

Functional Properties of Wheat-Cowpea Composite Flours, Proximate Composition and Sensory Acceptability of Date-Sweetened Cookies Made from the Flours

Allbright Ovuchimeru Amadi¹; Ifeoma Comfort Onyecheghe²; Lucky Chibuike Newton¹; Barigboma Miracle Nyima¹ and Chisom Okere Peter¹

¹Department of Food Science and Technology, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria. ²Department of Food Science and Technology, Imo State University, Owerri, Imo State, Nigeria.

Corresponding author: chibuike.newton@ust.edu.ng

DOI: <https://doi.org/10.62154/ajasfr.2026.023.01011>

Abstract

This study assessed the functional properties of wheat and cowpea composite flours; proximate composition and sensory acceptability of date-sweetened cookies made from the composite flours. Date flour was used as a natural sweetener to partially replace refined sugar and improve the nutritional quality of the cookies. The production process involved making composite flours from varying proportions of wheat and cowpea (90:10, 80:20, 70:30, and 60:40), which were then used to bake the cookies. The functional properties of the flour blends, as well as the proximate, physical, and sensory attributes of the final cookies, were evaluated. The functional properties results revealed that the inclusion of cowpea flour significantly ($p < 0.05$) decreased water absorption capacity (2.28-1.58 g/g) and swelling capacity (4.23-3.23%), oil absorption capacity increased from 2.19-2.37 g/g, whereas solubility index increased from 9.48-32.69%. Proximate composition of the cookies showed significant difference ($p < 0.05$), and ranged from 4.39-8.42%, 6.81-11.23%, 13.23-20.17%, 1.05-1.89%, 1.23-3.42% and 54.87-73.29% for moisture, crude protein, crude fat, ash, crude fibre and carbohydrate respectively, while the energy value ranged from 439.42-461.86 kcal/100g. Physically, the cookies exhibited spread ratio values ranging from 2.16 to 2.81. The sensory analysis showed that the control (100% wheat) had the highest overall acceptability (7.75), but was not significantly different ($p > 0.05$) from the samples which had 30-40% cowpea flour. This study proved successful in the use of cowpea flour in place of wheat flour in the preparation of date-sweetened cookie, which has been used to improve the functional and nutritional characteristics of the cookies.

Keywords: Cookies, Composite Flour, Cowpea Flour, Date Fruit Flour, Functional Properties, Proximate Composition.

Introduction

Cookies are small, flat baked goods usually made from flour, sugar and fat. They can be a snack, dessert or treat (Davidson, 2024; Daniel and Sokale, 2024). Snack foods such as cookies are culturally and socially relevant products throughout much of the world. They also possess cultural value due to variations between regions, with local formulas emphasizing on regional ingredients and techniques (Enriquez and Archila-Godinez, 2022).

Cookies are traditionally made using wheat flour as the main base. It is valued because of its gluten content that gives baked products structure, and at the same time its chewy texture (Puspitasari and Kok, 2025). Since it is extensively available and due to some good baking properties, it has taken an important place in cookie production. Wheat flour alone makes it difficult for there to be nutritional variation in the final product. Wheat flour, with its gluten content, offers desirable structural properties, however, its continued excessive use does not provide sufficient opportunities to improve the nutritional value by adding other flours (Ma et al., 2022). In recent years, there has been a growing interest in the use of alternative and complementary flours to enhance the nutritional value and functional properties of baked wheat products (Ugwuona et al., 2023).

Cowpea flour comes from a legume (*Vigna unguiculata*.) that has many nutrients. It is another way to raise the nutrient content of cookies. Its good amount of protein and fibre may lead to greater satiety and better digestive health (Affrifah et al., 2022). The use of cowpea flour in making cookies can help fight protein lack and support fiber intake (Mba et al., 2023). But, the special functional traits of cowpea flour like its water absorption capacity and protein interactions may greatly affect the texture and taste features of cookies (Queiroz et al., 2022).

Date (*Phoenix dactylifera*) adds natural sweetness and valuable micronutrients such as minerals and dietary fiber (Ujong et al., 2024; Obayomi et al., 2024). Its application in cookie formulation will mean less refined sugars used in cookies, thus making the dietary profile healthier. Date flour also imparts a characteristic flavor and color to baked goods which make them more organoleptically attractive (Ahaotu et al., 2021). The high sugar content of date flour may affect the baking properties of cookies through such properties as browning and spread (Ranasinghe et al., 2022).

Wheat flour has good baking characteristics and is a key component of cookie making, but when used alone, it lacks nutritional variety (Agba et al., 2024). The rising interest in enhancing the nutritional value of foods has led to the use of legume-based flours like cowpea flour to enhance protein and fibre content in foods (Aderinola et al., 2024). Besides, the substitution of refined sugar by natural sugar such as date can be used to improve the nutritional and functional properties of cookies. Another issue identified in biscuit making is the use of refined sugar and wheat flour which increases the carbohydrate content but not the nutritional value of the biscuit, therefore it is a very valid concern. The addition of refined sugar can significantly raise the glycemic index of cookies, which may also have implications for health, like insulin resistance and weight gain (Arukwe et al., 2025). Moreover, refined sugar, although it is the primary component of cookie dough, provides few nutrients and cookies based on wheat flour are naturally low in protein. Therefore, this study aimed to assess the functional properties of wheat–cowpea composite flours and the proximate composition, physical properties and sensory acceptability of cookies sweetened with dates and made with the composite flours. The study also aimed to assess

the suitability of cowpea flour as a nutritional fortificant in cookie production and the potential of date flour as a natural sweetener.

