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Quality Evaluation of Baked Cake from Wheat Breadfruit Composite Flour

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Abstract This study was conducted to investigate the chemical, functional, pasting and sensory properties of breadfruit-wheat composite flours and its cake making potentials using standard and analytical methods. Composite flour of wheat/breadfruit at different substitution ratios of (100:0%), 90:10%, 80:20%, 70:30%, 0:100%) were used to bake cake. The results revealed that there were significant difference ($p \leq 0.05$) in chemical composition (moisture, ash, fat, protein, crude fibre and carbohydrate content) and functional properties (bulk density, water absorption capacity, oil absorption capacity and swelling power) between the flour and cake samples. The cake samples had proximate composition ranging from 11.97- 14.25% moisture content, 8.36 – 12.50% protein content, 3.17 – 7.72% fat content, 1.26 – 1.76% ash content, 3.93 – 6.64% crude fibre content and 71.27 – 85.24% carbohydrate content. The functional properties of the flour samples ranged from 0.64 – 0.82 gcm^{-3} bulk density, 1.50 – 3.15% water absorption capacity, 1.78 – 2.28% oil absorption capacity and 5.25 – 7.85% swelling power. The pasting properties of the flour blend ranged from 1011-1400Cp peak viscosity, 396.17 – 1318Cp. Through viscosity, 82.50 – 546.50Cp breakdown viscosity, 554-988Cp setback viscosity 1345 – 2306Cp final viscosity, 6.0 – 7.0mins peak time and 81.93 – 92.08°C pasting temperature. Sensory evaluation results showed that all the cake samples had high ratings for all evaluated attributes. The 90:10% and 80:20% of wheat bread fruit flour substitution compared favourably with control (100%WF). Cakes from other substitution levels were generally acceptable.

Keywords: *breadfruit, wheat, cake and quality*

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1. Introduction

Cake is a form of bread or bread-like food. In its modern forms, it is typically a sweet baked dessert. In its oldest forms, cakes were normally fried breads or cheesecake and normally had a disk shape. Determining whether a given food should be classified as bread, cake or pastry can be difficult.

Modern cake, especially layer cakes, normally contain a combination of flour, sugar, eggs and butter or oil, with some varieties also requiring liquid (typically milk or water) and leavening agents (such as yeast or baking powder). Cakes are often filled with fruit preserves or dessert sauces (like pastry cream), iced with butter cream or other icings, and decorated with marzipan, piped borders or candid fruit [1].

Breadfruit has been processed into many forms for utilization. After peeling, the fruits are boiled, pounded and eaten with soups just like pounded yam. Processing of breadfruit into starches, [2] and flour [3] has also been reported. Although, breadfruit is nutritious, cheap and available in high abundance during its season, it has found limited applications in the food industries [4]. One major factor limiting its availability is its poor storageability, as the fruit undergo rapid physiological deterioration after harvesting.

However, the production of wheat in Nigeria is extremely low and far below domestic requirements. Compositing wheat with locally avialable cereals and root crops has been reported to be desirable [5]. It also encourages the agricultural sector and reduces wheat imports in many developing countries. Considerable efforts have been focused on the use of composite flour for bread and baked products in many wheat importing countries within the last two and half decades [6,7].

Wheat *(Tritium spp.)* [8] is a cereal grain, originally from the Levant region of the Near East and Ethiopian Highlands, but now cultivated worldwide. In 2010 world production of wheat was 651 million tons, making it the third most-produced cereal after maize (844 million tons) and rice (672 million tons) (http://faostat.fao.org/site/399/default.asp). In 2009, world production of wheat was 682 million tons, making it the second most-produced cereal after maize

(817 million tons), and with rice as close third (679 million tons) ("World Wheat, Corn and Rice", Oklahoma State University. FAOSTAT). This grain is grown on more land area than any other commercial food. World trade in wheat is greater than for all other crops combined [9].

Globally, wheat is the leading source of vegetable protein in human food, having higher protein content than either maize (corn) or rice, the other major cereals. In terms of total production tonnages used for food, it is currently second to rice as the main human food crop and ahead of maize, after allowing for maize's more extensive use in animal feeds. Wheat was a key factor enabling the emergence of city-based societies at the start of civilization because it was one of the first crops that could be easily cultivated on a large scale, and had the additional advantage of yielding a harvest that provides long-term storage of food. Wheat contributed to the emergence of city-states in the Fertile Crescent, including the Babylonian and Assyrian empires.

Wheat grain is a staple food used to make flour for leavened, flat and steamed breads, biscuits, cookies, cakes, breakfast cereal, pasta, noodles, couscous [10] and for fermentation to make beer, [11] other alcoholic beverages, or Biofuel [12].Wheat is planted to a limited extent as a forage crop for livestock, and its straw can be used as a construction material for roofing thatch [13,14]. The whole grain can be milled to leave just the endosperm for white flour. The by-products of this are bran and germ. The whole grain is a concentrated source of vitamins, minerals, and protein, while the refined grain is mostly starch.

