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Effect of Jackfruit Pulp Inclusion on the Physicochemical and Sensory Properties of Cake

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Abstract

The study investigated the effect of jackfruit pulp flour on wheat based cake. Cakes were prepared from different blends of wheat and jackfruit pulp flour blends in the ratios of 100:0 (A), 90:10 (B), 80:20 (C), 70:30 (D), 60:40 (E), 50:50(F) and 0:100(G) respectively. The flour blends were analyzed for chemical composition, functional and pasting properties, while cakes prepared from different flour blends were analyzed for proximate, mineral composition and sensory properties using standard methods. Data obtained showed that moisture, ash, crude fiber, crude protein and fat ranged from 10.15-11.41%, 1.75-4.71%, 1.12-2.08%, 3.77-5.85% and 1.30-1.87%, while carbohydrate, sugar, starch, amylose and amylopectin ranged from 74.65-81.35%, 3.85-8.09%, 72.77-80.66%, 25.20-28.94% and 71.06-74.80% respectively. Functional properties of the flour blends showed that loose density, packed density, water absorption, and oil absorption ranged from 0.48-0.57g/ml,0.76-0.82g/ml, 1.30-2.38ml/g, and 0.40-1.74ml/g respectively. Pasting properties showed that peak viscosity values ranged from 2966.50-5183.00RVA, trough 1831.50-3278.00RVA, breakdown 787.00-1135.00RVA, final viscosity 4317.00-4756.50RVA, setback 1428.50-2485.50RVA, peak time 5.67-6.07mins and pasting temperature 64.43-87.68ºC. Proximate composition of cake showed that moisture content ranged from 14.09-18.86%, ash from 1.52-1.88%, crude fiber from 2.39-5.16%, crude protein from 10.82-11.34%, fat from 19.75-20.36% and carbohydrate from 43.02- 50.83%. Mineral composition of the cake for manganese, copper, potassium and phosphorus ranged from 0.56-1.15mg/100g, 0.59-2.19mg/100g, 18.85-25.42mg/100g, 1.01-1.90mg/100g. Sensory evaluation scores for color, taste, flavor, after taste, crispness and overall acceptability ranged from 3.40-4.70, 3.75-4.40, 3.65-4.35, 3.75-4.30, 3.30-4.00 and 3.61-4.26 respectively. The study showed that jackfruit flour inclusion up to 40% was not significantly different from the control (100% wheat) and therefore could be a potential substitute for nutritionally enriched baked products.

Keywords: Jackfruit Pulp; flour; Physicochemical; Sensory; Properties; Cake

Introduction

Wheat is a major cereal crop in many parts of the world, that belongs to the Triticum family of which there are many thousands of species, with T. aestivum subspecies vulgare and the hard wheat Tritcum durum being the most important commercially [1]. It is nutritious, easy to store and transport and can be processed into various types of food. The whole wheat, which includes bran and wheat germ, is milled to leave just the endosperm for white flour, while the by-products of bran and germ are discarded. The loss of vitamins, fibre and minerals in the refined wheat flour has lead to widespread prevalence of constipation and other digestive disturbance [2]. Wheat therefore, is perhaps the most popular energy grain for the production of confectionery products, because of the unique properties of its protein (gluten), which combines strength and elasticity required to produce bread, cookies, cakes and pastries of desirable texture and flavor [3,4].

Cake is one of the relished and palatable baked products prepared from flour, sugar, shortening, baking powder, eggs and vanilla essence as principal ingredients. It is rich in protein, carbohydrate, fat, calcium. Cakes also contained vitamin A, vitamin B1 and vitamin C [5]. Preparation of plain cakes from wheat flour is a conventional practice, however, in tropical countries, wheat production is limited and importation of wheat flour to meet local demand is a necessity [6]. Therefore, the use of composite flour in which locally grown and underutilized crops replaces a portion of wheat flour is common in many developing countries to meet the high demand for functional foods with health benefits as well as decrease the demand for imported wheat and the use of locally grown non-wheat agricultural product [7]. Several studies have been carried out to improve the quality of cake. Khan, et al. [8] evaluated the quality characteristics of composite cake prepared from mixed jackfruit seed flour and wheat flour. Akubor & Ishiwu [9] supplemented cakes with plantain peel flour, while Kiin-Kabari & Eke-Ejiofor [10] produced cakes from composite flours of wheat and plantain flour. Jackfruit (Artocarpus heterophyllus) is among the underutilized fruits in Nigeria which comprises three parts namely; the skin (fibrous portion), pulp (bulbs), and seed embedded in pulps. The pulp of the ripe jackfruit may be eaten fresh or incorporated into fruit salad, the seeds are eaten when boiled or roasted.

Jackfruit has been reported to contain high levels of protein, starch, calcium and vitamin [11]. It is also rich in energy, dietary fiber which makes it a good bulk laxative. The fiber content helps to protect the colon mucous membrane by decreasing exposure time as well as binding to cancer causing chemicals in the colon. The pulp of the jackfruit is considered as a cooling and nutritious tonic.