Materials and Methods

Wheat flour, cowpea seeds, date fruits and other ingredients in adequate quantities were purchased from Mile 3 Market, Diobu, Port Harcourt Local Government Area of Rivers State. The chemicals and reagents used were of analytical grade and obtained from the Department of Food Science and Technology Laboratory, Rivers State University, Port Harcourt, Rivers State.

Cowpea Flour Production

Cowpea flour was produced using a modification of the methods of Olusina *et al.* (2024). First, the cowpeas were sorted and cleaned manually to remove any debris or damaged seeds. Next, the cowpeas were conditioned by soaking them in water for 11 hours at room temperature (25°C). The cowpeas were boiled in water at 100°C for 40 minutes from the time boiling started. After boiling, the water was drained, and the cowpeas were dehulled. The dehulled cowpea seeds were dried in an air oven (DHG-9140A, England) at 60°C for 5 hours, and allowed to cool. The dried cowpeas were then milled into flour using a hammer mill (EFS 2T, China), and sieved through a 150 µm mesh size.

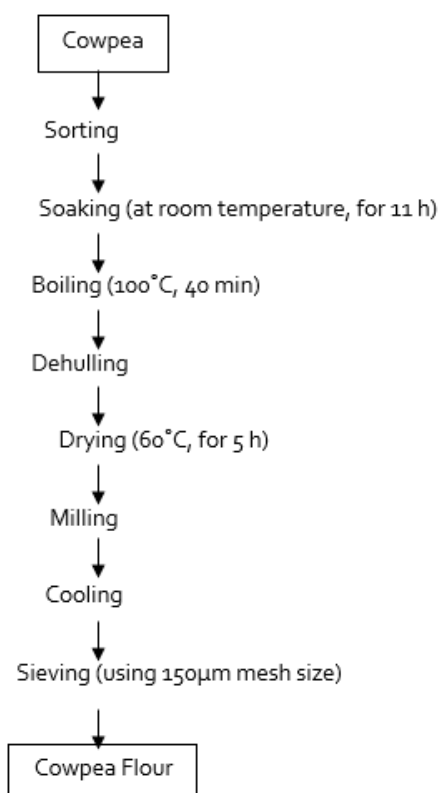


Fig. 1 Production of cowpea flour

Source: Olusina *et al.* (2024) (Modified).

Date Flour Preparation

Date flour was produced using a slight modification of the method of Asadu and Chukwu (2024). The date fruits were sorted, deseeded and then washed with potable water. The deseeded fruits were then dried in a hot oven (SM9053, Uniscope, England) for 6 hours at 50°C to a constant weight. The dried fruits were ground using attrition mill into flour. The flour was sieved through a 150 µm sieve mesh size to obtain the fine date flour.

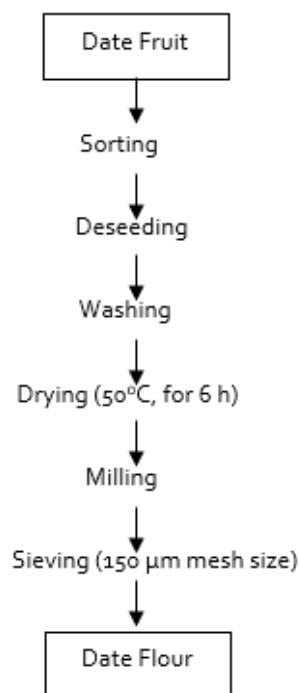


Fig. 2 Production of Date Flour

Source: Asadu and Chukwu (2024) with modification

Formulation of the Flour Blends

Wheat and cowpea flours were mixed at different proportions- 100: 0, 90:10, 80:20, 70:30 and 60:40 respectively. A Kenwood mixer (A901E, Kenwood Haunt Hampshire, made in England) was used for mixing the samples to achieve uniform blends. The flour formulation ratio is shown in Table 1 below.

Table 1: Formulation of composite flour (%)

Sample	Wheat	Cowpea
A (Control)	100	-
B	90	10
C	80	20
D	70	30
E	60	40

Production of Cookies

The method as described by Amadi *et al.* (2025) with slight modifications was used in the preparation of cookies. The flour blends, sugar (for control only), date flour (for samples B to E only), baking powder and salt were hand mixed in a bowl. Date flour was used as a natural sweetener to replace refined sugar, while the control sample (A) contained refined sugar only. This was followed by addition of margarine and further mixing by hand to obtain a bread crumb-like mixture. The mixture was transferred into food processor (Kenwood FDP65WH, Kenwood Ltd., England). Egg was added to the mixture and mixed at medium speed for 3 min to obtain the dough. The dough was manually rolled out on a floured board into sheets of uniform thickness of 4 mm and cut with a circular cookie cutter with diameter of 4 cm. The cut dough was transferred to baking trays lined with grease-proof paper and baked at 150°C for 25 min in a domestic oven. The cookies were allowed to cool to room temperature before packaging in air tight Ziploc and stored for further analysis.