Wheat protein is easily digested by nearly 99% of human population, as is its starch. Wheat also contains a diversity of minerals, vitamins and fats (lipids). With a small amount of animal or legume protein added, a wheat-based meal is highly nutritious.

The most common forms of wheat are white and red wheat. However, other natural forms of wheat exist. For example, in the highlands of Ethiopia grows purple wheat, a tetraploid species of wheat that is rich in anti-oxidants. Other commercially minor but nutritionally promising species of naturally evolved wheat species include black, yellow and blue wheat [9,15,16].

Breadfruit *(Artocarpus altilis)* is a tropical native to Malaysia and countries of the pacific and the Caribbean and it is an important food in the areas [17]. Breadfruit are found from sea level to about 1550m elevation. The latitudinal limits are approximately 17^0N and S, but maritime climates extend that range to the tropics of cancer and capricon [18]. The trees has a great productive ability with an average sized tree producing 400 to 600 fruits per year [19]. It has been reported that breadfruit yields in terms of food are superior to other starchy staples such as cassava and yam [20]. The mature fruit is a good source of carbohydrate (84%) with starch constituting more than 60% of the total carbohydrate [21].

Breadfruit is a staple food in many tropical regions. The trees were propagated far outside their native range by Polynesian voyagers who transported root cuttings and air-layered plants over long ocean distances. Breadfruit is very rich in starch, and before being eaten, they are roasted, baked, fried or boiled. Breadfruit has been processed into many forms for utilization. After peeling, the fruits are boiled, pounded and eaten with soups just like pounded yam. Processing into starches, [2] and flour [3] has also been reported. When cooked, the taste of moderately ripe breadfruit is described as potato-like, or similar to fresh-baked bread. Very ripe breadfruit becomes sweet, as the starch converts to sugar.

Although, breadfruit is nutritious, cheap and available in high abundance during its season, it has found limited applications in the food industries [4]. One major factor limiting its availability is its poor storage ability, as the fruits undergo rapid physiological deterioration after harvesting.

This study was conducted to investigate the chemical, functional, pasting and sensory properties of breadfruit-wheat composite flours and its cake making potentials.

2. Materials and Methods

2.1. Materials

The materials used for this research include the freshly matured but unripe breadfruits (*Artocarpus altilis*) and was purchased from a farm in Ijebu-Emuren, Ogun State. Others materials include wheat (*Tristicum aestivum)* flour, granulated sugar, vanilla essence, margarine, eggs, baking powder, and powdered milk which were purchased from a local market called Sabo, Ikorodu, Lagos State, Nigeria.

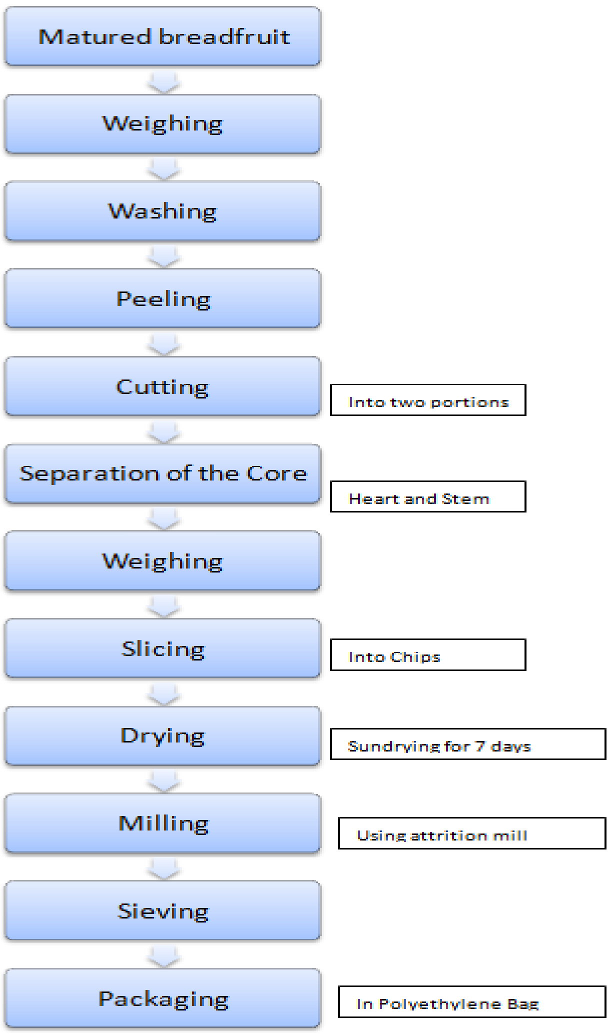

Figure 1. Process flow diagram for Breadfruit flour (*Source: Akubor PI., et al (2000)) [22]*

2.2. Preparation of Breadfruit Flour

In preparing the breadfruit flour as shown in Figure 1, Akubor., *et al* [22] the fresh fruits were washed in clean water to remove adhering latex and dirt, and subsequently peeled. After peeling, the fruits were sliced into chips and the core (heart and stem) was separated. The chips were then oven-dried in a cabinet oven drier, at a temperature of 60°C for 8 hours. The dried chips were then milled, using attrition mill and then passed through a 0.4mm screen to obtain fine flour. The fine flour was packaged in polyethylene bags for further use.