Jackfruit (Artocarpus heterophyllus) is a crop with great potentials due to its rich nutritive value, as a domestic raw material which has not been fully harnessed; it can be explored with the aim of providing diversification through value addition, reducing malnutrition and hunger. Presently, there are no ready-to-eat jackfruits snacks except the traditionally roasted/boiled seed and fresh pulp consumed as fruit. Therefore, introduction of jackfruit pulp flour into the domestic market will create variety, as well as reduce total dependence on wheat flour in the baking industry. Preparation of flour from jackfruit pulp would reduce post harvest looses, extend the shelf life of the flour and increase its industrial and domestic use, as value addition would contribute to the nutrition and health benefits to consumers. Therefore, the objective of the study is to determine the effect of jackfruit (Artocarpus heterophyllus) pulp inclusion on the physicochemical and sensory properties of wheat based cake.

Materials and Methods

Materials

Jackfruit (Artocarpus heterophyllus Lam), wheat flour, margarine, sugar, baking powder, eggs, and powder milk was purchased from Mile 3 Market, Port Harcourt.

Methods

Processing of Jackfruit Pulp Flour: Jackfruit was processed according to the method described by Haq [12]. The fruits were sorted; firm and matured ones were selected. The jackfruit was cut and seeds removed from the fibrous mesocarp. Sliced jackfruit pulp was cut into 0.1% sodium metabisulphite solution for 3 minutes and then dried at 550C. The dried pulp was milled into flour and stored in air-tight container until required for analysis. The flow chart for the preparation of jackfruit pulp flour is shown in Figure1.

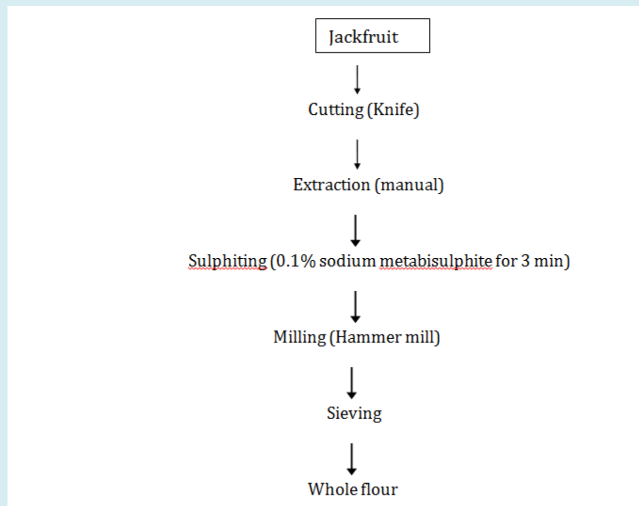

Figure 1: Production of jackfruit pulp flour Source: [12].

Formulation of Flour Blends

Flour consisting of different proportion 10- 50% inclusion of jackfruit to wheat and were blended. 100% wheat flour was used as control. The flours were weighed with a digital weighing balance and mixture together using a blender model Philips, HR1702.

Preparation of Cake- Creaming Method

Cake was prepared by creaming margarine and sugar manually for 15min in a stainless steel bowl until light and fluffy. Eggs were beaten and vanilla essence added to the creamed mixture gradually while beating continuously. Flour blends were sieved and baking powder gradually folded into the mixture and mixed until a soft and consistency batter was formed. The batter was transferred to a six inch greased baking pan and baked in a preheated oven (U Test Malzeme Test Cihazlari) at 2000C for 30min and further 20min at a reduced temperature of 170oC. A skewer was inserted into the cake center to ascertain if it was cooked and allowed to cool for 3min before use for analysis [13].

Chemical properties of Flour Blends and Cake

The moisture content, ash, protein, crude fiber, fat and carbohydrate were determined according to the procedure described by AOAC [14]. Amylose content of samples was determined by the method described by Williams, et al. [15], while amylopectin was calculated by difference as reported by Eke Ejiofor & Bivan [16]. Starch and sugar were determined by the method described by Eke [17].

Functional Analysis

Least gelation concentration was determined by the method of Onwuka [18], dispersibility by the method described by Kulkarni, et al. [19] bulk density was by the method described by Okaka & Potter [20]. Foam capacity was determined according to the method described by Narayana & Narasinga [21]. Solubility and swelling power was determined according to the method described by Takashi & Sieb [22], while the method of Abbey & Ibeh [23] was adopted for determination of water absorption capacity. Determination of Oil Absorption Capacity by the method of Adebowale, et al. [24]. Pasting properties of the flour samples were carried out using a Rapid Visco-Analyser (RVA Model 3c, New Port Science, Sydney) as described by Sanni, et al. [25].