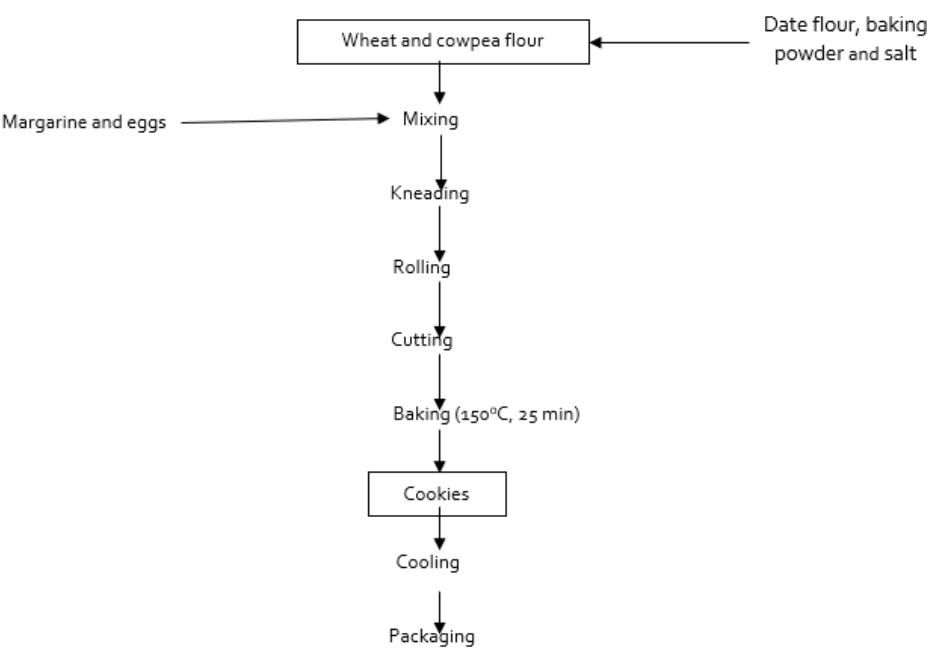


Fig. 3: Production of Cookies
Source: Amadi *et al.* (2025) (modified)

Table 2: Recipe for cookies production

Ingredients	Quantity
Flour	100 g
Baking fat	40 g
Sugar	50 g (for control only)
Date powder	60 g (for samples B to E)
Baking powder	0.5 g
Salt	0.5 g

Ingredients	Quantity
Milk	30 g
Egg	33 g

Source: Amadi *et al.* (2025) with slight modification

Determination of the Functional Properties of the Flours

Bulk density, water and oil absorption capacity were determined according to the method described by Onwuka (2018). Swelling power and solubility were determined according to the method described Aidoo *et al.* (2022). Briefly, water and oil absorption capacity were determined by centrifugal-gravimetric method after the centrifugation of 1 g of the samples in 10 mL of distilled water and vegetable oil respectively. Bulk density was determined gravimetrically before and after gentle tapping of 10 mL graduated cylinder filled with the samples until there was no further diminution of the sample levels. Swelling power and solubility were determined gravimetrically after heating to 85°C, holding for 30 min before centrifugation at 1000 rpm for 15 min. Swelling capacity was calculated by dividing the sediment weight with the sample weight. The soluble component in the supernatant after evaporation of water was used in the computation of solubility (%) by dividing the soluble component weight with the sample weight multiplied by 100.

Determination of the Proximate Composition and Energy Value of the Cookies

The moisture, protein, crude fibre, fat and ash contents of samples were analysed using the standard analytical method described by Association of Official Analytical Chemists (AOAC, 2023). Moisture content was determined gravimetrically after drying to a constant weight at 70°C in a hot air oven (DHG 9140A). Fat was determined using soxhlet extraction method with ethyl ether. Kjeldahl method and a nitrogen conversion factor of 6.25 was used for crude protein determination. Ash content was determined gravimetrically after the incineration of the samples in a muffle Furnace (Model SXL) at 550°C for 2 h. Enzymatic gravimetric method was utilized in the determination of crude fibre. Carbohydrate was calculated by difference {100 - (Moisture + crude protein + crude fibre + ash + fat)}. Energy values were obtained using Atwater factor of 4 Kcal/g for protein and carbohydrate and 9 Kcal/g for fat as described by Obinna-Echem *et al.* (2024a).