2.3. Production of Cake

Sugar and butter was mixed according to the method as described by Bennion and Bamford [23] as described in Figure 2. The baking fat and granulated sugar were creamed together with the mixer for 20mins until light. The eggs were beaten for 5mins with the homogenizer.

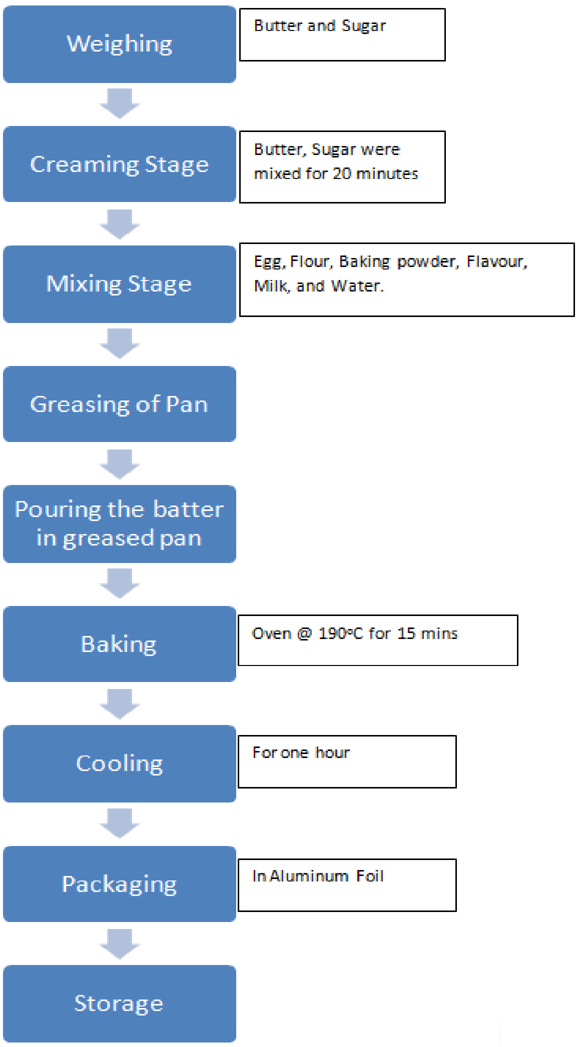

Figure 2. Process flow diagram for production of Cake (Source: [23])

Six additions (100% wheat, 10%, 20%, 30%, 100% substitution with breadfruit flour) were made over a period of 7mins with good creaming between the additions. This was done to prevent the curdling of batter. After batter developments of a soft velvety feel, the vanilla essence (flavouring) was added. The mixed batter, each at 150g were mixed with milk and water to proportion and poured into greased cake pans. These were put in the oven and baked at temperature of 190°C for 15mins. The cakes were cooled and removed from the pan after 1hr. The cooled cake will then be package in aluminium foils and kept in shelf until required for sensory evaluation.

2.4. Determination of Proximate Composition of Breadfruit Wheat Flour Cake

Determination of Ash

A clean platinum basin was heated for 15mins 500 – 550°C in a muffle furnace, and it was cooled in a desiccators containing silica gel. The basin was weighed and about 10ml of sample was transferred into the basin, the basin with the sample was weighed. The sample was evaporated to dryness on a steam bath. The residue was heated slowly over a low Bunsen flame until smoke is no longer giving off. The basin was transferred to muffle furnace and heated 500 – 550°C until the ash is grey. The basin was allowed to cool and the ash was moistened with1ml of water and it was evaporated to dryness. The ash was heated for 1 hour at 500 – 550°C in the muffle furnace; and the process was repeated until the ash was white and completely free from carbon. The basin was allowed to cool in the desiccators after the final heating. The basin with the ash was weighed and the weight of the empty basin was subtracted and the percentage weight of the sample was calculated [24].

Calculation

$$\%\text{ Ash content} = \frac{\text{weight of residue x 100}}{\text{Weight of sample}}.$$

Determination of crude fibre

Method: An accurately weighed quantity (about 3 gm) of the air dried fat free sample was transferred into a litre quick fit conical flask. 200mls of 0.2m sulphuric acid was boiled in 500mls quick conical flask fitted with a reflux condenser. 40mlsof boiling of 0.2m sulphuric acid was then added to the flour containing the sample in the acid. The remaining 160mls of boiling 0.2m sulphuric acid was poured and 2ml antifoam was added. The mixture was boiled in the 1 litre flask for exactly 30 minutes, and the flask was filtered with reflux condenser to maintain constant volume during the 30 minutes boiling period, and the flask was gently shake every few minutes of the 30 minutes boiling period, the acid mixture was allowed to stand for 1 minute and the mixture was poured into a 100mm diameter. No 2 porosity glass sinter funnel that has recently being warmed by running it through hot water. The funnel was connected to the Buchner flask and suction was applied so that the mixture is filtered in less than 10 minutes. The original, flask the funnel was washed and insoluble water was washed until the washings were free from acid. The insoluble matter was then washed back into the original flask by means of a quick bottle containing insoluble matter. The mixture was boiled for 30mins making sure that the constant volume was maintained by using reflux condenser. The mixture was allowed to cool for 1 minute, and it was filtered through 100mm diameter No 2 porosity glass sinter funnel previously used.

