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Proximate Composition of Snacks Produced from Pigeon Pea (*Cajanus cajan*) and Sorghum (*Sorghum bicolor*) Flour Blends for Household Consumption

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Abstract

The study evaluated proximate composition of queen cakes, biscuits and chin chin produced from pigeon pea and sorghum flour blends. It was an experimental study. Composite flour was formulated by blending pigeon pea and sorghum flour in ratios of 4:1, 1:1, and 3:2, respectively using 100 percent wheat flour as control. Proximate composition was determined using AOAC standard methods. Data were analyzed using means and standard deviation. Findings show significant variations in nutritional makeup of the snack samples. Protein composition of queen cake ranged from 6.94% to 9.71%, while carbohydrate quantity varied significantly from 51.06% to 58.31%. Protein content of biscuits ranged from 6.81% to 8.63%, whereas biscuits made with 100% wheat flour had highest moisture content at 9.19%. A mix of 60% pigeon pea and 40% sorghum had highest ash content at 2.36%, while the control biscuit sample had highest carbohydrate content at 69.50%. Moisture content of ***chin-chin*** ranged from 4.75% to 6.89%. Sample with highest protein content, 8.63%, was B, made with 80% pigeon pea and 20% sorghum. The 50% pigeon pea and 50% sorghum blend had highest carbohydrate level, while fat content varied between 8.15% and 20.48%. Sample D, made from 60% pigeon pea and 40% sorghum, had highest ash concentration across all evaluated snacks.

Keywords: Snacks, Pigeon Pea, Sorghum, Proximate, Composition, Flour, Blend.

Introduction

Snacks are small, quick meals eaten between meals to maintain health while satisfying appetite (Anozie *et al*., 2014). Snacks are ready-to-eat food, raw or cooked hot or chilled, but usually ready for immediate consumption at the point of sale without further treatment (Apata & Joseph, 2023). Most tropical countries face protein energy malnutrition due to the increasing population and enhanced dependence on cereal and tuber-based diets (Anozie *et al*., 2014). Similarly, promoting optimal health and the sustainable well-being of individuals through consuming nutritional and adequate snacks has become a major global discussion (Nwakanma, 2023). Snacks are consumed frequently and are seen as a major means of providing consumers with good dietary habits, it can be produced by roasting, baking, frying, or extrusion (Nawaz *et al*., 2019). Snacks that are commonly consumed in Nigeria include queen cake, biscuits, *chin-chin*, meat pies, buns, egg rolls, doughnuts, puff-puff (deep-fried dough balls), and samosa, among others.

Asomugha *et al*., (2017) emphasized that an adequate food intake in terms of quality and quantity is crucial for a healthy and productive life. This has led to major attention being drawn to the nutritional quality of snack products, which may not meet the requirements of nutrient balance. Adding nutrient-dense plant components to food formulations is one promising strategy for improving foods' nutritional profiles and fostering well-being (Ravindran, 2018). Snacks can be made from varied food items like millet, rice, pigeon peas, African yam beans, sorghum, and kidney beans, among others.

Pigeon pea (*Cajanus cajan*) is one of the important leguminous foods found in Nigeria. It is rich in protein (19 to 20%) and minerals (Adeola *et al*., 2017). Pigeon pea is ranked sixth globally after pea, broad beans, lentils, chickpeas, and common beans. It is called *fio-fio* in Abia State. The colors of the seeds are gray, white, cream, brown, black, or motted. Its cultivation dates back to 3000 years ago in Asia and other countries. The nutritional components of pigeon pea (*Cajanus cajan*) are considered crucial for human nutrition when compared to other legumes and pulses like African yam beans, cowpeas, soya beans, and kidney beans. It has been reported to possess high anti-nutritional factors, strong biological, pharmacological activities, including anti-diabetic, anti-inflammatory, and antioxidant (Telari & Devindra 2018; Oluwole et al., 2021).