Determination of the Physical Properties of the Cookies

The method described by Amadi *et al.* (2025) was used to determine the weight, height (thickness), diameter and spread ratio the cookies. The weights of cookie samples were determined with the aid of a weighing balance (KERN ALJ500-4, Germany) immediately after cooling. To determine the diameter, three cookies were placed edge to edge and their total diameter was measured with the aid of a ruler. The cookies were rotated at angles of 90° for duplicate reading. The experiment was repeated twice and average diameter was recorded in millimetres. The cookies thickness was measured with the aid of a digital vernier

calliper (Mitutoyo Corp., Japan) with 0.01mm precision. For spread ratio, two rows of three well-formed cookies were made and the height measured. They were arranged horizontally edge to edge and the sum of their diameters measured. The spread ratio was calculated as diameter divided by height.

Sensory Evaluation of the Cookies

The sensory properties of the cookies were determined using the method described by Iwe (2010). A 20-member semi-trained panel was used to evaluate the colour, taste, crispiness, aroma, texture and general acceptability of the cookies using a 9-point hedonic scale (9 = liked extremely, 8 = liked very much, 7 = liked, 6 = liked mildly, 5 = neither liked nor disliked, 4 = disliked mildly, 3 = disliked, 2 = disliked very much and 1 = disliked extremely). Participation in the sensory evaluation was voluntary, and informed consent was obtained from all panelists prior to participation.

Statistical Analysis

Data obtained for all the analysis carried out was subjected to statistical analysis using IBM SPSS Statistics (version 26). Statistical differences and relationship among variables were evaluated by analysis of variance under general linear model and Tukey pairwise comparison at 95% confidence level.

Results and Discussion

Functional Properties of Composite Flours from Wheat and Cowpea

The functional properties of the composite flours made from wheat and cowpea are shown in Table 3. Substituting wheat flour with cowpea flour significantly impacts the functional properties of the composite flour blends. These properties are crucial as they influence the handling of the dough and the final quality of the baked product.

The bulk density of the flours ranged from 0.40 g/ml to 0.42 g/ml, with the lowest values found in samples B (90% wheat flour, 10% cowpea flour) and D (70% wheat flour, 30% cowpea flour) and the highest in sample E (60% wheat flour, 40% cowpea flour). The values for bulk density are comparable to those reported by Olosunde et al. (2025), who observed bulk density values ranging from 0.43 to 0.50 g/cm³ in composite flour blends. Bulk density is a measure of the heaviness of a flour sample and is dependent on the density and particle size of the flour. The results show that there was no statistically significant difference ($p > 0.05$) between the control (Sample A; 100% wheat flour) and the blends. This suggests that the incorporation of cowpea flour did not considerably change the packing characteristics of the composite flour which can be packed the same way (Obinna-Echem et al., 2024b).

Water absorption capacity (WAC) ranged ($p < 0.05$) from 1.58 to 2.28 g/g, the lowest and highest obtained for sample E and A respectively. Water absorption capacity indicates the extent to which a food product associates with water with a limited water supply as in the case of doughs pastes (Obinna-Echem et al., 2024a). The water absorption capacity (WAC)

decreased as the proportion of cowpea flour in the blend increased. The result is contrary to Adepeju et al. (2024) who reported that high protein flours (HPF) typically have high water absorption capacities as a result of hydrophilic nature of their protein. The observed reduction in WAC may be due to the processing of cowpea flour into flour which involves boiling and dehulling that may cause alteration of the structure of the protein with reduction in the availability of hydrophilic sites for water binding (Ohanenye et al., 2022).

Oil absorption capacity (OAC) varied from 2.19 g/g to 2.37 g/g; sample A with the lowest OAC, and sample E with the highest. The OAC increased on addition of cowpea flour. Amadi et al. (2025) also reported increase in OAC of wheat flour, with inclusion of soybean flour. This indicates that flour with higher protein and fibre content has a higher capacity to bind oil. This property is useful in cookie production, since it serves to improve mouthfeel and flavour retention of the whole product (Awuchi et al., 2019).

The solubility index varied from 9.48% to 32.69%, with minimum in A and maximum in E. The increase in solubility index with cowpea flour substitution suggests greater solubility of cowpea proteins and carbohydrates in water compared to wheat flour (Naiker et al., 2019). There was significant difference between the wheat flour and the wheat-cowpea flour blends ($p < 0.05$). The solubility index (21.52-32.69%) of the wheat-cowpea flour blends are comparable to that (29.30-33.70%) reported by Orisa et al. (2023) for the solubility of wheat and defatted African elemi pear flour blends.

The swelling capacity ranged from 3.23% to 4.23%, with sample E having the lowest value and sample A having the highest. The swelling capacity decreased as the cowpea flour content increased. Swelling capacity is related to the ability of starch granules to absorb water and swell, and the decrease in this property suggests that the proteins and fibre in the cowpea flour may be interfering with the swelling of the starch granules (Adeyoju et al., 2021). This is also in line with the trend observed for WAC.