The whole of insoluble material from the flask was transferred on to the funnel by means of boiling water; and the insoluble matters was washed with boiling water, then with 1% hydrochloric acid and finally with boiling water until the washings are free from acid. The insoluble residue was washed into a weighed silica crucible [No 4 porosity]. [24].

The sintered silica crucible and content was washed twice with absolute alcohol and three times with diethyl ether. The crucible and content was then heated at 600°C to constant weight. The eight of the ash was subtracted from the weight of the total insoluble material dried at 100°C; and the difference was reported as fiber.

The percentage fiber in the original sample was calculated using the moisture content [24].

Calculation

Crude fiber

= weight of Ash - weight of total insoluble material

$$\text{\% Crude fiber} = \frac{\text{Weight of sample after drying x100}}{\text{Weight of sample after ashing}}.$$

Determination of protein by Kjeldhal method

The percentage protein was determined following the method of Pearson, [25]. An accurately weighed quantity of sample (about 3g) was transferred into a 500ml Pyrexkjeldahl flask. One catalyst tablet and 25ml of sulphuric acid A.R. was added and the flask neck was closed with a glass bulb stopper, then the flask was strongly heated and continuous heating for an hour after the liquid have become clear.

The digest was allowed to cool and washed into 800ml distilled flask, water was added until volume in flask was approximately 500ml then 10 drops of phenolphthalein indicator was added.

The distillation apparatus was connected up with the condenser delivery tube dipping into 100ml of 4% boric acid solution. Approximately 80ml of 50% sodium hydroxide solution was poured through the dropping funnel into the distillation flask the plug in the funnel was replaced and sealed the plug with a few drops of water. The distillation flask was heated at a constant rate until a minimum of 250ml of distillate was being collected. The condenser was washed down and the delivery tube into the boric and acid solution was titrated with 0.5N H_2SO_4 using screened methyl red indicator. Then the result was calculated as percentage nitrogen in the sample, and percentage protein in the sample was calculated. [24]

Calculation

% Nitrogen

$$= \frac{\text{Titre value x normality of Acid x 0.014}}{\text{Weight of sample}} \text{x100.}$$

Moisture determination

The metal dishes and lids was heated for 15 minutes at 105°C and then cooled in desiccators, the dishes and lids were weighed. About 5g of the samples was weighed into the dish, the weight of the dish lids and was recorded. The dish and sample was then transferred into an oven at 105°C for 1 hour 30 minutes. The lid was placed under the dish, and then cooled in desiccators, then the lid was kept on the dish, the dish and the sample was re-heated at 105°C for 30 minutes, re-weighed after cooling and replaced until the weight was constant [25].

Calculation

% moisture content

$$= \frac{\text{weight of sample-weight of residue}}{\text{Weight of sample}} \text{ x 100.}$$

Fat content determination

The method as described by AACC (1995) [26] was used. 0.5g of samples was weighed into a conical flask (100ml) and 25ml of the solvent mixture, chloroform AR or B.P.C 2:1(by volume) was added. The content of the flask are then brought to the boil on an electric hot plate while being stirred with a glass rod and immediately filtered with (What man No, 541 papers) into a glass stopper flask (500ml).

The extraction was repeated with three further 25ml portions of the mixture, and the filter was allowed to drain thoroughly between each extraction. The solvent was distilled from the flask and the flask allowed cooling. Petroleum spirit A.R (40 – 60°C boiling range) 25ml, was then added, followed by 3-5g anhydrous Na_2So_4. The flask was stopped and shaken vigorously for several minutes.

The petroleum spirit extracted was then poured into a stopped tube and allowed to stand. A portion (10ml) was then added into a weighed bottle, and the solvent was removed by evaporation on a warm water- bath, the weighed bottle was heated at 90 – 100°C in an oven for 10 minutes, cooled and weighed. [24]

Calculation

% fat

$$= \frac{\text{weight of flask+extracted fat-weight of flask}}{\text{Weight of sample}} \text{x100.}$$

Carbohydrate determination

The carbohydrate content was calculated by difference.

(% carbohydrate = 100% - %Protein + % Ash + % Crude fibre + % Fat + % Moisture).

