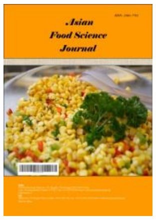

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Characteristics of Coconut (*Cocos nucifera*) Flour and Its Application in Cake

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Authors' contributions

This work was carried out in collaboration among all authors. Author NAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JO and VO managed the analyses of the study. Author JO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of the study was to evaluate the physicochemical, sensory and functional properties of coconut flour (CF), coconut wheat composite flour (CWCF) and Cake produced from CF and CWCF.

Methodology: Flour was prepared from matured ripe coconut fruit (CF). It was then blend with wheat flour (WF) into coconut wheat composite flour (CWCF) to produce cake. The CF and CWCF were subjected to proximate composition and functional properties analyses. Also, the physical properties, proximate composition and the sensory attributes of the cakes produced from CF and CWCF were determined.

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Results: The moisture content of CF and CWCF ranged from 4.5 to 9.04 g/100 g, the ash content of CF and CWCF ranged from 4.10 to 6.41 g/100 g and the dietary fiber content of CF was 11.16 g/100 g. CWCF exhibited a higher (87.1± 0.6) water absorption capacity and packed bulk density (0.79 ± 0.3 g/ mL). In this study, the cake volumes increased significantly ($P < 0.05$) in wheat flour (WF) as compared to CWCF and CF. The specific cake volume observed ranged from 1.48 to 2.01 mL/g. The blend of 50% coconut and 50% wheat flour increased significantly ($P < 0.05$) the moisture content of the CWCF cakes. The total carbohydrate content of the cakes varied from 20.40 ± 0.02 g/ 100 g to 63.05±0.14 g/ 100 g. Fat, ash and crude fiber and minerals (Ca, K, P Zn, Mg and Fe) increased in CWCF cakes. The sensory analysis conducted showed that there was a significant difference ($P < 0.05$) between CF cakes, WF cakes and CWCF cakes in the sensory qualities of appearance, texture, flavour and overall acceptability. In terms of appearance, the panelists scored coconut cake highest, but was significantly different ($P < 0.05$) from coconut wheat cake and wheat one. The least liked sample in terms of texture was wheat one.

Conclusion: The present study underscored the potential application of coconut flour in the production of cake and possibly other bakery products.

Keywords: Coconut; wheat; composite flour; functional properties; cake.

1. INTRODUCTION

Coconut (*Cocos nucifera*) contains higher amounts of dietary fiber (60 g/100 g) and other nutrients [1]. Coconut contains low amount of digestible carbohydrates, and has no gluten [2]. The dietary fiber in coconut has significant health benefits. These include the inhibition of chronic diseases such as cancer, cardiovascular diseases and diabetes mellitus. Also, it has the ability to reduce weight [2].

Coconut has a glycemic lowering effect. Low glycemic index food particularly such containing high dietary-fiber, has been demonstrated to moderate post-prandial blood glucose and insulin responses enhancing blood-glucose and lipid concentrations in humans and patients having diabetes mellitus [1]. Moreover, coconut is known for the production of coconut milk, coconut oil and flour. Coconut flour can be utilized to produce several delicious pies, cookies, cakes, breads, snacks and desserts [2].

The main ingredient used in cake production is wheat flour. However, wheat flour has some shortcomings, especially wheat allergic reactions, celiac disease, and gluten sensitivity, which disturb a higher percentage of people in some populations [3]. The allergic reactions of wheat may be instantaneous or not, depending on the time range within which the food is ingested, and the appearance of the symptoms [4]. Also, the replacement of some proportion of wheat flour with coconut flour may reduce allergic reactions that may be associated with the consumption of bakery products.

In addition, wheat flour has a lower amount of dietary fiber [1]. Besides, substantial amounts of wheat flour are imported from Europe for the bakery industry in Ghana. Hence, the application of coconut flour, which is available locally for the production of cake, will enhance the nutritional value of the cake, and besides its usage in cake production may lead to reduction of wheat importation, and also help to save foreign currency.

Many researchers have studied the possibility of adding natural ingredients to enhance the nutritional qualities of wheat flour for the production of bakery products [5,6,7,8,9]. Thus, adding coconut flour to wheat flour would provide the essential quantities of dietary fiber and other nutrients known to inhibit diet related non-communicable disease. In addition, it can be used to produce food products for individuals who are allergic to gluten.

In this paper, the physicochemical properties of CF and CWCF and its application in cakes were studied. The physical properties of coconut cake (CC), coconut wheat cake (CWC) and wheat cake (WC) were compared.

2. MATERIALS AND METHODS

2.1 Materials

Matured ripe coconut and wheat flour was purchased from Kumasi Central Market in the Ashanti Region of Ghana. Other ingredients such as sugar, salt, margarine (80% fat) and baking soda were bought from a super market in the Kumasi Metropolis in the Ashanti Region of Ghana.