Table 3: Functional properties of composite flours from wheat and cowpea

Sample	Bulk Density (g/ml)	Water Absorption Capacity (g/g)	Oil Absorption Capacity (g/g)	Solubility Index (%)	Swelling Capacity (%)
A	0.41 ^a ±0.02	2.28 ^a ±0.01	2.19 ^c ±0.00	9.48 ^e ±0.01	4.23 ^a ±0.06
B	0.40 ^a ±0.01	2.00 ^b ±0.00	2.28 ^b ±0.02	21.52 ^d ±0.03	4.07 ^{ab} ±0.06
C	0.41 ^a ±0.01	1.78 ^c ±0.02	2.27 ^b ±0.00	24.36 ^c ±0.03	3.90 ^b ±0.10
D	0.40 ^a ±0.01	1.78 ^c ±0.01	2.20 ^c ±0.00	28.53 ^b ±0.01	3.47 ^c ±0.06
E	0.42 ^a ±0.00	1.58 ^d ±0.01	2.37 ^a ±0.00	32.69 ^a ±0.01	3.23 ^d ±0.06

Values are means ± Standard Deviation of three determinations. Means in the same column with different superscript are significantly different at $p < 0.05$

Keys:

A = 100% wheat flour (control)

B = 90% wheat flour; 10% cowpea flour

C = 80% wheat flour; 20% cowpea flour

D = 70% wheat flour; 30% cowpea flour

E = 60% wheat flour; 40% cowpea flour

Proximate Composition and Energy Value of Date-Sweetened Cookies Produced from Composite Flours of Wheat and Cowpea

The proximate composition and energy value of date-sweetened cookies made from composite flours of wheat and cowpea are presented in Table 4.

The moisture content of the cookies ranged from 4.39% to 8.42%, with sample A having the lowest value and sample E having the highest. The increased protein and fibre contents of cowpea flour may be responsible for the higher moisture content values observed in the cookies. This has the ability to enhance water retention during baking. In addition, the reduction in gluten strength caused by the partial substitution of wheat flour may have also reduced moisture loss during the baking process. The hygroscopic nature of sugars which are present in date flour may also have played a part in the moisture retention in the cookies. The moisture content is lower than that reported by Adesola *et al.* (2025) who reported moisture content levels of 7.82% to 10.23% when analyzing cookies produced from wheat flour, soybean, Bambara groundnut and African yam bean.

The crude protein values ranged from 6.81% to 11.23%, sample A had the least and sample E the highest. The crude protein content of the cookies also increased significantly ($p < 0.05$) with higher inclusion levels of cowpea flour. This increase can be attributed to the high protein content of cowpea flour, which contributes to improved nutritional quality of the cookies (Enyiukwu *et al.*, 2020).

The values of the crude fat ranged from 13.23% to 20.17%, sample A had the least and sample E the highest. The crude fat content of the cookies increased with substitution of wheat flour by cowpea flour. The oil absorption capacity of cowpea has some association with this trend. The fat content from this study (13.23-20.17%) was also lower than 31.5-40.43% reported by Asomugha *et al.* (2022) for their cookies produced from sorghum, groundnut, soybean and wheat flour blends. The relatively low-fat content of the cookies may contribute to improved shelf stability; however, shelf-life studies are required to confirm this.

The ash content had a minimum of 1.05% and a maximum of 1.89%, sample A had the least and sample E the highest. Ash content is an indicator of the total mineral content of a food product (Orisa *et al.*, 2023). There was no significant difference ($p > 0.05$) in the ash content of the samples. The ash content however increased with increase in the inclusion level of cowpea flour.

Crude fibre was in the range of 1.23% to 3.42%, found to be lowest in sample A and highest in sample E. The percentage of crude fibre also increased linearly with increase in cowpea flour. The increase in crude fibre content may be attributed to the naturally higher dietary fibre content of cowpea flour (Obinna-Echem *et al.*, 2020).

The carbohydrate content varied ($p < 0.05$) from 54.87% to 73.29%, with sample E having the lowest value and sample A having the highest. The carbohydrate content decreased as the

proportion of cowpea flour increased. This is as a result of the rise in other components like protein, fat, ash, and fibre. The carbohydrate values that were obtained in this study were comparable to those reported by Adesola et al. (2025), who reported carbohydrate content values ranging from 68.14% to 73.69%.

The energy value ranged from 439.42 kcal/100 g to 461.86 kcal/100 g, with sample B having the lowest value and sample C having the highest. The energy value of cookies from this study were higher than 393.34-401.68 kcal/100g reported by Deedam et al. (2020) for *chin-chin* produced with blends of wheat and soursop flours. A high energy value in a cookie indicates a rich source of calories, which can help the consumer to meet increased energy needs but can contribute to weight gain and diet-related health issues if consumed excessively (Johnson et al., 2023).