2.5. Determination of the Functional Properties of Breadfruit – Wheat Composite Flour

Bulk density (Loose and Packed)

The method of Fasasi et al, [24] was used. Five empty calibrated centrifuge tubes were weighed. The tube was weighed. The tube was gently filled with each sample. The level reached before tapping was noted ad recorded. The bottom of the calibrated centrifuge tube was constantly tapped until there was no further change in the volume. The weight of the tube and its constant was taken and recorded. The weight of sample alone was determined by difference. Bulk density was calculated as follows:

$$\text{B.D. }(\text{gml}) = \frac{\text{Weight of sample}}{\text{Weight of occupies}} = \frac{W_2\text{-}W_1}{W_3}$$

Where W_1=Weight of tube
W_2=Weight of tube and sample
W_3=Volume occupied by sample

Swelling capacity

The swelling power of each sample was determined by Fasasi et al, [27] at 80°C and 90°C. 1g each sample was mixed into 50ml distilled water contaminated in a centrifuge tube. The slurry was mechanically stirred with a stainless steel paddle at a rate just sufficient to keep the flour completely suspended.

The tube with the slurry was gently lowered into a water bath and held at 80°C, 40°C for 15 minutes with slow but continuous stirring to prevent dumping. The centrifuge tube was then removed, wiped dry and weight with it content. The test tube containing the paste was centrifuge at 300 x g for 10 minutes using spectra UK (Merlin 503) centrifuge. The supernatant was decanted after centrifugation and weight of the sediments taken. Thereafter, the moisture content of sediment gel was determined to get the day matter content of the gel.

$$\text{Swelling powder} = \frac{\text{weight of wet mass of sediment}}{\text{Weight of dry matter in gel}}.$$

Water absorption capacity (WAC)

The Water Absorption Capacity was determined at room temperature and at temperatures ranging between 60 to 90°C using a combination of the AACC [24] method.

A 2g sample was dispersed in 20ml of distilled water. The contents were mixed for 30 seconds every 10 minute using a glass rod, and after mixing five times, it was then centrifuged at 4,000g for 20 minutes. The supernatant was carefully decanted and then the contents of the tube were allowed to drain at a 45° angle for 10 minutes and then weighed. The water absorption capacity was expressed as percentage increase of the sample weight.

Oil absorption capacity (OAC)

The method of Fasasi *et al.*, [27] was adopted. 5ml of sorrel oil (0.88g/ml) was added to 1g of each sample in 10ml graduated centrifuge tubes. The mixture was stirred with glass rod to disperse the sample oil. After holding for a period of 30 min, it was centrifuge for 30min at 3500pm. The excess oil absorbed was expressed as the percentage oil bound by 100g sample. The density of the oil was determined by using the specific gravity bottle.

Calculation

$$\text{Oil absorption capacity }(\text{OAC}) = \frac{\text{weight of bond oil}}{\text{Weight of sample}}.$$

2.6. Determination of Pasting Characteristics of Breadfruit –Wheat Composite Flour

The pasting characteristics of flour samples were determined using a rapid visco Analyser.

Sensory evaluation

The method described by Iwe [28] was used for the sensory analysis. The organoleptic properties of the cake made from breadfruit and wheat flour which served as control were tasted by 20 semi-trained panelists randomly selected from the staff and students of Lagos State Polytechnic, Ikorodu campus, Lagos State, Nigeria. All products were put in different coded dishes and served to the panelists. Quality attributes such as appearance, colour, texture, taste, mouth-feel, and general acceptability of the products were scored on a 9-point hedonic scale. The degree of likeness was expressed as follows;

- Like extremely - 9
- Like very much - 8
- Like moderately - 7
- Like slightly - 6
- Neither like nor dislike - 5

3. Results and Discussion

3.1. Proximate Composition of Breadfruit-Wheat Composite Flour Cake

The result on proximate composition of breadfruit-wheat composite flour cake was shown on Table 1. The moisture content ranged from 11.97 – 14.25% with 30% breadfruit cake having the lowest value while 100% wheat flour cake had the highest. Sanni *et al.*, [29] reported that the lower the moisture content of a product to be stored the better the shelf stability of such product. Hence, low moisture ensures higher shelf stability in dried products. The moisture content of a food is indicative of the dry matter in that food. However, low residual moisture content in confectionaries is advantageous in that microbial proliferation is reduced and storage life may be prolonged if stored inside appropriate packaging materials under good environmental condition; cake sample from composite flour containing 30% breadfruit flour has the lowest protein content of 8.36 while 100% wheat flour cake had the highest value 12.50%. The fat content ranged from 3.17 – 7.72% while ash content ranged from 1.26-1.76%. The ash content of a food material could be used as an index of mineral constituent of the food because ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of an oxidizing agent [30]. The crude fibre and carbohydrate contents ranged from 3.93-6.64 and 71.27 – 85.24.

3.2. The Proximate Composition of Wheat and Breadfruit Flour

The proximate composition of wheat and breadfruit flour is presented in Table 2. The protein ranged from 11.46-14.09. 100% breadfruit flour had the lowest protein content of 11.46% while 100% wheat flour had the highest value 14.09% while the crude fibre, fat and ash contents ranged from 10.29-14.91%, 0.56-1.82%, and 2.37-6.49%. The moisture content ranged from 9.78-10.52% with 100% wheat flour having the lowest value while 100% breadfruit flour had the highest value. Sanni *et al.*, [29] reported that the lower the moisture content of a product to be stored the better the shelf stability of such product. Hence, low moisture ensures higher shelf stability in dried products. The moisture content of a food is indicative of the dry matter in that food. The carbohydrate content ranged from 64.28-90.71% with 100% wheat flour having the lowest value while 100% breadfruit flour having the highest value.