2.2 Methods

2.2.1 Processing of coconut flour and preparation of composite flour

Five hundred grams (500 g) of coconuts were selected. As shown in Fig. 1 the coconuts were de-husked and the liquid drained. The thin layer of brown skin was removed, and the meat cut into smaller pieces using a paring knife. It was then transferred into a liquidizer containing 0.5 L of boiling water and was blended for 5 min, until the pulp was smooth. The milk was separated from the meal using cheesecloth. The meal was washed again in hot (100°C) water to reduce the oil content. The residue obtained was then weighed and dried using Hot Air Oven Dryer (Apex, Royce Ross Ltd) at 60°C until a constant weight was attained. The dried coconut was then milled into flour using plate mill (Quaker City Grinding Co, Model 4-E, Phoenixville, PA). The coconut flour was sieved using a 100 μm mesh sieve. The flour obtained was stored in polyethylene bags at room temperature and was used for the preparation of the cake products. In this study, 100% wheat flour (WF), 100% coconut flour (CF) was used. Also, the composite flour was made by mixing 50% CF and 50% WF. The percentage of the composite flour was chosen on base of preliminary studies.

2.2.2 Physicochemical analyses

2.2.2.1 Moisture determination

Moisture in the flours and the cake samples were determined by employing the methods of [10]. In brief, 5 g of sample was transferred into previously dried and weighed dish. The dish was placed in an oven thermostatically controlled at 105 °C for 5 hours until a constant weight was obtained and weighed after cooling in a desiccator. The percentage of moisture was then calculated using the formula below:

$$\text{Moisture} = \frac{(\text{weight of wet sample} - \text{weight of dry sample})}{\text{weight of wet sample}} \times 100\ [\%] \qquad (1)$$

2.2.2.2 Crude protein determination

Crude protein of the sample flour and cake samples was determined by employing the Kjeldahl method. One gram (1 g) of the sample was placed into the digestion flask. Selenium tablets used as Kjedahl catalyst was added to the sample. Twenty milliliters (20 mL) of concentrated sulphuric acid was mixed with the sample and was fixed to the digester for 8 hours until solution obtained was clear. The cooled digest was placed into 100 mL volumetric flask and made up to the mark with distilled water. The distillation apparatus was set and rinsed for 10 min after boiling. Twenty milliliters (20 mL) of 4% boric acid was pipetted into a conical flask. Five (5) drops of methyl red were added to the flask as an indicator and the sample was diluted with 75 mL distilled water. Ten milliliters (10 mL) of the digest was made alkaline with 20 mL of 20% NaOH and distilled. The steam exit of the distillatory was closed and the change of color of the boric acid solution to green was timed. The mixture was distilled for 15 min. The filtrate was then titrated against 0.1 N HCl. The percentage total was calculated:

$$\text{Protein} = \%\ \text{nitrogen} \times \text{conversion factor}\ (6.25)\ [\%] \qquad (2)$$

2.2.2.3 Crude fat determination

The fat content of the flour cake sample was estimated using the method of [10] using Soxhlet extraction apparatus. In brief, a previously dried (air oven at 100°C) 250 mL round bottom flask was weighed accurately. About 5.0 g of flour sample was weighed to 22 × 80 mm paper thimble. Into the thimble a small of cotton wool was placed to prevent loss of the sample. About 150 mL of petroleum spirit B.P. 40-60°C was added to the round bottom flask and the apparatus assembled. The Soxhlet extractor with condenser connected was refluxed for 6 hours on the heating mantle. After extraction, the thimble was removed and the solvent recovered by distillation. The flask and fat/oil were then heated in an oven at about 103°C to evaporate the solvent. The flask and contents were then transferred into a desiccator to cool. They were then finally weighed and recorded using the formula;

$$\text{Fat} = \frac{(\text{weight of flask} + \text{oil}) - \text{weight of flask}}{\text{weight of sample}} \times 100\ [\%] \qquad (3)$$

2.2.2.4 Ash determination

Ash in the flour and cake sample was estimated by employing the standard method of [10]. In brief, 5 g of flour sample was taken in a weighed crucible and ignited until no charred particles remained in the crucible and then the crucible was put in muffle furnace for 2 hours at about 600°C until the ash was obtained. Thereafter, the crucible was cooled in a desiccator and re-weighed.

$$\text{Ash} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100\ [\%] \qquad (4)$$