Sensory Evaluation

Coded samples of the cakes were presented to twenty (20) semi trained panelist comprising of students of the Department of Food Science and Technology Rivers State University (RSU), for sensory evaluation. The attributes evaluated include color, taste, flavor, after taste, crispiness and over all acceptability using a 5-point Hedonic scale, with 5= like extremely and 1= dislike extremely according to Iwe [26]. The data obtained were analyzed using analysis of variance while the means were compared using Duncan's multiple range test.

Statistical Analysis

Analyses were done in duplicate and all data obtained subjected to analysis of variance (ANOVA) using statistical package for social science (SPSS), version 20.0 software 2011. Duncan's new multiple range test was used to identify significant difference at 5% probability according to the method described by Wahua [27].

Results

Chemical Composition (%) of Wheat/Jack fruits Pulp Flour Blends

The result of the chemical composition of wheat/ jackfruit pulp flour blends are shown in Table 1. Moisture content ranged from 10.15-11.41%, with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest. Ocheme, et al. [28] reported a lower moisture content ranging between 8.00-9.10% for wheat and groundnut protein concentrate flour blends. The moisture content of the flour blend was within the acceptable limit of not more than 15% for long term storage of flour [29]. The low moisture content of the flour samples would enhance its storage stability by preventing mould growth. Onimawo & Akubor [30] reported that wheat flour with more than 15% moisture content can attract insects, molds and bacteria [31].

The ash and fiber contents of the flour blends ranged between 1.75-4.71% and 1.12-2.08% respectively, with sample G (100% jackfruit flour) having the highest and sample A (100% wheat flour) as the lowest value. The results increased significantly ($p<0.05$) as the level of jackfruit pulp inclusion increased. This result indicate that jackfruit pulp flour contain appreciable amount of mineral than wheat flour. Igbabul, et al. [32] reported ash and fibre content between 1.39-1.57% and 2.16-2.49% for wheat, sweet potato and hamburger bean seed flour blends. Ash content is indicative of the amount of minerals in any food sample and fiber important for digestive health and regular bowel movements.

Sample	Moisture	Ash	Fibre	Protein	Fat	Carbohydrate	Sugar	Starch	Amylose	Amylopectin
A	10.15_{d}	1.45_{d}	1.12_{e}	3.77_{b}	1.87_{a}	81.35_{a}	3.85_{f}	72.77_{d}	25.20_{d}	74.80_{a}
B	10.25_{cd}	2.11_{d}	1.34_{de}	3.79_{b}	1.73_{ab}	80.79_{b}	4.57_{e}	74.09_{cd}	26.59_{c}	73.42_{b}
C	10.49_{cd}	2.23_{cd}	1.49_{d}	3.98_{b}	1.61_{bc}	80.22_{c}	5.10_{d}	75.66_{bcd}	26.99_{bc}	73.01_{c}
D	10.55_{bcd}	2.60_{bcd}	1.52_{cd}	4.08_{b}	1.60_{bc}	79.66_{d}	5.48_{c}	75.87_{bc}	27.16_{b}	72.85_{c}

E	10.71bc	3.14bc	1.78bc	4.16 b	1.46cd	78.77e	5.91 b	78.45ab	28.46 a	71.55 d
F	11.05 ab	3.29b	1.93ab	4.29b	1.39cd	78.06 f	6.05 b	80.44 a	28.54 a	71.46 d
G	11.41a	4.71a	2.08a±	5.85a	1.30d	74.65g	8.09 a	80.66 a	28.94 a	71.06 d

Table 1: Chemical Composition (%) of Wheat/Jackfruit pulp flour blends.
Values are means of duplicate determination ±SD.
Means having the same letter within a column are not significantly different (p<0.05).
key:A= 100% wheat flour:0%jackfruit flour, B= 90% wheat flour: 10% jackfruit flour
C= 80% wheat flour: 20% jackfruit flour, D= 70% wheat flour: 30% jackfruit flour
E= 60% wheat flour: 40% jackfruit flour, F= 50% wheat flour: 50% jackfruit flour G= 0%
Wheat flour: 100% jackfruit flour

Crude protein of the flour blends ranged from 3.77-5.85% with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value. Sample G was significantly (p<0.05) higher than sample A. Igbabul, et al. [32] reported higher protein content between 12.05-15.15% for wheat, sweet potato and hamburger bean seed flour blends.

The crude fat contents of the flour blends ranged between 1.30-1.87%, with sample A (100% wheat flour) having the highest value and sample G (0% wheat flour: 100% jackfruit flour) had the lowest value. The results decreased significantly (p<0.05) as the level of jackfruit pulp flour increase. Khan, et al. [8] reported a decrease in fat which ranged between 1.25-1.32% for wheat flour and jackfruit seed flour. Low fat content obtained as the level of jackfruit pulp flour increased suggests that jackfruit could be incorporated in weight reduction diets. According to Buckman, et al. [33] low fat content in flour reduces the risk of oxidation and rancidity which causes off-flavor

The carbohydrate content as determined by difference method ranged between 74.65-81.35%, with sample A (100% wheat flour) having the highest value. This parameter decreased significantly (p<0.05) as the level of jackfruit pulp inclusion increased. Akubor & Ishiwu [9] also reported a decrease in carbohydrate (62.20-75.30%) for plantain peel and wheat flours.