3.3. Functional Properties of Breadfruit-Wheat Composite Flour

Table 3 showed the functional properties of breadfruit-wheat composite flour. The functional properties are those parameter that determines the application and use of food material for various food products. The value of bulk density of the flour samples ranged from 0.64-0.82gcm^{-3}. There was no significant difference ($p \leq 0.05$) in bulk density of the composite flour samples with 90:10% wheat-breadfruit flour, 80:20% wheat-breadfruit flour, 70:30% wheat-breadfruit flour, but there was significant difference ($p \leq 0.05$) with 100% wheat flour, 100% breadfruit flour to the other composite flour samples. The bulk density is generally affected by the particle size and density of flour or flour blends and it is very important in determining the packaging requirement, raw material handling and application in wet processing in the food industry [31,32,33]. The values of water absorption capacity ranged from 1.50-3.15%. 100% BF had the highest value while 100%WF having the lowest value. There was no significant difference ($p<0.05$) water absorption capacity of 90:10 WF-BF, 80:20WF-BF, but there was significant different ($p<0.05$) with 100% wheat flour, 100% BF and 70:30 WF:BF to the other composite flour sample. This could be indicative of the fact that addition of breadfruit flour to wheat confers low water binding capacity to wheat flour, which in turn improves the reconstitution ability [33,34] and textural properties of dough obtainable from breadfruit-wheat composite flour. High water absorption capacity is also attributed to lose structure of starch polymers while low value indicates the compactness of the structure [35,36]. The swelling power of flour samples ranged from 5.25-7.85%. There was significant differences ($p \leq 0.05$) in the swelling power of the flour samples. Moorthy and Ramanujam [37] reported that the swelling power of flour granules is an indication of the extent of associative forces within the granules. Swelling power is also related to the water absorption index of the starch-based flour during heating [2]. The oil absorption capacity of flour or flour blends samples ranged from 1.78-2.28%. BF had the highest oil absorption capacity due to less infinity to absorb more oil, whereas 30% BF/WF composite had the lesser oil absorption capacity. There was no significant difference ($p>0.05$) in oil absorption capacity of 100% WF, 90:10 WF/BF, 70:30 WF/BF but there was significant difference ($p<0.05$) with 100% BF, 80:20WF/BF. The higher the oil in the flour the least the affinity to absorb oil. Akubor, [38] report that hydration is required to improve the handling characteristics of baked products.

Table 1. Proximate analysis on cake

Sample	Protein(%)	Fibre(%)	Fat(%)	Ash(%)	Moisture(%)	Carbohydrate(%)
XYZ	12.50±0.14^{e}	6.64±0.06^{c}	7.72±0.34^{e}	1.76±0.11^{c}	14.25±0.50^{d}	71.27±0.40^{a}
PQR	5.81± 0.78^{a}	5.38±0.82^{b}	3.17±0.10^{a}	1.41±0.01^{b}	13.77±0.10^{-cd}	85.24±0.78^{e}
WJC	10.62±0.03^{d}	5.69±0.01^{b}	6.89±0.13^{d}	1.26±0.02^{a}	13.07±0.18^{bc}	75.55±0.20^{b}
LPD	9.31±0.10^{c}	5.25±0.04^{b}	4.92±0.03^{b}	1.31±0.01^{ab}	12.28±0.50^{ab}	79.22±0.10^{c}
FAB	8.36±0.34^{b}	3.93±0.04^{a}	5.45±0.03^{c}	1.39±0.01^{ab}	11.97±0.20^{a}	80.87±0.30^{a}

Means with the same superscript in a column are not significantly different ($P \leq 0.05$) XYZ=Control (100% wheat, cake), PQR = (100% breadfruit cake), WJC = (90% / 10% Breadfruit cake), LPD = (80% wheat / 20% breadfruit cake), FAB= (70% wheat / 30% breadfruit cake).

Table 2. Proximate analysis on composite flour

Sample	Protein (%)	Fibre (%)	Fat (%)	Ash (%)	Moisture (%)	CHO (%)
XYZ	14.09±0.20^{d}	13.32±0.50^{d}	1.82±0.04^{d}	6.49±0.02^{e}	9.78±0.04^{a}	64.28±0.04^{a}
PQR	01.46± 0.03^{a}	04.91±0.10^{a}	0.56±0.02^{a}	2.37±0.01^{a}	10.52±0.05^{d}	90.71±0.13^{e}
WJC	12.87±0.10^{c}	11.42±0.03^{c}	1.49±0.02^{c}	5.70±0.03^{d}	9.85±0.01^{a}	68.52±0.02^{b}
LPD	12.46±0.40^{c}	10.69±0.01^{b}	1.45±0.01^{bc}	4.96±0.00^{c}	10.23±0.04^{b}	70.47±0.40^{c}
FAB	11.82±0.10^{b}	10.29±0.02^{b}	1.39±0.01^{b}	4.18±0.10^{b}	10.36±0.03^{c}	72.33±0.01^{d}

Means with the same superscript in a column are not significantly different ($P>0.05$) XYZ=Control (100% wheat, flour), PQR = (100% breadfruit flour), WJC = (90% / 10% Breadfruit flour), LPD = (80% wheat / 20% breadfruit flour), FAB = (70% wheat / 30% breadfruit flour).