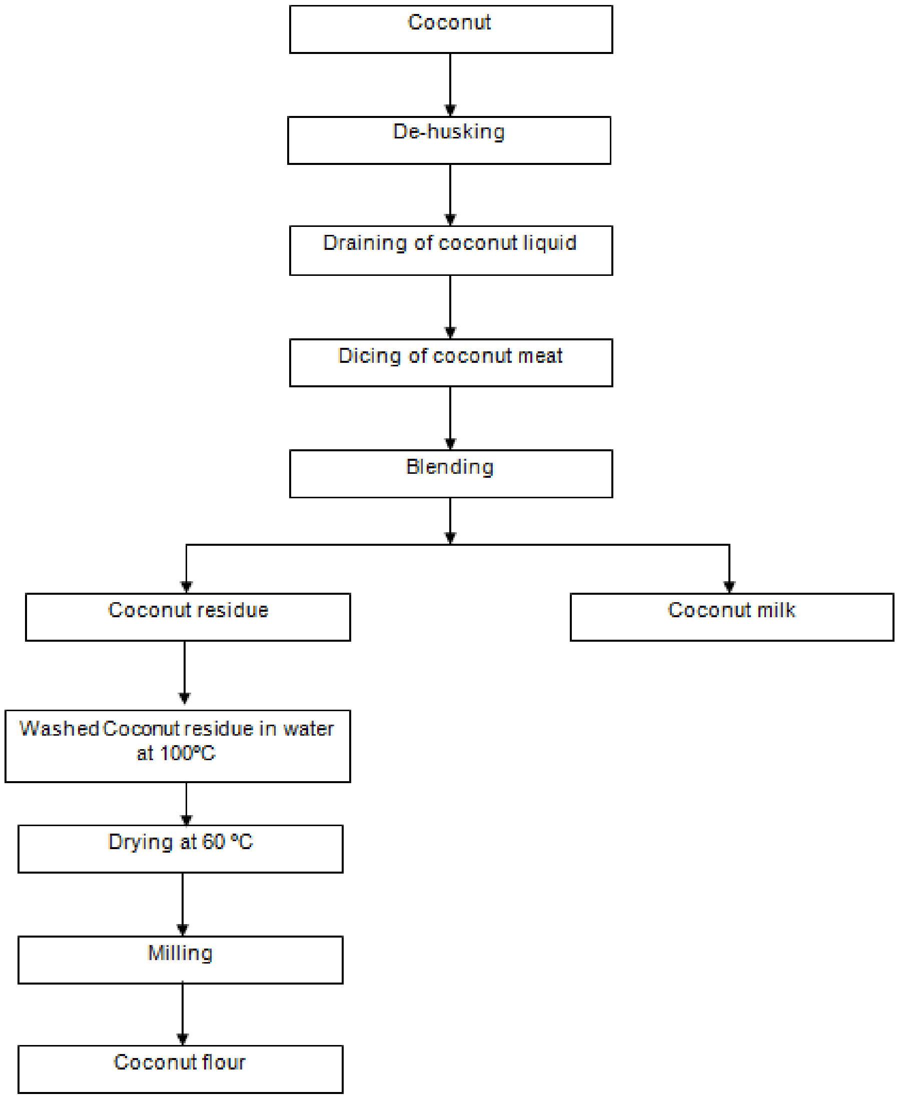

Fig. 1. Flow chart for the production of coconut flour

2.2.2.5 Total carbohydrate determination

The total carbohydrate of the flour and cake samples was determined by differential method [11]. This was achieved by subtracting per cent amounts of crude protein, crude fat, moisture, and ash from 100%.

2.2.2.6 Crude fibre determination

Two grams each of the samples were boiled under reflux for thirty minutes with 200 mL of the solution containing 1.25 g of H_2SO_4 per 100 mL of solution. The solution was filtered through linen on a flaunted funnel and washed with water until the washing is no longer acidic. The residue was then transferred to a beaker and boiled for thirty minutes with 100 mL of solution. The final residue was filtered through a thin—but—closer pad of washed and ignited asbestos in a Gosh crucible. The residue was then dried in an electric oven and weighed; the residue was incinerated, cooled, and weighed.

$$\text{Crude Fiber} = \frac{(\text{Weight of crucible} + \text{Sample}) - (\text{Weight of sample crucible} + \text{Ash})}{\text{Weight of sample}} \times 100\ [\%] \qquad (4)$$

2.2.2.7 Determination of phosphorus content of flour and cake

Phosphorus determination was conducted by the molybdenum blue method [12]. Two grams (2 g) of sample was ashed and 5.0 mL of 5 M H_2SO_4 and 5 mL of 4% molybdate solution (25.0 g/l sodium molybdate in 5 mL H_2SO_4) added in a 100 mL volumetric flask. This was continued by adding 4 mL of 2% ascorbic acid. The mixture was heated until a deep blue colour was developed. Deionised water was added up to 100 mL mark. The absorbance was read at 655 nm using the atomic absorbance spectrophotometer (Perkin Elmer ASS, 5100 PC). A standard curve was drawn by measuring absorbance at 655 nm of standard solutions containing 0.0 mg, 1.0 mg, 2.0 mg, 3.0 mg, 4.0 mg, and 5.0 mg of phosphorus in 100 mL deionised water. The phosphorus content of the flour and cake sample was obtained from the standard curve.

2.2.2.8 Determination of iron, calcium, potassium, zinc and magnesium content

One gram (1.0 g) of flour and cake sample was weighed into dissimilar digestion flasks and 10.0 mL of nitric acid (HNO_3) added to each flask and samples were placed in a fumed chamber overnight. The flasks were again heated in a fumed chamber until production of red nitrogen dioxide (NO_2) fumes terminated. The flasks were cooled and 4.0 mL of 70% perchloric acid ($HClO_4$) added to each flask. The mixture was heated again to evaporate the content to dryness. The content of each flask was quantitatively transferred into a 50 mL volumetric flask and diluted to the mark using deionised water. Absorbance was read using the atomic absorbance spectrophotometer (Perkin Elmer AAS, 5100 PC) against a blank. The wavelengths at which the absorbance was read for iron, zinc, calcium, potassium and magnesium were 248.3 nm, 213.9 nm, 422.7 nm, 766.5 nm and 285.2 nm respectively. The iron, zinc, calcium, potassium and magnesium content in the samples were determined from their respective standard curves prepared from standard solutions of these minerals [12].