Table 4: Proximate composition (%) and energy value (kcal/100 g) of date-sweetened cookies produced from composite flours of wheat and cowpea

Sample	Moisture	Crude Protein	Crude Fat	Ash	Crude Fibre	Carbohydrate	Energy (kcal/100g)
A	4.39 ^a ±0.05	6.81 ^e ±0.09	13.23 ^d ±0.02	1.05 ^c ±0.08	1.23 ^e ±0.02	73.29 ^a ±0.04	439.46 ^d ±0.29
B	5.62 ^d ±0.03	7.87 ^d ±0.10	14.75 ^c ±0.03	1.35 ^b ±0.05	1.61 ^d ±0.02	68.80 ^b ±0.14	439.42 ^d ±0.50
C	6.01 ^c ±0.03	8.61 ^c ±0.00	19.84 ^b ±0.13	1.42 ^b ±0.07	1.90 ^c ±0.08	62.23 ^c ±0.11	461.86 ^a ±0.72
D	7.49 ^b ±0.00	9.73 ^b ±0.01	20.06 ^a ±0.05	1.50 ^b ±0.03	2.28 ^b ±0.02	58.94 ^d ±0.05	455.24 ^b ±0.30
E	8.42 ^a ±0.12	11.23 ^a ±0.09	20.17 ^a ±0.02	1.89 ^a ±0.06	3.42 ^a ±0.04	54.87 ^e ±0.21	445.89 ^c ±0.37

Values are means ± Standard Deviation of three determinations. Means in the same column with different superscript are significantly different at $p < 0.05$

Physical Properties of Date-Sweetened Cookies Produced from Composite Flours of Wheat and Cowpea

The physical properties of date-sweetened cookies made from composite flours of wheat and cowpea are presented in Table 5. Physical characteristics are crucial as they directly affect the consumer's perception of the product.

The weight of the cookies ranged from 3.13 g to 3.63 g, with sample B having the lowest value and sample A, having the highest. The weight of the cookies from this study (3.13-3.63 g) differs from 4.48-5.41 g reported by Orisa et al. (2023) for cookies produced from wheat and defatted African elemi flour blends.

The diameter varied ($p < 0.05$) from 3.10 cm to 3.40 cm, with sample C having the lowest value and sample E, having the highest. The diameter of the cookies was higher than 2.80-3.04 cm; reported by Amadi et al. (2025) for cookies from wheat/soy/peanut peel flour blends. The height (thickness) of the cookies was between 1.17 cm and 1.53 cm, with sample B recording the least and sample A the highest.

The height (thickness) of the cookies increased as the proportion of cowpea flour decreased. The reason is the relatively lower forming ability of the gluten network in the

composite flours, hence the reduced integrity to hold the shape of the cookie during baking (Zou et al., 2022).

The spread ratio ranged from 2.16 to 2.81 with the lowest spread ratio being for sample A and the highest being for sample B. The spread ratio, which is the ratio between the diameter and height of the cookies, is an important quality criterion in the manufacture of cookies. As the amount of cowpea flour increased, the ratio of the cookies spread increased. The increase was most likely due to the tendency of higher ratio to flatten the cookie thus signifying increased baking activity. The higher spread ratio in composite cookies could be due to dilution of the gluten network after substitution with cowpea flour, which would cause increased spread of the dough during baking (Dhal et al., 2023).

Table 5: Physical properties of date-sweetened cookies produced from composite flours of wheat and cowpea

Sample	Weight (g)	Diameter (cm)	Height (Thickness) (cm)	Spread Ratio
A	3.63 ^a ±0.15	3.30 ^{ab} ±0.10	1.53 ^a ±0.06	2.16 ^b ±0.14
B	3.13 ^b ±0.12	3.27 ^{ab} ±0.06	1.17 ^c ±0.06	2.81 ^a ±0.17
C	3.23 ^b ±0.15	3.10 ^b ±0.00	1.27 ^c ±0.06	2.45 ^{ab} ±0.11
D	3.37 ^{ab} ±0.06	3.27 ^{ab} ±0.12	1.47 ^{ab} ±0.12	2.24 ^b ±0.22
E	3.20 ^b ±0.17	3.40 ^a ±0.10	1.33 ^{bc} ±0.06	2.55 ^{ab} ±0.06

Values are means ± Standard Deviation of three determinations. Means in the same column with different superscript are significantly different at $p < 0.05$

Sensory Properties of Date-Sweetened Cookies Produced from Composite Flours of Wheat and Cowpea

Figure 4 shows the sensory properties of date-sweetened cookies produced from composite flours of wheat and cowpea. Sensory analysis as reported by Obinna-Echem et al. (2023) is an important criterion for assessing quality in the development of new products and for meeting consumer requirements.

The colour score ranged from 7.20 to 7.95, with the lowest score for sample C and the highest for sample E. There was no significant difference ($p > 0.05$) between samples. This shows that the addition of cowpea flour did not negatively impact the visual appeal of the cookies. It contributed to a more appealing colour, due to browning reactions during baking involving the added protein and sugars.

The taste scores ranged from 6.75 to 7.90, with sample B receiving the lowest score and sample A the highest. This signifies that although the control sample recorded the highest taste score, cookies formulated with cowpea flour and date flour remained generally acceptable to the panelists, as no significant differences ($p > 0.05$) were observed among several of the samples.

Crispiness scores ranged from 5.45 to 7.85; sample C with the lowest and sample D with the highest. Crispiness of cookie is affected by things such as the moisture content and spread ratio (Panghal et al., 2018).