Table 3. Functional properties of wheat and breadfruit flour samples

Sample	Bulk Density (g/ml)	Water Absorption Capacity (%)	Oil Absorption Capacity (%)	Swelling Power (%)
XYZ	0.82±0.01^{c}	1.50±0.01^{a}	1.81±0.01^{a}	5.25±0.01^{a}
PQR	0.64± 0.01^{a}	3.15±0.04^{d}	2.28±0.01^{c}	7.85±0.02^{e}
WJC	0.75±0.01^{b}	1.66±0.00^{b}	1.81±0.01^{a}	5.80±0.03^{c}
LPD	0.75±0.01^{b}	1.63±0.04^{b}	1.89±0.01^{b}	7.22±0.03^{d}
FAB	0.74±0.00^{b}	1.92±0.01^{c}	1.78±0.01^{a}	6.33±0.01^{c}

MEANS ± S.D with the same superscript in a column are not significantly different ($P>0.05$).XYZ=Control (100% wheat, flour), PQR= (100% breadfruit flour), WJC = (90% / 10% Breadfruit flour), LPD = (80% wheat / 20% breadfruit flour), FAB = (70% wheat / 30% breadfruit flour).

3.4. Pasting Properties of Breadfruit-Wheat Composite Flour

Table 4 showed the pasting characteristics of the different breadfruit and wheat flour combinations. Pasting property is one of the most important properties that influence quality and aesthetic considerations in the food industry since they affect texture and digestibility as well as the end use of starch-based food commodities [31,32,33].

Peak viscosity which is an index of the ability of starch-based fruits to swell freely before their physical breakdown [27,38,39] ranged from 1011-1400cp. There was no (Relative Visco-Analyser unit). There was no significant difference($p \leq 0.05$) in peak viscosity of flour and flour blends with 100%WF, 90:10 WF/BF, 80:20 WF/BF, 70:30 WF/BF but there was significant difference ($p<0.05$) with 100BF to the other flour samples. High peak viscosity is an indication of high starch content [39] and this could explain why 100% breadfruit flour had highest peak value compared to other flour samples. Trough is the minimum viscosity value in the constant temperature phase of the RVA pasting profile and it measures the ability of the paste to withstand breakdown during cooling. The values ranged between 396.17-1318 Cp with 100% BF having the highest and 100%WF flour having the lowest value. There was no significant difference ($p>0.05$)in the trough viscosity of the flour samples. The breakdown viscosity (Bv) is a measure of the cooked flour to disintegration. The value ranged between 82.50-546.50. 100% WF had the highest value (546.50Cp) breakdown viscosity while 100% BF had the lowest value (82.50 Cp) breakdown viscosity. This implies that the WF is more stable to heat and mechanical shear than the BF. There was no significant difference ($p \leq 0.05$) in BV of the flour samples with 100%WF, 90:10WF/BF, 80:20WF/BF, 70:30WF/BF but there was significant difference ($p \leq 0.05$) with 100% BF flour to other flour sample. The setback viscosity ranged from 554-988 Cp.There was no significant difference ($p \leq 0.05$) in setback viscosity of the flour samples with 100% wheatflour,90:10WF/BF, 80:20WF/BF, 70:30WF/BF but there was significant difference with 100% breadfruit flour to the other flour samples. The higher the setback viscosity the lower the retrogradation of the flour paste during cooling and the lower the staling rate of the product made from the flour [40]. Final viscosity is commonly used to define the quality of particular starch-based flour, since it indicates the ability of the flour to form a viscous paste after cooking and cooling. It also gives a measure of the resistance of paste to shear force during stirring [31,41,42]. The final viscosity ranged between 1345-2306Cp with 10% breadfruit composite having the lowest value and 100% BF flour having the highest value. Peak time which is a measure of the cooking time ranged between 6.0-7.0mins with 30% breadfruit composite flour having the lowest and 100% BF having the highest value. There was no significant difference ($p \leq 0.05$) in the peak time of the flour samples. Pasting temperature ranged from 81.93-92.08°C. A higher pasting temperature indicate higher water binding capacity, higher gelatinization tendency and lower swelling property of starch-based flour due to high degree of association between starch granules [41,42]. There was no significant difference ($p \leq 0.05$) in the pasting temperature of the flour samples.

The result of the mean sensory scores of quality attributes of the cake samples are given in the Table 5.