Similarly, sorghum (*Sorghum bicolor)* is the fifth major significant cereal in the world. It has 95% to 98% of the nutritional value of maize, the vitamin content for maize is similar to sorghum except that sorghum has a higher mineral content than maize showing that it can be successfully used in food fortification (Balota, 2012). Nigeria is the third largest processor of sorghum after united states and India and the third largest producer in Africa (Nwakalor & Obi, 2014). Sorghum shows greater resistance to drought than wheat and maize. It is the largest staple cereal crop accounting for 50% of the total output and occupying about 45% of the total land area devoted to cereal crop production in Nigeria (FAO, 2019). Legume fortification of cereals has been attempted to create more palatable and nutritious products in varying forms and this includes fortification of snacks like biscuits, cakes, *chin-chin* among others.

Queen cakes are convenient food products that are sweet, often baked, and prepared from flour, sugar, shortening, egg, baking powder, and other ingredients (Olatunde *et al*., 2019) It can be produced from either creaming method, whisking method, melting method and rubbing in method.

Similarly, biscuits is an unleavened crispy, sweet pastry produced from wheat flour, shortening, and sugar with the addition of baking powder (Adebo, 2020). They are ready-to-eat baked nutritive snacks consumed by all age groups in different parts of the world (Adebo, 2020, Arukwe, 2023).

Chin-chin is also a popular traditional Nigerian crunchy snack prepared using wheat flour, butter, milk, and eggs. It is deep fried until golden brown and a crispy texture is achieved (Adebayo *et al*., 2017, Apata & Joseph, 2023). Chin chin is an ideal light refreshment snack that can be stored adequately in air-tight containers. Its wide acceptance has promoted commercial production and marketing of the product by entrepreneurs. The concept of using composite flour in the production of food products is not new and has been subject to numerous studies and recommendations (Ezeocha, *et al.,* 2022, Arukwe *et al*., 2023).

To improve the nutritional contents of snacks consumed in households, there is a need for diversification of snacks produced from pigeon peas and sorghum. Assessing the proximate composition of these snacks is vital to comprehend their nutritional contributions, especially in light of the increasing preference for healthier dietary options.

Purpose of the Study

The study analyzed proximate composition of snacks produced from pigeon pea (*Cajanus cajan*) and sorghum (*Sorghum bicolor*) flour blends for household consumption.

Specifically, it determined the proximate composition of:

1. queen cakes produced with pigeon pea and sorghum flour blends.
2. biscuits produced with pigeon pea and sorghum flour blends.
3. chin chin produced with pigeon pea and sorghum flour blends.

Materials and Methods

***Design of the Study*:** The study employed a laboratory-based experimental design

***Sources of raw Materials*:** Matured dry seeds of pigeon pea and sorghum grains, wheat grains used as control and bakery ingredients including sugar, margarine, eggs, baking powder, milk, flavorings, salt and nutmeg were purchased from Orie Ugba market in Umuahia Abia state, Nigeria. All equipment, reagents and chemicals that were used for the proximate analysis were obtained from the Food Science Laboratory College of Applied Food Science and Tourism, Michael Okpara University of Agriculture Umudike (MOUAU).

***Sample Preparation*:** Samples for experiment were prepared as follows:

Pigeon Pea Flour: Matured dry pigeon pea seeds were sorted to remove contaminants, soaked for 24 hours, dehulled by rubbing, and washed thoroughly to remove the seed coat. The dehulled seeds were oven-dried at 60°C for 24 hours, then milled using a Nutri-blender and sieved with a US 70 (180 µm) sieve. The resulting flour was stored in an airtight polyethylene bag at 37°C until used for making cakes, biscuits, and chin-chin.

Sorghum Flour: The following procedures were used for the processing of sorghum grains into flour. Sorghum grains were thoroughly sorted to remove impurities, washed severally, drained with colander before being dried for four hours at 50 to 55°C using hot air. To reach the required particle size, the dry grains were ground in a commercial hammer mill and then sieved through a US 70 (180 µm) sieve. The resultant flour was kept at room temperature in an airtight container.