Sugar content of the flour blends ranged from 3.85-8.09%, with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value. Eke Ejiofor, et al. [34] reported a lower sugar content ranging between 0.50-2.48% for jackfruit seed flour which may be as a result of the different processing method used for the samples.

Starch content of the samples ranged from 72.77-80.66%, with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value.

The results increased significantly (p<0.05) as the level of jackfruit pulp inclusion increased. Juma & Viena [35] also reported higher starch content (72.70-80.68%) for wheat and selected local flours in Philippines. High starch content in flour generally leads to high swelling power, solubility, and water-binding capacity [36]. Flours with high starch content will be more suited for applications where the functionality of starch is crucial.

The amylose content ranged from 25.20-28.94%, with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value. Amylose content was significantly (p<0.05) different with the level of jackfruit inclusion. Aprianita, et al. [37] reported a lower amylose content ranging from 5.59-18.12%, for selected commercial tubers available in Australia The amylose content of the raw material is an important factor with regard to end use properties of the product [38].

Amylopectin content ranged from 71.06-74.80% with sample A (100% wheat flour) having the highest value. This study showed that amylopectin increased with a decrease in amylose, meaning that one is a function of the other and both properties are important in food preparation and development. Amylopectin contributes to high viscosity and waxiness in starch [39]. Chemical composition of flour blends showed that moisture, as, crude fiber, crude protein, sugar, total starch and amylase content increased with an increase in the level of substitution of jackfruit flour inclusion.

Functional Properties of Wheat/Jackfruit Flour Blends

The result of functional properties of wheat/jackfruit pulp flour blends is presented in Table 2. The functional properties of flours play an important role in the manufacturing of products as it determines the application and use of food materials for various food products [40].

Sample	Loose density (g/ml)	Packed density(g/ml)	Water absorption (ml/g)	Oil absorption (ml/g)
A	0.48 ^{d}±0.01	0.76 ^{d}±0.00	1.30^{c}±0.00	1.74 ^{a}±0.33
B	0.49^{cd}±0.00	0.76 ^{cd}±0.01	1.50^{bc}±0.00	0.49^{b}±0.01
C	0.50^{c} ±0.00	0.78 ^{bc}±0.00	1.58 ^{bc}±0.00	0.51 ^{b}±0.12
D	0.50 ^{c}±0.00	0.79 ^{b}±0.01	1.60^{bc}±0.00	0.63 ^{b}±0.03
E	0.53^{b}±0.00	0.80 ^{ab}±0.00	1.61^{bc}±0.00	0.81 ^{b}±0.01
F	0.54 ^{b}±0.00	0.80^{ab}±0.00	1.79 ^{b}±0.09	0.61 ^{b}±0.08
G	0.57 ^{a}±0.00	0.82^{a}±0.01	2.38 ^{a}±0.24	0.40 ^{b}±0.26

Table 2: Functional Properties of Wheat/Jackfruit Flour Blends.
Values are means of duplicate determination ±SD. Means having the same letter within a column are not significantly different ($p<0.05$).
Key: A= 100%wheatflour, B= 90% wheat flour: 10% jackfruit flour,
C= 80% wheat flour: 20% jackfruit flour, D= 70% wheat flour: 30% jackfruit flour,
E= 60% wheat flour: 40% jackfruit flour, F= 50% wheat flour: 50% jackfruit flour
G= 100% jackfruit flour

The value for loose density of wheat/jackfruit flour blend ranged from 0.48-0.57g/ml. with sample A (100% wheat flour) having the lowest loose density and sample G (100% jackfruit flour) having the highest value, while packed density of the flour blends ranged from 0.76-0.82g/ml with sample A and B having the lowest values and sample G (100% jackfruit flour) had the highest value. There were significant different (P<0.05) in the loose and packed densities. The values were comparable with the values (0.56g/ml) reported by Adepeju, et al. [41] for breadfruit flours, when compared to values (0.55- 0.72g/ml) for flour formulated from plantain, pigeon pea and maize flours reported by Ige [42]. The increase in bulk density is an indication that the flour will occupy less space and reduce transportation and packaging cost. Lower bulk density may result in greater oxygen transmission within the packed food and increase the tendency for oxidative rancidity. Bulk density is important in determining packaging requirement, material handling and application in wet processing in the food industries [43].

Water absorption capacity of the flour blends ranged between 1.30- 2.38ml/g with sample A (100% wheat flour) having the lowest water absorption and sample G (100% jackfruit flour) the highest which increased significantly (P <0.05) as the level of jackfruit pulp flour increased. Yetunde, et al. [44] also reported on increase for wheat and cocoyam flour blends. Flour with high water absorption capacity have been reported to be good ingredients in bakery applications as they improve handling characteristics and lead to improved freshness of baked products [45]. Water absorption capacity is the ability of flour to absorb water and swell for improved consistency in food. It is desirable in food systems to improve yield, consistency and give body to the food [46].