Cakes samples (XYZ, PQR, WJC, FAB) are not significantly different ($p>0.05$) while cake sample (LPD) was significantly different from other samples (XYZ, PQR, WJC, FAB) ($P \leq 0.05$) in terms of colour. In terms of aroma, cakes samples (XYZ,WJC, FAB) are not significantly different ($p \leq 0.05$) while cake sample (PQR) is significantly different from samples (XYZ, WJC, FAB) ($P \leq 0.05$).There was significant difference between cake samples (PQR, LPD) and there was significant difference in cake samples (LPD) and (XYZ, WJC, FAB) ($P<0.05$). Cake samples (XYZ, WJC, FAB) are not significantly different ($p \leq 0.05$) while cake sample (PQR) is significantly different from samples(XYZ,WJC,FAB) ($P \leq 0.05$) and there was a significant difference in cake samples (LPD) and (XYZ, WJC, FAB) ($P \leq 0.05$) in terms of taste. In terms of softness, there was no significant difference in the cake samples while cake samples (XYZ, PQR, WJC, FAB) was not significantly different ($p>0.05$), only sample (LPD) was significantly different from cake samples (XYZ, PQR, WJC, FAB) in terms of overall acceptability.

Table 4. Pasting properties on flour

Sample (%)	Peak Viscosity (CP)	TroughViscosity (CP)	Break Down (CP)	Final Viscosity (CP)	Setback Viscosity (CP)	Peak time (min)	Pasting Temp. (^{0}C)
XYZ	1186.50 ± 13.44^{a}	396.17 ± 551.31^{a}	546.50 ± 193.04^{b}	1486.00 ± 24.04^{a}	554.00 ± 230.52^{a}	6.14 ± 551.35^{a}	92.08 ± 0.04^{b}
PQR	1400.50 ± 41.72^{b}	1318.00 ± 38.18^{b}	82.50 ± 3.54^{a}	2306.00 ± 37.98^{b}	988.00 ± 19.80^{b}	7.00 ± 0.00^{a}	81.93 ± 0.60^{a}
WJC	1011.00 ± 7.07^{a}	684.00 ± 7.07^{ab}	327.00 ± 14.14^{b}	1345 ± 2.12^{a}	662.00 ± 5.66^{a}	6.07 ± 0.10^{a}	90.99 ± 0.67^{b}
LPD	1158.00 ± 152.74^{a}	788.50 ± 111.02^{ab}	369.50 ± 41.72^{b}	1501.00 ± 166.88^{a}	712.50 ± 55.86^{a}	6.04 ± 0.05^{a}	86.38 ± 5.76^{ab}
FAB	1036.00 ± 7.07^{a}	707.00 ± 4.24^{ab}	315.50 ± 7.78^{b}	1369.00 ± 9.90^{a}	657.00 ± 12.73^{a}	6.00 ± 0.00^{a}	83.15 ± 1.20^{a}

Mean with the same superscript in a column are not significant different (P>0.05).XYZ=Control (100% wheat, flour),PQR= (100% breadfruit flour), WJC = (90% / 10% Breadfruit flour), LPD = (80% wheat / 20% breadfruit flour), FAB = (70% wheat / 30% breadfruit flour).

Table 5. Sensory evaluation on cake samples

Sample	Colour	Taste	Aroma	Softness	Overall Acceptability
XYZ	7.80 ± 0.90^{b}	7.30 ± 1.30^{d}	7.30 ± 1.50^{b}	8.30 ± 1.03^{b}	7.70 ± 1.35^{b}
PQR	7.10 ± 1.12^{a}	6.40 ± 0.90^{a}	5.80 ± 1.52^{a}	7.40 ± 1.14^{a}	6.80 ± 0.95^{a}
WJC	7.60 ± 0.94^{ab}	7.30 ± 0.97^{b}	7.10 ± 1.53^{b}	8.00 ± 1.10^{ab}	7.70 ± 0.98^{b}
LPD	8.40 ± 0.93^{c}	8.10 ± 1.05^{c}	8.40 ± 0.81^{c}	8.60 ± 0.76^{b}	8.60 ± 0.90^{c}
FAB	7.70 ± 0.80^{ab}	6.80 ± 1.30^{ab}	6.80 ± 1.02^{b}	7.40 ± 1.23^{a}	6.90 ± 1.45^{a}

Mean with the same superscript in a column are not significant different (P>0.05).XYZ=Control (100% wheat, flour),PQR = (100% breadfruit flour), WJC = (90% / 10% Breadfruit flour), LPD = (80% wheat / 20% breadfruit flour), FAB= (70% wheat / 30% breadfruit flour).

All the cakes were generally accepted by the panelists in terms of colour and softness. Generally, the most acceptable cake samples were samples XYZ (100% Wheat flour: 0% Breadfruit flour), WJC (Wheat, 90%: Breadfruit 10%) and LPD (Wheat, 80%: Breadfruit, 20%) were like extremely by the panelists in terms of Taste, Colour, Aroma, Softness and Overall acceptability.

4. Conclusions

Cakes of desirable chemical composition and functional properties comparable to 100% wheat flour cakes have been produced from breadfruit-wheat composite flour. The use of breadfruit in cakes making would greatly enhance the utilization of this crop in sub-Saharan African countries like Nigeria where the crop has not been optimally utilized.

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