2.2.3 Functional properties of coconut flour and coconut-wheat composite flour

2.2.3.1 Bulk density and loose bulk density determination

Bulk Density (BD) of CF and CWCF were determined using the method of [13]. In brief, fifty grams (50 g) of the flour (CF and CWCF) was weighed into 50 mL graduated measuring cylinder. The samples were packed by gently tapping the cylinder on the bench top 10 times from a height of 5 cm. The volume of the sample was then recorded and the bulk density computed using the formula (5) while the loose bulk density was also determined before tapping and was computed using the formula (6).

$$\text{Bulk density} = \frac{\text{Weight of the sample}}{\text{Volume of the sample after tapping}}\ [\text{g/mL}] \qquad (5)$$

$$\text{Loose bulk density} = \frac{\text{Weight of the sample}}{\text{Volume of the sample before tapping}}\ [\text{g/mL}] \qquad (6)$$

2.2.3.2 Determination of water absorption capacity

One gram (1 g) flour of each (CF and CWCF) was weighed separately (and also together with a clean dry centrifuge tube, into which it was placed). Distilled water was mixed with the flour to make up to 10 mL of dispersion. It was then centrifuged at 3500 rpm for 15 min. The supernatant was discarded and the tube with its content re-weighed as gram. The gain in mass was the water absorption capacity of the flour sample [14].

2.2.4 Preparation and baking of cake

In a medium sized bowl, eggs (10 g), coconut milk extract (100 mL); sugar (10 g), salt (2 g), margarine (10 g), nutmeg powder (1 g), and vanilla (2 g) were mixed using a liquidizer. In a separate bowl, coconut flour (200 g), baking powder (10 g) and nutmeg powder (1 g) were combined. The coconut flour was slowly added to the wet ingredients and stirred gently until no lumps remained. The mixture was spooned into a greased 6 x 2 inch loaf pan and baked in a pre-heated electric oven (De'Longhi Kenwood A.P.A Ltd, M0746, Hong Kong) at 180 °C for 30 min until a toothpick inserted in the center comes out clean (approx.30-32 min). The cake samples were allowed to cool for 10 min, which was then packaged in a sealed polyethylene bags and stored at 4°C until analyzed. The same procedure as described above was followed for the production of wheat flour cakes and wheat coconut composite flour cakes [15].

2.2.5 Physical properties of cake

2.2.5.1 Cake weight determination

The weight of the cakes was determined using the method of [16]. Laboratory scale (KERN 95

510 Gott. Kern and Sohn GmbH, D-72458 Albstadt, Germany) was used and readings recorded in grams. Mean weight values were computed for each sample.

2.2.5.2 Cake volume and specific volume

The volume of the cake was measured using the rapeseed displacement method [17]. In brief, a calibrated empty container was filled to the mark with sorghum grains. The container was then emptied and the cake sample placed inside and filled again with the grains. The displaced sorghum was first weighed and then its volume (representing the cake volume) determined using a measuring cylinder. The specific volume was calculated using the formula

$$\text{Specific cake volume} = \frac{\text{Cake volume}}{\text{Cake weight}} \quad [\text{g/mL}] \ (7)$$

2.2.6 Sensory analyses

The cake products were subjected to sensory evaluation using the method of [18]. A total of 50 panelists who are semi-trained partook in the assessment. The parameters assessed included colour, texture, flavour and overall acceptability. The coded samples were served in clean plastic plates at a room temperature in individual booths with satisfactory fluorescent light. Sample presentation to the panelist was random. Panelist were to taste and rate them using a five point hedonic scale (5-like very much, 4-like much, 3-neither like nor dislike, 2-dislike much, and 1-dislike very much).

2.3 Data Analyses

One-way ANOVA was conducted on the samples using the OriginPro version 9.0 (Northampton, USA), and the significance was determined using the Tukey test at $P < 0.05$. The results were expressed as mean and standard deviation (SD).

3. RESULTS AND DISCUSSION

3.1 Chemical Analyses of Coconut Flour and Coconut-wheat Composite Flour

The proximate compositions of CF and CWCF are presented in Table 1. CF had significantly lower moisture than CWCF, which could guarantee a longer shelf-life [19]. Considering the lower moisture content in CWCF it can be used for the production of bakery products, since bakery products ought to have a satisfactory shelf life. Hence, the low moisture content of the CF may extend the shelf life of products produced from CWCF. The ash and the protein contents in CF were significantly ($P < 0.05$) lower than those in CWCF. In addition, a significantly ($P < 0.05$) higher total carbohydrate and crude fiber were present in CWCF than CF. These findings may be as a result of individual contributions of the dietary carbohydrate and dietary fibre from CF and CWCF [1,20].