Oil absorption capacity of the flour blends ranged between 0. 40- 1.74 ml/g. with sample G (100% jackfruit flour) having the lowest value and sample A (100% wheat flour) as highest. There were significant difference (P <0.05) between sample A (100% wheat flour) and Sample G (100% jackfruit pulp flour). Result of the present study showed that wheat flour had higher oil absorption than jackfruit flour though wheat/jackfruit flour blend had oil absorption increase with an increase in substitution of jackfruit pulp flour. Ocloo, et al. [47] reported oil absorption capacity of 1.7ml/g for flour produced from jackfruits seeds. Values of 1.07- 1.13ml/g were reported for tiger-nut flour [48] while Narayana & Narasinga [21] reported values of 1.2-1.4ml/g for raw winged bean. Eke & Akobundu also reported value of 1.42ml/g for African yam bean. The difference observed could be attributed to the method used as well as the varietal differences.

Pasting Properties of Wheat/Jackfruit Flour Blends

The result of the pasting properties of wheat/jackfruit flour blends are shown in Table 3. Pasting properties are important indices in determining cooking qualities of flours [49]. When starch-based foods are heated in the presence of water, they go through a series of changes involving disruption of molecular order within starch granules, which includes irreversible swelling, loss of birefringence, leaching of amylose and reduced crystallinity. They changes influence quality and aesthetic considerations in the food industry, since they affect texture and digestibility as well as the end use of staple foods [24].

Sample	Peak Viscosity	Trough	Breakdown	Final Viscosity	Setback	Peak Time (min)	Pasting Temp (ºC)
A	2966.50b±183.1	1831.50b ±103.90	1135.00b±79.20	4317.00a ±210.70	2485.50a±106.80	6.00a±0.10	87.68a±0.39
B	2971.0b± 673.2	1865.50b ±430.60	1005.50ab±242.5	4431.50a ±79.90	2116.00ab±267.30	6.07a±0.19	87.50a±0.64
C	2990.50b ±2.10	1869.00b ±17.00	771.50ab±85.60	4454.00a ±182.40	1735.00bc±128.70	6.07a±0.09	87.45a±0.00
D	3766.00b ±18.80	2020.00b ±86.30	746.50ab±33.20	4557.50a ±31.80	1688.00bc±17.00	6.04a±0.05	86.98a±1.38
E	3814.00b ±73.50	2092.00b ±14.1	607.00b±66.50	4609.00a ±24.00	1467.00c±60.80	5.97a±0.14	88.05a±0.00
F	3863.00b ±87.7	2322.00b ±114.60	541.00b±26.90	4682.50a ±112.40	1360.50c±2.10	5.97a±0.14	80.63a±8.10
G	5183.00a ±69.3	3278.00a ±94.80	787.00ab±141.40	4756.50a ±55.90	1428.50c±79.90	5.67a±0.00	64.43b±0.04

Table 3: Pasting Properties (RVU) of Wheat/Jackfruit Flour Blends.
Values are means of duplicate determination ±SD. Means having the same letter within a column are not Significantly different (p<0.05).
Key: A= 100% wheat flour:0% jackfruit flour, B= 90% wheat flour: 10% jackfruit flour, C= 80% wheat flour: 20% jackfruit flour, D= 70% wheat flour: 30% jackfruit flour E= 60% wheat flour: 40% jackfruit flour, F= 50% wheat flour: 50% jackfruit flour G= 0% wheat flour: G=100% jackfruit flour

Peak viscosity ranged from 2966.50-5183.00 (RVU) with sample A (100% wheat flour) as the lowest and sample G (100% jackfruit flour) having the highest value. The peak viscosity of wheat/jackfruit pulp flour blends were not significantly difference (p < 0.05) as the level of jackfruit pulp flour increased. The values in the present study are higher than that (743.50- 4260.50 RVU) reported by Eke Ejiofor, et al. [34] for jack fruit seed flour. Sample G (100%jack fruitpulpflour) exhibited significant (p<0.05) higher peak viscosity when compared to Sample A (100% wheat flour). These values were comparable with the result of Adepeju, et al. [41] for breadfruit flours. The higher peak viscosity of the flour blends might be of amylose to amylopectin and the resistance of its starch granules to swelling. Peak viscosity is indicative of the strength of the pastes which are formed from gelatinization during food processing applications and higher peak viscosity corresponds to a higher thickening power of the starch [50].

Trough viscosity values of the flour blends ranged from 1831.50-3278.00 (RVU) with sample A (100% wheat flour) having the lowest value and sample G (100% jackfruit flour) having the highest value. Trough is the minimum viscosity value in the constant temperature phase of the profiles and measures the ability to withstand breakdown during cooling. Ige [42] reported a lower value for formulated food from plantain, pigeon pea and maize flour.