Wheat Flour (control): The method described by Bello *et al*., (2020) was used in the processing of wheat flour. The wheat grains were weighed, sorted out to remove contaminants, washed with tap water, drained, and oven-dried at 60^{0}C for 20 hours. The dried wheat grains were milled into flour with a hammer mill at the food science lab (MOUAU), sieved through 150 µm mesh, packaged in air-tight Ziploc bag, and kept for further use.

Formulation of Composite Flour

Composite Flours (Control)	Ratio	Code		
		Cake	Biscuit	Chin chin
100% Wheat flour	1	QCA	BSA	CHA
80%Pigeon Pea flour and 20% Sorghum flour	4:1	QCB	BSB	CHB
50% Pigeon pea flour and 50% Sorghum flour	1:1	QCC	BSC	CHC
60% Pigeon pea flour and 40% Sorghum flour	3:2	QCD	BSD	CHD

Recipe of snacks (queen cake, biscuit, and chin chin)

Ingredients	Quantity		
	Queen cake	Biscuits	chin chin
Flour	200g	200g	200g
Sugar	80g	80g	80g
Margarine	100g	100g	100g
Baking powder	2 teaspoons	2 teaspoon	2 teaspoon
Nutmeg	1 teaspoon	1 teaspoon	1 teaspoon
Eggs	2	22	
Milk	20ml	20ml	20ml
Vanilla essence	½ teaspoon	-	-
Water	-	20ml	20ml
Salt	-	-	0.3g
Vegetable oil	-	-	1 liter

Method of preparation

1. Sieve flour to remove lumps and incorporate air for a lighter texture.
2. Cream the fat and sugar together until soft and fluffy using a wooden spoon, for queen cake. For biscuits and chin-chin, rub the fat into the flour until crumbly, then stir in the sugar.
3. Beat eggs and gradually mix them into the batter. Add milk and water as needed to achieve the required consistency.
4. For queen cakes, mix in baking powder, nutmeg, and vanilla essence to create a smooth dropping consistency.
   For biscuits and chin-chin, knead the dough thoroughly.
5. Pour queen cake batter into a well-greased cake pan.
   Roll out biscuit and chin-chin dough thinly using a rolling pin. Cut into desired shapes

6. Bake queen cakes in a moderate oven (about 20 minutes). Bake biscuits in a moderately hot oven (about 10 minutes). Deep-fry chin-chin in hot vegetable oil until golden brown.
7. Cool and store properly before use.

Proximate Composition analysis

The proximate composition of the snack products was analyzed using the Association of Official Analytical Chemists (AOAC) 2016 method to determine contents of:

Moisture via thermogravimetric in a muffle furnace (Sanyo Gallen Kamp, Weiss Technik, West Midlands, UK) at 500C for 24 hours.

Ash by heating two grams in a ceramic crucible at 550°C for three hours. The samples were then weighed using the formula, ash (%) = (w2 - w1) / (weight of sample) x 100, which was applied.

Protein by Kjeldahl method. After distillation and titration, nitrogen was corrected using a factor of 5.25.

Fat by exhaustive extraction of 0.5g of sample with petroleum ether in a micro Soxhlet extraction unit (Gerhardt, Bonn, Germany).

Fiber by digesting two grams of each treatment in a conical flask with 200ml of 1.25% H2so4 solution and boiling for 30 minutes. The solution and content were poured into a Buchner funnel, filtered, and dried. The dry residue was heated in a muffle furnace until it turned to ash, then cooled in desiccators and weighed. These analyses were carried out in the food science laboratory of the Department of Home Economics at Michael Okpara University of Agriculture Umudike.