Scores on aroma and texture were obtained within the ranges 6.2-7.60 and 5.80-7.60 respectively; sample C being awarded the lowest score, and sample A, the highest. The lower scores on aroma and texture of the blends, might have resulted from the beany flavour and texture of cowpea flour which was unable to be masked by the other ingredients.

Overall, acceptability varied between 6.31 and 7.75 with sample C recording the least value and sample A having the highest score in conformity with results obtained from the individual sensory attributes where the control still maintained high scores. It should be noted that even the lowest-scoring sample was above 6, which shows that all of the cookie formulations were generally slightly liked by the panelists (Iwe, 2010). This indicates that cowpea flour incorporation and sugar replacement with date can be considered as an option for nutritionally enhanced cookies without a significant drop in sensory quality. Adesola et al. (2025), engaged in the production of cookies made from composite flours of soybean, bambara groundnut and African yam bean flour reported overall acceptability ranged from 6.40 to 8.25. This research indicates similarity of findings.

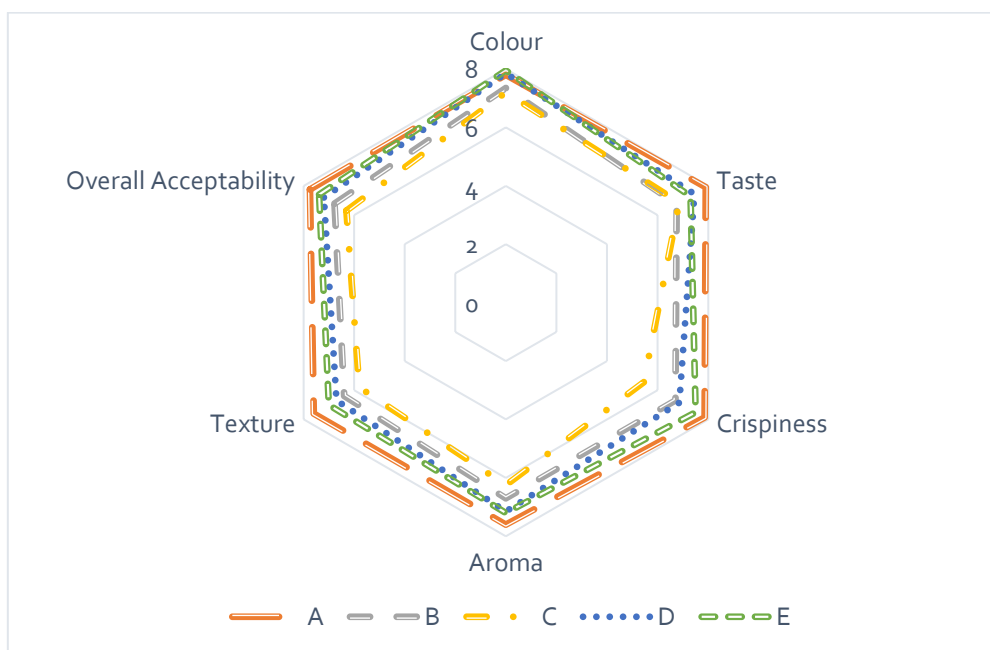


Figure 4 Sensory properties of date-sweetened cookies produced from composite flours of wheat and cowpea

Hedonic scale: 1 = dislike extremely, 2 = dislike very much, 3 = dislike slightly, 4 = dislike moderately, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = liked very much, 9 = liked extremely

One limitation of this study is that the control sample differed from the composite flour samples in both flour composition and sweetener type. While the control sample contained refined sugar, the composite flour samples were sweetened with date flour. Therefore, differences observed between the control and treatment samples may reflect the combined effects of both the cowpea flour substitution and the date flour incorporation. As a result, comparisons among samples B–E provide a more reliable assessment of the effects of increasing cowpea flour substitution levels. Future studies should include date-sweetened controls to isolate the specific effects of cowpea flour substitution.

Conclusion and Recommendation

This study showed the potential of using cowpea flour as a supplement in wheat flour to produce cookies with higher nutritional value. The results showed that substitution of cowpea flour in the cookies increased the protein, fibre, ash, and fat contents of the cookies and that there was an effect on the functional and physical properties of the flour blends and cookies. Sensory scores of cookies reduced slightly with the increase in cowpea flour substitution, but all the cookies produced were acceptable to the panelists. The results indicated that cowpea flour can be used as a good local source to enhance the nutritional value of cookies, and date flour can be added as a natural source of sweetener in bakery products. The shelf life, mineral composition, antioxidant activity and consumer acceptance of the products should be investigated under longer storage periods in future studies. The level of flour substitution could also be optimized, to further improve sensory quality while retaining nutritional benefits.

Acknowledgement

The authors acknowledge the Department of Food Science and Technology, Rivers State University, Port Harcourt, for providing laboratory facilities and technical support for this study.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Contributions

All authors contributed substantially to the conception, laboratory analysis, manuscript preparation, revision, and approval of the final manuscript.