Breakdown viscosity ranged from 541.00-1135.00 (RVU) with sample F (50% wheat flour:50% jackfruit flour) having the lowest breakdown and sample A (100% wheat flour). Eke–Ejiofor, et al. [34] reported a lower value for jackfruit seed flour. The breakdown viscosity is an index of the stability of starch [51]. The rate of starch breakdown depends on the nature of the material, the temperature, the degree of mixing and shear applied to the mixture [52]. Moorthy & Ramanujam [53] suggested that the cohesiveness of starch is attributed to the breakdown viscosities of starch molecules during heating and stirring.

Final viscosity of flour blends ranged from 4317.00 - 4756.50 (RVU) with sample A (100% wheat flour) having the lowest value and sample G (100% jackfruit flour) having the highest value. Final viscosity indicates the ability of the flour to form viscous paste. The result of the present study showed an increase as the level of jackfruit pulp flour increased. The increase in viscosity which occurs as a result of cooling is mainly due to re-association between starch molecules especially amylose. The result of the final viscosity suggests that the proportion of starch and by extension the amylose content of 100% wheat flour is considerably lower than that of the 100% jackfruit pulp flour.

Setback viscosity ranged from 1428.50-2485.50 (RVU) with G (100% jackfruit flour) having the lowest value and sample A (100% wheat flour) had the highest value. The results of setback viscosity deceased significantly as the level of jackfruit flour increases. Eke [54] also reported that lower set back is an indication that the starch has a low tendency to retrogade or undergo syneresis during a freeze thaw cycle. Set back viscosity is an indication of a stability of cooked paste against retrogadation and can be used to predict the nature of the flour.

Peak time ranged from 5.67-6.07min with sample G (100% jackfruit flour) having the lowest value and sample B and C had the highest value. The peak time is a measure of the cooking time and results were not significantly different (p <0.05) from each other. The present finding is lower than the result of Armonrat & Kamonilip [55], who reported peak time values of 8.70 min and 8.65min for wet and dry milled jackfruit seed flour samples. Pasting temperature ranged from 64.43-87.68 ºC with G (100% jack fruit flour) having the lowest value and sample A (100% wheat flour) had the highest value.

Proximate Composition (%) Of Cake Produced from Wheat/Jackfruit Flour Blend

The result of the proximate composition of cakes prepared from wheat/jackfruit pulp flour blends are shown in Table 4. Moisture content ranged from 14.09-18.86%, with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value. This result may be as a result of the high starch/sugar content of jackfruit pulp which has influence in the water absorption capacity of jackfruit pulp flour in relation to wheat flour. This attribute influenced the ability of the blends to retain water than the wheat flour. Akubor & Ishiwu [9] reported higher moisture content between (29.00-31.00%) for cakes prepared from plantain peel flour and wheat flour blends. Haq, et al. [12] also reported moisture content between 14.88-27.04% for composite fruit cake with whole wheat flour and jackfruit pulp flour. The moisture contents of the cake were progressively increased with increasing level of jackfruit pulp flour. This may also be due to the fibre content in the jackfruit pulp. Berry & Karla [56] mentioned that the jackfruits are normally fibrous and are composed of mono, di, and polysaccharides.

Sample	Moisture	Ash	Fibre	Protein	Fat	Carbohydrate
A	14.09^{d}±0.01	1.52^{d}±0.03	2.39^{d}±0.21	10.82^{b}±0.09	20.36^{a}±0.00	50.83^{a}±0.33
B	14.49^{cd}±0.01	1.58^{d}±0.02	3.03^{cd}±0.64	10.92^{b}±0.04	20.20^{b}±0.06	49.80^{ab}±0.73
C	15.09^{cd}±0.01	1.58^{d}±0.03	3.52^{bc}±0.04	10.92^{b}±0.03	20.01^{c}±0.06	48.89^{ab}±0.11
D	15.20^{cd}±0.09	1.63^{cd}±0.04	3.78^{bc}±0.11	10.94^{b}±0.01	19.88^{cd}±0.04	48.60^{b}±0.28
E	15.54^{c}±0.09	1.72^{bc}±0.06	3.87^{bc}±0.26	11.01^{ab}±0.07	19.80^{d}±0.01	48.07^{b}±0.06
F	17.48^{b}±0.46	1.80^{ab}±0.03	4.18^{ab}±0.09	11.03^{ab}±0.12	19.78^{d}±0.01	45.77^{c}±0.46
G	18.86^{a}±0.77	1.88^{a}±0.02	5.16^{a}±0.07	11.34^{a}±0.14	19.75^{d}±0.03	43.02^{d}±0.99

Table 4: Proximate Composition (%) Of Cake Produced from Wheat/Jackfruit Flour Blend.
Values are means of duplicate determination ±SD. Means having the same letter within a column are not significantly different (p<0.05).
Key: A=100%wheatflour, B= 90% wheat flour: 10% jackfruit flour, C= 80% wheat flour: 20% jackfruit flour, D=70% wheat flour: 30% jackfruit flour, E= 60% wheat flour: 40% jackfruit flour, F= 50% wheat flour: 50%jackfruit flour, G=100% jackfruit flour

