Evaluation of Cold Extruded and Baked read-to-eat snacks from blends of breadfruit (*TreculiaAfricana*), Cashewnut (*Anacardiumoccidentale*) and Coconut (*cocosnucifera). Food Science and Quality Management*, 23.

31. Okoh, P.N. (1998). Cereal grains in nutritional quality of plant foods (eds). In: AU. Osagie and O.U. Eka: Nutritional quality of plant foods. Post Harvest Research Unit., University of Benin, Nigeria,Pp; 32-52.

32. Okpala L.C. and E.C. Okoli (2011). Nutritional Evaluation of Cookies Produced from Pigeonpea, Cocoyam and Sorghum flour blends. *African Journal Biotechnology*, 10: 433-438.

33. Olaoye, O.A., Onilude, A.A., and Oladoye, C.O. (2007). Breadfruit Flour in Biscuit Making: Effects on Product Quality. *African Journal of Food Science*, 020-023

34. Onwuka (2005). Food Analysis and Instrumentation: Theory and Practice, Naputhali Prints, Lagos, 64-155, 122-128.

35. Opeoluwa, O. O.; Ijarotimi, O. S.; and Fagbemi, T. N.; (2015). Evaluation of Nutritional Properties of High Protein-Fibre Based Snacks Formulated from Wheat, Soybeans Concentrate and Cassava Fibre. *Sky Journal of Food Sci*ence. 4(3): 030-041.

36. Pamplona, R. and D. George, (2004). Encylopedia of foods and their healing powers. A guide to food science and therapy (2): pp: 264.

37. Poonam, D. (2013). A study on Development of coconut Based Gluten Free Cookies. *International Journal of Engineering Science Invention*, 2(12):10-19.

38. Ragone, D. (1997). Breadfruit Artocarpusartilis (Parkinson) Fosberg. Promoting the Conservation and use of Underutilized and Neglected Crops. Institute of Plant Genetics and Crop Plants Research, Gatersleben International Plant Genetic Resources Institute, Rome, Italy Soetjipto NN, Lubis AS (1981). Vegetables: IBPGR Secretariat, Rome, P. 330.

39. Samalia, J. and Nwabueze, T.U (2013). Quality Evaluation of Extracted Full-fat Blend of African breadfruit-Soybean-Corn Snack. *International Journal of Scientific and Technology Research*, 2(9):1-3.

40. Slavin J. L. (2008). American Dietetic Association. Position of the American Dietetic Association: Health Implications of Dietary Fiber. *J Am Diet Assoc*. 108 (10): 1716-1713.

41. Sosulski, F. W. and Wu, K.K. (1988). *Cereal Chemistry*, 65(3): 186-191.

42. Tappy, L., Wursch, P., Randim, J., Felber, J.P and Jequier, E. (1986). Metabolic effect of Pre-cooked instant preparations of bean and potato in normal and diabetic subjects. *American Journal. Clinical: Nutrition*, 43:30-31.

DOI: dx.doi.org/10.7324/IJASRE.2018.32634

43. Temple, V. J.; Badamos, E. J.; Ladeji, O. and Solomon, M. (1996).Proximate Chemical Composition of Three Locally Formulated Complimentary Foods, *Nest Africa Journalof Biological Science*, 5:134-143.

44. Teresita, R. P.; Ma Rachel, V. P. and Mildied A. U. (2013). Proficiency Test on Total Dietary Fibre in Wheat Flour. *International Journal of Chemical Engineering and Applications*, 4(2): 23-45.

45. Trinidad, P.T., Mallillin, A.C., Valdez, D.H., Loyola, A.S., Askali-Mercado, F.C., Castillo, J.C., Encabo, R.R., Masa, D.B., Maglaya, A.S. and M. T. Chua (2006). Dietary Fiber from Coconut Flour: A Functional Food. *Innovative Food Science and Emerging Technologies*, 7 (4), 309-317.