Statistical analysis: Mean and standard deviation were used for data analysis. Duncan multiple range test and analysis of variance (ANOVA) were also used

Results

Table 1: Proximate Compositions of Queen Cakes

Samples	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
Queen cake QCA	$25.29^{a} \pm 0.29$	$6.94^{d} \pm 0.02$	$0.95^{d} \pm 0.04$	$14.77^{b} \pm 0.04$	$1.08^{c} \pm 0.02$	$51.06^{d} \pm 0.27$
QCB	$15.42^{d} \pm 0.50$	$9.71^{a} \pm 0.14$	$1.35^{c} \pm 0.05$	$17.33^{a} \pm 0.72$	$1.34^{a} \pm 0.04$	$54.84^{b} \pm 0.88$
QCC	$22.50^{b} \pm 0.10$	$8.17^{c} \pm 0.10$	$1.67^{b} \pm 0.03$	$8.20^{d} \pm 0.05$	$1.18^{b} \pm 0.02$	$58.31^{a} \pm 0.15$
QCD	$21.29^{c} \pm 0.34$	$8.74^{b} \pm 0.02$	$2.64^{a} \pm 0.04$	$13.69^{c} \pm 0.04$	$0.93^{d} \pm 0.03$	$52.70^{c} \pm 0.37$

*Means with the same superscript in the same column are not significantly different (P > 0.05) for each product. **Key:** QCA -Queens cake A (100% wheat flour, QCB-Queens cake B (80% pigeon pea seeds flour and 20% sorghum grains flour) QCC -Queens cake C (50% pigeon pea seeds flour and 50% sorghum grains flour) QCD -Queens cake D (60% pigeon pea seeds flour and 40% sorghum grains flour)*

Table 1 shows moisture content ranging from 15.42 percent (80% pigeon pea, 20% sorghum) to 25.29 percent (100% wheat flour). Protein content varied from 6.94 percent (100% wheat flour) to 9.71 percent (80% pigeon pea, 20% sorghum), while ash content ranged from 0.95 percent (100% wheat flour) to 2.64 percent (60% pigeon pea, 40% sorghum). Fat content was highest at 17.33 percent (80% pigeon pea, 20% sorghum) and lowest at 8.20 percent (50% pigeon pea, 50% sorghum), with crude fiber ranging from 0.93 percent to 1.34 percent. Carbohydrate content varied between 51.06 percent (100% wheat flour) and 58.31 percent (50% pigeon pea, 50% sorghum).

Table 2: Proximate Composition of Biscuits

Samples	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Crude fiber (%)	Carbohydrate (%)
BSA	$9.19^{b} \pm 0.13$	$6.81^{d} \pm 0.90$	$1.13^{d} \pm 0.04$	$11.62^{c} \pm 0.03$	$1.75^{a} \pm 0.01$	$69.50^{a} \pm 0.09$
BSB	$8.50^{b} \pm 0.17$	$8.63^{a} \pm 0.11$	$2.14^{b} \pm 0.03$	$13.71^{a} \pm 0.12$	$1.59^{b} \pm 0.08$	$65.43^{b} \pm 0.19$
BSC	$6.87^{c} \pm 0.20$	$7.28^{c} \pm 0.03$	$1.79^{c} \pm 0.02$	$13.65^{a} \pm 0.05$	$1.18^{d} \pm 0.02$	$69.24^{a} \pm 0.24$
BSD	$6.83^{c} \pm 0.17$	$7.69^{b} \pm 0.10$	$2.36^{a} \pm 0.04$	$12.62^{b} \pm 0.13$	$1.32^{c} \pm 0.03$	$69.17^{a} \pm 0.13$

Means with the same superscript in the same column are not significantly different (P > 0.05) for each product. ***Key***: *BSA -Biscuit A (100% wheat flour, BSB-Biscuit B (80% pigeon pea seeds flour and 20% sorghum grains flour) BSC -Biscuit C (50% pigeon pea seeds flour and 50% sorghum grains flour) BSD - Biscuit D (60% pigeon pea seeds flour and 40% sorghum grains flour)*