Ash values ranged from 1.52-1.88% with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value. The ash content of the cakes in the present result showed that the ash contents of the cakes increased with an increase in the inclusion of jackfruit pulp flour. Hossain, et al. [57] reported an increase in ash content (1.19-1.53%) for cake prepared from wheat flour and jackfruit seed flour blends. Yetunde & Chimela [44] reported ash content between 1.54-1.86% for cakes prepared from wheat-cocoyam flour blends. Ash content indicates mineral matter in food. Increase in ash content indicates that samples with high percentage of ash will be good sources of minerals. The ash content of any food material represents the inorganic materials in the food and these inorganic materials are composed of mineral element, which are important for building rigid structures and regulatory functioning of the body [58].

Crude fibre content of cakes ranged from 2.39-5.16% with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value. The present study showed that fiber content increased with an increase in the inclusion of jackfruit pulp flour, with samples significantly different ($p<0.05$) from one another

Crude protein content of cakes ranged from 10.82-11.34% with sample G (100% jackfruit flour) having the highest value and sample A (100% wheat flour) as the lowest value. The crude protein content of the cakes showed significantly ($p<0.05$) difference as the substitution of jackfruit pulp flour increased. Yetunde & Chimela [44] reported a low protein content (6.61-8.27%) for cakes prepared from wheat-cocoyam flour blends. Research findings have show that both jackfruit pulp flour and jackfruit seeds flour are high in protein.

Crude fat ranged from 19.75-20.36% with sample A (100% wheat flour) having the highest value and sample G (100% jackfruit flour) had the lowest value. The crude fat contents of the cakes decreased from 20.36-19.75%, as the inclusion of jackfruit pulp increased. The result showed a significantly difference ($p<0.05$) existing among the samples. High oil retention improves the mouth feel and retains the flavor of cakes [59].

Carbohydrate content of cakes reduced from 50.83 - 43.02% with sample A (100% wheat flour) having the highest value and sample G (100% jackfruit flour) having the lowest value. The carbohydrate content as determined by difference method reduced with an increase in the inclusion of jackfruit pulp flour with samples showing significant difference ($p<0.05$). Proximate composition result shows that moisture, ash, fiber and protein increased with increase in the substitution of jackfruit pulp flour while fat and carbohydrate decreased, meaning that the end product cake had a good nutritional potential for consumers due to the reduced fat and carbohydrate contents.

Mineral Composition of Cakes Produced from Wheat /Jackfruit FlourBlend

The results of the mineral composition of cakes prepared from wheat/jackfruit flour blends are presented in Table 5. Manganese content ranged from 0.56-1.15mg/100g with sample A (cake made with 100% wheat flour) having the lowest value and sample G (cake made with 100% jackfruit flour) having the highest value. The manganese content showed a significantly difference ($p<0.05$) amongst the cake with content increasing as substitution level increased. Manganese acts as a cofactor for enzymes involved in energy production by the mitochondria [60].

Sample	Manganese	Copper	Potassium	Phosphorus
A	0.56 ^{e}±0.01	0.59 ^{bc}±0.49	18.85^{g}±0.06	1.01^{g}±0.01
B	0.68^{d}±0.00	1.05 ^{bc}±0.01	19.32^{f}±0.11	1.25^{f}±0.01
C	0.72 ^{d}±0.01	1.32 ^{bc}±0.19	20.27^{e}±0.00	1.38^{e}±0.00
D	0.88 ^{c}±0.02	1.25^{bc}±0.07	21.88^{d}±0.00	1.52^{d}±0.00
E	0.94 ^{bc}±0.01	1.51^{ab}±0.01	24.32 ^{b}±0.01	1.77^{c}±0.01
F	1.00 ^{b}±0.03	2.13^{a}±0.03	23.81^{c}±0.01	1.86 ^{b}±0.00
G	1.15^{a}±0.04	2.19^{a}±0.00	25.42^{a}±0.01	1.90^{a}±0.00

Table 5: Mineral Composition (mg/100g) of Cakes Produced from Wheat /Jackfruit Flour Blend.
Values are means of duplicate determination ±SD. Means having the same letter within a column are not significantly different ($p<0.05$).
Key: A= 100%wheatflour, B= 90% wheat flour: 10% jackfruit flour,
C=80%wheatflour: 20%jackfruitflour, D=70%wheatflour:30%jackfruitflour
E= 60% wheat flour: 40% jackfruit flour,
F=50% wheat flour: 50% jackfruit flour
G=100% jackfruit flour

Copper ranged from 0.59-2.19mg/100g with sample A (100% wheat cake) having the lowest value and sample G (100% jackfruit cake) having the highest value. However, jackfruit pulp flour inclusion increased the copper content of the product. Albi & Jayamuthunagai [61] reported a low content (2.20ppm) for jackfruit seed flour and its incorporation on pasta.