The mineral contents followed similar trends as observed for CWCF where higher ($P < 0.05$) minerals were recorded comparable to CF. In this study, findings shows that partial substitution of wheat flour by CF increased the protein content of CWCF significantly ($P < 0.05$). Cereal, including wheat protein, lacks lysine, thus substituting wheat flour with CF may increase the lysine content [21,22]. Hence, incorporation of CF into wheat flour may enhance the protein content of CWCF, which can improve the nutritional quality of bakery products that may be from CWCF.

3.2 Functional Properties of Coconut Flour and Coconut-wheat Composite Flour

As depicted in Table 2 the study found that the water absorption capacity (WAC) was higher in CWCF (87.1± 0.6%) as compared to that of the CF (76.1 ± 0.1 %). It has been showed that dough made from composite flour absorbed more water [23,24]. This agrees with the outcome of this present study. The WAC of CWCF is higher than that reported for wheat, maize and cowpea [25]. The differences observed may be as a result of the variation in the protein concentration, their degree of interaction with water and the conformational features of the CF and CWCF [26]. The finding of this study shows that both CF and CWCF can be applied in foods including bakery products, which may need hydration to enhance its handling abilities [20]. This significant increase ($P < 0.05$) in WAC may lead to the production of soft textured cake [26].

The packed bulk density (PBD) of CF and CWCF were studied. PBD is commonly affected by particle size and density of flours, and it is significant in evaluating the packaging requirement, material handling and its application in wet processing [27]. In this study, the PBD of CWCF (0.79 ± 0.3 g/ mL) and of CF (0.56 ± 0.2 g/ mL) was obtained. The higher PBD score of CWCF may offer greater packaging benefit, because greater amount of CWCF can be packed. However, the determination of PBD indicates how the flour particle size can influence the package design. This can also be used to determine the type of packaging material needed within a constant volume. Besides, as reported by [28] higher PBD is desired for better dispensability and a decrease in paste thickness. Furthermore, the higher bulk density observed may be attributed to the presence of more crude fiber in composite flour, which is in agreement with the clarification made by [29].

Report by [30] show that low PBD's of flour demonstrate good physical properties in transportation and storage. Also, the loose bulk density (LBD) in the study shows that CWCF had the highest value (0.64 ± 0.1 g/ mL) comparable to CF 0.35 ± 1.2 g/ mL. The observed differences in this study may be linked to differences in the composition of CWCF and CF, as well as the environmental influences under which the coconut and the wheat were grown. The storage period and the time of harvesting and processing may contribute to the observed variations [11].

3.3 Physical Properties of the Cakes Produced from Coconut-wheat Composite Flour

Table 3 shows the physical properties of the cakes produced from coconut-wheat composite flour. The cake volume for cake sample produced with 100% CF had the least (21.4 ± 0.1 mL) as compared to that of the100% WF (26.3 ± 0.2 mL) and that of 50% CF and 50% WF composite flour (24.3 ± 0.5 mL).The cake volume increased significantly ($P < 0.05$) in WF samples as compared to CWCF samples and that of the CF samples. This finding indicates that the cake volume of CWCF reduced when the cakes were produced from 50% CF and 50% WF. A similar observation was reported in a study where an increase in the percentage of tiger nut in wheat-tiger nut composite flour gave a reduced volume of the bake product [31]. Similarly, in a study lower volumes were recorded for composite flours bake products as opposed to wheat flour bake products [32]. Also, the reduction in wheat structure forming proteins and the decrease ability of the dough to encircle air throughout proofing may have a volume depressing effect on the composite flours bake products [33].

The weight of a cake can be determined by quantity of dough-baked and the amount of moisture and carbon dioxide diffused out of the cake throughout baking. There was a significant difference ($P < 0.05$) between CF cakes, WF and CWCF cakes in terms of the weight. CWCF cakes recorded the highest weight. This may be explained as the decrease in carbon dioxide retention ability in the composite flour dough causing an increase in the weight of the cake. Hence, it can possibly be said that the decrease of wheat flour composition and incorporation of coconut flour contributed to the bulkiness of the flour leading to the high cake weight.

The specific volume observed in this study ranged from 1.48 to 2.01 mL/g (Table 3). However, significant differences ($P < 0.05$) exist among the cake samples. It was realized that, the composite flour of WF recorded a higher cake specific volume as compared with those produced from only coconut flour and CWCF. A study has revealed that gluten-free flour when combined with wheat flour weakens the gluten network formed during the mixing and kneading of the dough [34], which may cause the specific volume of the cake to decrease as compared to that of the control [15]. In general, increased volume produces profit for the bakery industry while increased in weight of bakery products is more appreciated by the consumers because it gives consumers satisfaction. This is because consumers are often enthralled with bakery products having high-rise weight and volume. The specific volume of bakery products, which designates the ratio of two properties, has been accepted as a reliable measure of the size of bakery products.