Table 2 shows significant differences (p>0.05) between the control (100% wheat flour) and composite flour blends. Moisture content ranged from 6.83 percent (60% pigeon pea, 40% sorghum) to 9.19 percent (100% wheat flour), while protein content varied from 6.81 percent to 8.63 percent. Ash content ranged from 1.13 percent (100% wheat flour) to 2.36% percent (60% pigeon pea, 40% sorghum), and fat content from 11.62 percent to 13.71 percent. The crude fiber was lowest at 1.18 percent (50% pigeon pea, 50% sorghum) and highest at 1.75 percent (100% wheat flour), while carbohydrate content ranged from 65.43 percent to 69.50 percent.

Table 3: Proximate composition of Chin chin

Samples	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Crude fiber (%)	Carbohydrate (%)
CHA	$4.75^{c} \pm 0.37$	$6.87^{c} \pm 0.03$	$1.28^{c} \pm 0.03$	$20.48^{a} \pm 0.10$	$2.20^{a} \pm 0.05$	$64.42^{b} \pm 0.20$
CHB	$4.75^{c} \pm 0.37$	$6.87^{c} \pm 0.03$	$1.28^{c} \pm 0.03$	$20.48^{a} \pm 0.10$	$2.20^{a} \pm 0.05$	$64.42^{b} \pm 0.20$
CHC	$6.89^{a} \pm 0.46$	$6.82^{c} \pm 0.06$	$1.30^{c} \pm 0.01$	$8.15^{d} \pm 0.05$	$1.80^{b} \pm 0.05$	$75.05^{a} \pm 0.56$
CHD	$6.21^{b} \pm 0.13$	$7.34^{b} \pm 0.14$	$1.76^{a} \pm 0.03$	$19.30^{b} \pm 0.10$	$1.85^{b} \pm 0.05$	$63.54^{c} \pm 0.30$

Means with the same superscript in the same column are not significantly different (P > 0.05) for each product. ***Key:*** *CHA-Chin chinA (100% Wheat flour, CHB -Chin chin B (80% pigeon pea seeds flour and 20% sorghum grains flour), CHC -Chin chin C (50% pigeon pea seeds flour and 50% sorghum grains flour), CHD -Chin chin D (60% Pigeon pea seeds flour and 40% sorghum grains flour)*

Table 3 shows the moisture content of chin-chin samples, which ranges from 4.75 percent (100% wheat flour) to 6.89 percent (50% pigeon pea, 50% sorghum), while protein content varied between 6.82 percent and 7.65 percent. Ash content ranged from 1.28 percent to 1.76 percent, fat content from 8.15 percent to 20.48

percent, and crude fiber from 1.80 percent to 2.27 percent. Carbohydrate content was highest at 75.05 percent (50% pigeon pea, 50% sorghum) and lowest at 63.54 percent (60% pigeon pea, 40% sorghum).