Potassium content of cakes ranged from 18.85-25.42mg/100g with sample A (100% wheat cake) having the lowest value and sample G (100% jackfruit cake) having the highest value. Potassium content showed significantly different ($p<0.05$) from each other as the level of substitution increased. Potassium is crucial to heart function and plays a key role in skeletal and smooth muscle contraction, making it important for normal digestive and muscular function.

Phosphorus ranged from 1.01-1.90mg/100g with sample A (100% wheat cake) having the lowest value and sample G (100% jackfruit cake) having the highest value. Result showed that there was significant different ($p<0.05$) in phosphorus between the samples as substitution increased. Phosphorus is needed for bone growth, kidney function and cell growth. The high mineral composition of the cakes shows that jackfruit pulp consumption and value addition could help to mitigate some mineral deficiencies.

Sensory Evaluation of Cakes from Wheat/ Jackfruit Blends

The results of the sensory evaluation of cakes prepared from wheat/ jackfruit flour blends are presented in Table 6. Color indices ranged from 3.40-4.70, on a five point preference scale with sample G (100% jackfruit cake) having the lowest score and sample B (cake made with 90% wheat flour: 10% jackfruit flour) having the highest value. However jackfruit pulp flour inclusion up to 50% was acceptable in term of color and did not significantly different from each other while sample F and G were significant different from other samples.

Samples	Color	Taste	Flavor	After Taste	Overall Accept
A	$4.65^{a}±0.88$	$4.20^{a}±1.07$	$4.10^{a}±1.10$	$4.15^{a}±1.02$	$4.17^{a}±0.90$
B	$4.70^{a}±0.73$	$4.40^{a}±0.68$	$4.35^{a}±0.67$	$4.30^{a}±0.92$	$4.26^{a}±0.86$
C	$4.15^{ab}±0.81$	$4.10^{a}±1.11$	$4.05^{a}±1.37$	$3.90^{a}±0.67$	$3.85^{a}±0.57$
D	$4.05^{ab}±1.19$	$3.90^{a}±1.33$	$4.00^{a}±1.34$	$3.90^{a}±0.97$	$3.89^{a}±0.88$
E	$3.80^{ab}±1.06$	$3.90^{a}±1.02$	$3.85^{a}±1.04$	$3.85^{a}±1.09$	$3.86^{a}±0.95$
F	$3.40^{b}±1.00$	$3.85^{a}±1.42$	$3.70^{a}±1.26$	$3.75^{a}±1.16$	$3.67^{b}±0.86$
G	$3.40^{b}±1.00$	$3.75^{a}±1.16$	$3.65^{a}±1.23$	$3.75^{a}±1.12$	$3.61^{b}±0.99$

Table 6: Sensory Evaluation of Cake Produced from Wheat/Jackfruit Flour Blend
Values are means of duplicate determination ±SD. Means having the same letter within a column are not significantly different ($p<0.05$).
Key:A=100%wheatflour,B= 90% wheat flour: 10% jackfruit flour C=80%wheatflour:20%jackfruitflour,D=70%wheatflour:30%jackfruitflour: E= 60% wheat flour: 40% jackfruit flour, F= 50% wheat flour: 50% jackfruit flour G=100% jackfruit flour.

Taste scores ranged from 3.75-4.40 with sample G (100% jackfruit cake) having the lowest score and sample B (90% wheat flour: 10% jackfruit flour) cake as highest. While after taste scores ranged between 3.75-4.30 with sample G (100% jackfruit cake) having the lowest score and sample B (90% wheat flour: 10% jackfruit flour). Taste is one of the important sensory quality parameters of a food product. Cakes with 10% jackfruit pulp flour scored the highest and most preferred. There was no significant different ($P <0.05$) in flavor, after taste and crispness. As the jackfruit pulp flour inclusion increased acceptance reduced. This result was similar with the result of Khan, et al. [8] of composite cake prepared from mixed jackfruit and wheat flour. The score for flavor ranged between 3.65-4.35 with sample G (100% jackfruit cake) having the lowest score and sample B (90% wheat flour: 10% jackfruit flour).

The score for overall acceptability ranged from 3.61-4.26 with sample G (100% jackfruit flour) having the lowest score and sample B (90% wheat flour: 10% jackfruit flour). Overall acceptability are not significantly different from each other except for sample F and G which are significantly different ($P < 0.05$) from other samples. Hence it can be conducted that 10% level of jackfruit flour blend inclusion was adjudged the best, highest in ranking and sample F and G are significantly ranked the least.

Conclusion

The results of the study revealed that substitution of wheat flour with jackfruit pulp flour increased the ash, protein and fibre contents of cake samples and positively influence the properties of the composite flour blend. It was found that cake produced with 10% jackfruit pulp flour was significantly preferred in most sensory attributes. Therefore, jackfruit pulp flour could be utilized as composite flour for cakes and confectioneries as it would help to improve nutritional composition of food and add value to the underutilized raw material.

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