3.4 Chemical Composition of the Cakes

The chemical composition of the cakes is presented in Table 4. The CC containing only coconut flour had moisture content of 10.01 ± 0.01 g/100 g as compared to that of WC. However, the blend of 50% coconut and 50% wheat flour increased significantly ($P < 0.05$) the moisture content of the CWC. This may be due to the high fiber concentration, which probably cause significant increase in water absorption capacity of the CWC. A similar result was reported on adding diverse concentrations of coconut flour in the preparation of cake where the moisture content increased [35]. Similarly, the fat, ash and crude fiber and minerals (Ca, K, P Zn, Mg and Fe) increased in CWC. This is might be due to the coconut flour containing protein, fat, ash, minerals and crude fiber. Therefore, blending wheat flour with coconut flour may probably increase the nutritional value of the CWC comparable to CC and WC. However, the total carbohydrate content of the cakes varied from 20.40 ± 0.02 g/ 100 g to 63.05 ± 0.14 g/ 100 g with CWC being highest, whiles the lowest was WC (Table 4). The total carbohydrate content (63%) of the CWC was significantly higher than those reported for coconut wheat cookies with 10%, 20% and 30% coconut flour incorporation [35]. The dissimilarity in the carbohydrate contents among the cake samples may be due to the difference in protein, fat, ash and moisture content.

3.5 Sensory Evaluation of the Cake Products

The mean scores of the sensory attributes of the various cake samples are presented in Table 5. In terms of colour, the panelists scored sample coconut cake highest, but were significantly different ($P < 0.05$) from coconut wheat cake and wheat cake. The least liked sample in terms of texture was wheat cake. However, the score for texture was higher in coconut wheat cake. The dietary fiber in coconut wheat cake may have increased the water absorption capacity, which might cause coconut wheat cake to be softer and provided mouth-feel. This may also contribute to coconut wheat cake being the most preferred cake product in terms of its taste. Besides, the distinctive taste of coconut wheat cake may be attributed to the fact that CWCF has a distinctive nutrient and fiber composition. Moreover, it was realized that coconut cake was the second most favored product.

Table 1. Proximate composition of flours

Chemical component (DW)	CF	CWCF
Moisture (g/100 g)	4.50 ± 0.12^a	9.04 ± 0.02^b
Ash (g/100 g)	4.10 ± 0.15^a	6.41 ± 0.10^b
Protein (g/100 g)	19.11 ± 0.02^a	21.5 ± 0.03^b
Carbohydrate (g/100 g)	49.80 ± 0.18^a	84.7 ± 0.05^b
Crude fiber (g/100 g)	11.16 ± 0.21^a	17.3 ± 0.08^b
Fat (g/100 g)	10.70 ± 0.01^a	11.0 ± 0.51^b
Minerals		
- Ca (mg/g)	0.31 ± 0.03^a	0.42 ± 0.14^b
- K (mg/g)	0.40 ± 0.06^a	0.75 ± 0.25^b
- Zn (mg/g)	0.32 ± 0.02^a	0.88 ± 0.21^b
- P (mg/g)	0.41 ± 0.04^a	0.67 ± 0.43^b
- Mg (mg/g)	0.04 ± 0.01^a	0.34 ± 0.34^b
- Fe (mg/g)	0.10 ± 0.46^a	0.57 ± 0.12^b

^{a,b} Different letters, Means within rows are significantly different (P < 0.05); coconut flour (CF); 50:50% wt. coconut-wheat composite flour; Dry weight (DW)

Table 2. Functional properties of CF and CWCF

Functional properties	CF	CWCF
WAC (%)	76.10 ± 0.1^a	87.14 ± 0.6^b
BD (g/ mL)	0.56 ± 0.2^a	0.79 ± 0.3^b
LBD (g/ mL)	0.35 ±1.2^a	0.64 ± 0.1^b

$^{a-b}$Different letters, Means within rows are significantly different (P < 0.05); Coconut flour (CF); Coconut-wheat composite flour (CWCF) ; Water absorption capacity (WAC); Loose bulk density (LBD);Bulk density(BD)

Table 3. Physical properties the cakes produced from CF, WF and CWCF

Properties	CF	WF	CWCF
Cake volume (mL)	21.40 ± 0.10^b	26.29 ± 0.23^a	24.25 ± 0. 51^c
Cake weight (g)	14.45 ± 0.15^b	13.08 ± 0.26^a	16.12 ± 0.12^c
Specific cake volume (mL/g)	1.48 ± 0.31^b	2.01 ± 0.12^a	1.51± 0.11^c

^{a,b,c} Different letters, Means within rows are significantly different (P < 0.05); coconut flour (CF); coconut-wheat composite flour (CWCF); wheat flour (WF)