Discussion

The moisture content of the queen cake samples varied significantly, ranging from 15.42% to 25.29%, with sample QCB (80% PPF: 20% SF) recording the lowest value. This suggests a potential for longer shelf stability compared to others, given that higher moisture content accelerates microbial growth and spoilage (Ayensu et al., 2019). The moisture content observed in this study was relatively higher than the (17.74% to 20.69%) range reported by Olatunde et al. (2019) for pigeon pea, sweet potato, and wheat flour blends. The ash content, which serves as an indicator of mineral composition, was higher in the composite queen cakes than in the control, ranging from 0.95% to 2.64%. This increase suggests that the incorporation of pigeon pea and sorghum flour enhances the mineral content of the cakes, potentially addressing micronutrient deficiencies (Adebayo-Oyetoro et al., 2017; Ayo et al., 2010). A similar increase in ash content was observed in studies on composite flour products (Arukwe et al., 2023; Anozie et al., 2014). Protein content was significantly higher in the queen cakes made from pigeon pea and sorghum flour than in the control (100% wheat flour). Sample QCB (80% PPF: 20% SF) exhibited the highest protein content, reinforcing previous findings that pigeon pea is a protein-rich legume (Ohizua et al., 2017). The observed values suggest that these formulations could be beneficial in enhancing protein intake. Fat content varied across the samples, with values ranging from 8.20% to 17.33%. Sample QCC (50% PPF: 50% SF) had the lowest fat content, while QCB (80% PPF: 20% SF) had the highest. The lower fat content in some samples suggests improved shelf stability since higher fat content can lead to rancidity (Olatunde et al., 2019). These findings align with the previous study on composite flour products (Akubor, 2017). Crude fiber content ranged from 0.98% to 1.34%, with sample QCB (80% PPF: 20% SF) recording the highest value. This increase is beneficial for digestion and overall gut health (Ubor et al., 2022). The carbohydrate content ranged from 51.06% to 58.31%, with the control sample (QCA) having the lowest value and QCC (50% PPF: 50% SF) the highest. The increase in carbohydrate content with higher sorghum substitution aligns with findings by Arukwe et al. (2022), who recorded (55.88% and 72.06%) on Gruels prepared from blends of sorghum and pigeon pea flours.

Biscuits moisture content ranged from 6.83% to 9.19%, with samples containing pigeon pea and sorghum having lower values than the control. Protein content ranged from 6.81% to 8.63%, with sample BSB (80% PPF: 20% SF) having the highest value, consistent with Adejumo et al. (2020) for cookies from unripe banana and pigeon pea flour. The increased protein content aligns with findings that pigeon pea flour improves the nutritional profile of bakery products (Adeola & Ohizua, 2018). The ash content in biscuits varied significantly (1.13% 2.36%), with higher values in composite flour samples, indicating a higher mineral content (Amadi, 2019). Fat content ranged from 11.62% to 13.71%, with sample BSB (80%

PPF: 20% SF) recording the highest value. The carbohydrate content (65.43%–69.50%) was significantly higher in the control sample, as expected due to the predominant presence of wheat flour (Makinde et al., 2019).

Chin-chin moisture content ranged from (4.75% to 6.89%), with composite flour samples having higher values than the control. The range obtained in the study was lower than the (10.47% to 10.75%) reported by Abioye *et al* (2020) in chin-chin produced from wheat-germinated finger millet flour. Protein content ranged from (6.82% to 7.65%), with sample CHB (80% PPF: 20% SF) recording the highest value. Ash content was also higher in composite flour samples (1.28%–1.76%), suggesting an improved mineral profile (Abioye et al., 2020). Fat content varied significantly (8.15%–20.48%), with the control sample having the highest value, indicating the potential for rancidity in high-fat products (Adegunwa et al., 2014). Crude fiber ranged from (1.80% to 2.27%), with sample CHB (80% PPF: 20% SF) recording the highest value. Carbohydrate content ranged from (63.54% to 75.05%), with sample CHC (50% PPF: 50% SF) having the highest value, reflecting the contribution of sorghum flour. The findings indicate that pigeon pea and sorghum blends enhance protein and mineral content while maintaining desirable carbohydrate levels for energy provision.

Conclusion

This study shows that snacks made from pigeon pea and sorghum flour blends are nutritionally rich and suitable for human consumption. Sample B (80% pigeon pea, 20% sorghum) had the highest protein content, making it a good alternative protein source, while Sample D (60% pigeon pea, 40% sorghum) had high ash content, indicating a rich mineral profile. These findings suggest that these snacks could help address protein-energy malnutrition and also help households have a reliable source of nourishing and affordable locally produced snacks.

Recommendations

In view of the findings of the study, the following recommendations were made.

1. Healthy and quality snacks should be prepared from pigeon pea and sorghum flour blends by nutritionists and homemakers. This will help to promote the utilization of indigenous plants.
2. Further research should be carried out on the antioxidants, sensory evaluation, and microbiological quality of snacks produced from pigeon pea and sorghum.

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