Table 4. Proximate composition of cake produced from CF, WF and CWCF

Chemical component (DW)	CC	WC	CWC
Moisture (g/100 g)	10.01 ± 0.01[a]	4.13 ± 0.20[b]	12.5 ± 0.03[c]
Ash (g/100 g)	2.30 ± 0.15[a]	0.91 ± 0.01[b]	1.95 ± 0.10[c]
Protein (g/100 g)	16.30 ± 0.07[a]	11.13 ± 0.13[b]	19.40 ± 0.29[c]
Carbohydrate (g/100 g)	20.40 ± 0.02[a]	52.74 ± 1.11[b]	63.05 ± 0.14[c]
Crude fiber (g/100 g)	10.14 ± 0.16[a]	6.50 ± 0.02[b]	15.80 ± 0.21[c]
Fat (g/100 g)	12.17 ± 0.08[a]	9.01 ± 0.18[b]	29.14 ± 0.41[c]
Minerals			
- Ca (mg/g)	0.15 ± 0.11[a]	0.03 ± 0.00[b]	0.18 ± 0.04[c]
- K (mg/g)	0.24 ± 0.10[a]	0.05 ± 0.01[b]	0.21 ± 0.01[c]
- Zn (mg/g)	0.22 ± 0.11[a]	0.10 ± 0.02[b]	0.24 ± 0.06[c]
- P (mg/g)	0.30 ± 0.15[a]	0.21 ± 0.03[b]	0.43 ± 0.12[c]
- Mg (mg/g)	0.03 ± 0.01[a]	0.01 ± 0.00[b]	0.03 ± 0.01[c]
- Fe (mg/g)	0.05 ± 0.02[a]	0.02 ± 0.01[b]	0.05 ± 0.02[c]

[a-c] different letters, means within rows are significantly different ($p < 0.05$); coconut cake (cc); wheat cake (wc); coconut wheat cake (cwc); coconut flour (cf); 50:50% wt. coconut-wheat composite flour; dry weight (dw)

Table 5. Sensory attributes

Cake Type	Appearance	Texture	Flavour	Overall Acceptability
CC	4.46 ± 0.05[a]	4.38 ± 0.65[a]	4.38 ± 0.23[a]	4.12 ± 0.21[a]
CWC	4.00 ± 0.23[b]	4.42 ± 0.08[b]	3.40 ± 0.55[b]	4.60 ± 0.11[c]
WC	3.16 ± 0.51[c]	3.28 ± 0.13[c]	3.05 ± 0.13[c]	3.20 ± 0.148[c]

[a-c] Different letters, within columns are significantly different ($P < 0.05$); Coconut cake (CC); coconut wheat cake(CWC); wheat cake (WC)

4. CONCLUSION

Coconut flour and coconut wheat flour were prepared evaluated in cake making. The CFWF recorded higher dietary fibre content than CF. Similar trends was observed for the ash, minerals protein, carbohydrates and fat contents of the composite flour. Also; CFWF showed better functional properties than that of CF. the results of the study have shown that CFWF and CF are suitable for cake making. The cake formulated with 50% CF and 50% WF scored higher for its textural attributes, and had the overall acceptability score, which is significantly higher than that of cakes made from composite flour and coconut flour. However, CF appears to be promising in bakery products, and it may be a better alternative for wheat flour in product preparation. The application of coconut flour as a functional food in food products may prevent the prevailing chronic diseases, and also inspire the food industry to produce value-added products from coconut flour. This will lead to increment in the production of coconut and promotion of the coconut industry.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Trinadad T, Masa D, Encabo R, Chua M, Maglaya A, Castillo J, Loyola A. Dietary fiber from coconut flour: A functional food. Innovative Food Science and Emerging Technology. 2006;309-317.
2. Ramaswamy L. Coconut flour: A low carbohydrate, gluten free flour. International Journal of Ayurvedic and Herbal Medicine. 2014;1426-1436.
3. Pereira B, Venter C, Grundy J, Clayton CB, Arshad SH, Dean T. Prevalence of sensitization to food allergens, reported adverse reaction to foods, food avoidance, and food hypersensitivity among teenagers. Journal of Allergy and Clinical Immunology. 2005;122(5):984–91.
4. Jacqueline B. Marcus. Culinary nutrition: The science and practice of healthy cooking. 1st ed. USA: Academic Press; 2013.
5. Becker R. Preparation, composition and nutritional implications of amaranth seed oil. Cereal Foods World. 1989;34:950–953.
6. Welch RW, Haferfür die menshliche Ernährung imvereing ten Königsreich. Getr. MehlBrot. German. 1991;45:89–92.

7. Giami SY, Mepba HD, Kiin-kabari DB, Achinewhu SC. Evaluation of the nutritional quality of breads prepared from wheat-fluted pumpkin (*Telfairia occidentalis* Hook) seed flour blends. Plant Foods for Human Nutrition. 2003;1–8.
8. Klava D. Improvement of nutritive value of wheat bread. Doctoral Dissertation. Faculty of Food Technology, University of Agriculture, Jelgava, Latvia; 2004.
9. Bodroza-Solarov M, Bojana Filipcev, Zarko Kevresan, Anamarija Mandic, Olivera Simurina. Quality of bread supplemented with popped *Amaranthus Cruentus* grain. Journal of Food Process Engineering. 2008;602-618.
10. AOAC Official method of Analysis. 18th ed. Association of Officiating Analytical Chemists, Washington DC, Method 935.14 and 992. 24; 2005.
11. Ihekoronye AI. Ngoddy PO. Integrated food Science and technology for the tropics. 1st ed. London: Macmillan Press; 1985
12. Engmann FN, Afoakwah AN, Owusu PD, Sefah W. Proximate and mineral composition of snail (*Achatina achatina*) meat; any nutritional justification for acclaimed health benefits? Journal of Basic and Applied Scientific Research. 2013;8-15.
13. Appiah F, Asibuo JY, Kumah P. Physical and functional properties of bean flours of three cowpea (*Vigna unguiculata* L. walp) varieties in Ghana. African Journal of Food Science. 2011;100-104.
14. Moorthy SN, Rickard J, Blanshard JMV. Influence of gelatinization characteristics of cassava starch and flour on the textural properties of some food products In: Dufour O'Brien editor. Cassava flour and starch: Progress in research and development, Best ed. Colombia: CIAT Publications; 1996.
15. Tanya SNC. Development of high fibre cake using gram flour International Journal of Information Research and Review. 2016;2513-2515.
16. Malomo SA, Eleginmi AF, Fashakin JB. Chemical composition, rheological properties and bread making potential of composite flours from bread fruit, breads and wheat. African. Journal of Food Science. 2011;400-410.
17. Maeda KC, Cereda MP. Avaliacao de duasmetodologias de expansaoaoforno do polvilhoazedo. Ciência e Tecnologia de Alimentos. 2001;139-43.
18. Larmond E. Laboratory methods for sensory evaluation of foods, publication No. 1637, Canada Department of Agriculture, Ottawa; 1977.
19. Singh A, Hung Y, Corredig M, Phillips RD, Chinnan MS, McWatters KH. Effect of milling method on selected physical and functional properties of cowpea (*Vigna unguiculata*) paste. International Journal of Food Science and Technology. 2005; 525-536.
20. Oppong D, Arthur E, Osei SK, Badu E, Sakyi P. Proximate composition and some functional properties of soft wheat flour. International Journal of Innovative Research in Science, Engineering and Technology. 2015;753-758.
21. Bressani R, Wilson DL, Behar M, Scrimshaw NS. Supplementation of cereal protein with amino acids, 111. Effect of amino acid supplementation of wheat flour. Journal of Nutrition, American Society of Nutrition. 1960;176-186.
22. Barrett DM, Somogyi L, Ramaswamy H. Processing fruits: Science and technology, 2nd ed. Florida: CRC Press; 2005.
23. Morita NT, Miyazaki M, Yamamori M, Miura H. Dough and baking properties of high amylase and waxy wheat flours. Cereal Chemistry. 2002;491–495.
24. Mbofung CMF, Abuobakar YN, Njintang A, Abduo B, Balaam F. Physico-chemical and functional properties of six varieties of Taro (*Colocasia esculenta* L. *schott*) flour. Journal of Food Technology 2006;135-142.
25. Owen G. Cereal Processing Technology. Cambridge: Wood head Publishing; 2001
26. Lakshmi M, Swarnali DM, Usha R. Development and analysis of composite flour bread Journal of Food Science and Technology. 2015;4156–4165.
27. Karuna D, Noel G, Dilip K. Production and use of raw potato flour in Mauritian traditional foods. Food and Nutrition Bulletin United Nation University. 1996; 162–168.
28. Udensi A, Eke O. Proximate composition and functional properties of flour produced from *Mucuna cochinensis* and Mucunautles. In Proceedings of the 1st Annual Conference of the College of Agriculture and Veterinary Medicine, Abia State University. 2000;170–174.

29. Singh N, Singh B, Sandhu KS, Bawa AS, Sekhon KS. Extrusion behaviour of wheat, rice and potato blends. Journal of Food Science Technology. 1996;291–294.
30. Agunbi SO, Sanni MO. The effect of ambient storage of cassava tubers on starch quality. In Root Crops. The small processor and development of local food industries for market economy. Proceedings of the Eight Triennial Symposium of the International Society for Tropical Root Crops. African Branch (ISTRC-AB), IITA Ibadan, Nigeria. 2001; 12–16.
31. Ade-Omowaye BIO, Akinwande BA, Bolarinwa IF, Adebiyi AO. Evaluation of tigernut (*Cyperus esculentus*) – Wheat composite flour and bread. African Journal of Food Science. 2008;087-091.
32. Aluko RE, Olugbemi LB. Sorghum as a raw material in the baking industry. In Symposium on the current status and potential of industrial uses of Sorghum in Nigeria, Kano (Nigeria) ICRISAT; 1989.
33. Akobundu ENT, Ubbaonu CN, Ndupuh CE. Studies on the baking potentials on non-wheat composite flours. Journal of Food Science and Technology. 1988;211–214.
34. Taha AOM. The role of sorghum flours starches (amylose/ amylopectin) in composite bread quality. MSc. Thesis. University of Khartoum, Sudan; 2000.
35. Shakhawat H, Mohammad RIS, Saifullah Md, Shahidullah KSWT, Afzal R. Md, Shams-Ud-Din. Incorporation of coconut flour in plain cake and investigation of the effect of sugar and baking powder on its baking quality. International Journal of Nutrition and Food Sciences. 2016;31-38.

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