References

- Adepeju, A. B., Adewa, T. T., Oni, K. O., Oyinloye, A. M., & Olugbuyi, A. O. (2024). Nutrient rich complementary food formulation using locally sourced compositions. *FUOYE Journal of Pure and Applied Sciences (FJPAS)*, 9(1), 30-55.
- Aderinola, T., Ajayeoba, T., Akanni, G., Uzomah, A., Onyeaka, H. & Adeboye, A. (2024). Legume-based functional foods in West Africa for managing non-communicable diseases: a comprehensive review of dietary strategies. *Nutrire*, 49(2), p.47.

- Adesola, D., Bukola, O., Olubunmi, A. O., Adedoyin, O. A., Olubunmi, B. O., Omotola, F. A., & Oluwatoyin, O. G. (2025). Evaluation of Macronutrients, Functional Properties of Composite Flour and Sensory Properties of the Developed Biscuits. *European Journal of Nutrition & Food Safety*, 17(1), 44-54.
- Adeyoju, O. A., Adebawale, K. O., Iromidayo Olu-Owolabi, B., Chibudike, H. O., & Chibudike, E. C. (2021). Nutritional and functional properties of flour and protein isolates from germinated Sorojo Cowpea *Vigna unguiculata* (L.) Walp. *Journal of Food Science and Nutrition Research*, 4(2), 161-174.
- Affrifah, N.S., Phillips, R.D. & Saalia, F.K. (2022). Cowpeas: Nutritional profile, processing methods and products—A review. *Legume Science*, 4(3):131.
- Agba, T.D., Yahaya-Akor, N.O., Kaur, A., Ledbetter, M., Templeman, J., Wilkin, J.D., Onarinde, B.A. & Oyeyinka, S.A. (2024). Flour functionality, nutritional composition, and in vitro protein digestibility of wheat cookies enriched with decolourised *Moringa oleifera* leaf powder. *Foods*, 13(11), p.1654.
- Ahaotu, I., Eze, O. & Maduka, N. (2021). Quality assessment of cornbreadfruit-date flour and sensory evaluation of chin-chin prepared using the composite flour. *Advances in Biotechnology and Microbiology*, 16(3):36-53.
- Aidoo, R., Oduro, I. N. Agbenorhevi, J. K., Ellis, W.O. & Pepra-Ameyaw, N. B. (2022). Physicochemical and Pasting Properties of Flour and Starch from two New Cassava Accessions. *International Journal of Food Properties*, 25(1): 561-569. <https://doi.org/10.1080/10942912.2022.2052087>
- Amadi, A. O., Orisa, C. A., Ezenwa, H. C., & Okwudi, V. D. (2025). Quality Assessment of Cookies Produced from Blends of Wheat, Soybean and Peanut Peel Flours. *IPS Applied Journal of Nutrition, Food and Metabolism Science*, 3(1), 34-43. <https://doi.org/10.54117/iajnfms.v3i1.89>
- AOAC International. (2023). Official methods of analysis (22nd ed.). Association of Official Analytical Chemist (AOAC) International. Washington DC.
- Arukwe, D.C., Okoli, J.N., Nwachukwu, C.A. & Kenekchukwu, A.L. (2025). Chemical Composition, Functional Properties and Consumer Acceptability of Cookies Produced from Blends of Wheat, Orange Fleshed Sweet Potato and Pawpaw Flours. *Sahel Journal of Life Sciences FUDMA*, 3(2), 71-83.
- Asadu, K.C., & Chukwu, C.T. (2024). Production and quality evaluation of bread from blend of biofortified cassava, wheat and dry date flour. *World Journal of Advanced Research and Reviews*, 21(3), 032-041.
- Asomugha, I. C., Ejinkonye, U. B., & Ajuobi, C. P. (2022). Chemical Composition and Sensory Evaluation of Cookies Produced from Red Variety of Sorghum, Groundnut and Soybean Flours. *Nigeria Journal of Home Economics*, 9(5):103-117.
- Awuchi, C. G., Igwe, V. S., & Echeta, C. K. (2019). The functional properties of foods and flours. *International Journal of Advanced Academic Research*, 5(11), 139-160.
- Daniel, E.O. & Sokale, A.I. (2024). Sensory of Standardized Cookie Recipe using Healthy Alternatives. *International Journal of Women in Technical Education and Employment*, 5(1):1-8.
- Davidson, I. (2024). *Biscuit, cookie and cracker production: process, production and packaging equipment*. Elsevier.
- Deedam, N.J, China, M.A., & Wachukwu, H.I. (2020). Utilization of Soursop (*Annona muricata*) Flour for the Production of Chin-Chin. *Agriculture and Food Sciences Research*, 7(1): 97-104.
- Dhal, S., Anis, A., Shaikh, H.M., Alhamidi, A. & Pal, K. (2023). Effect of mixing time on properties of whole wheat flour-based cookie doughs and cookies. *Foods*, 12(5):941.
- Enriquez, J. P., & Archila-Godinez, J. C. (2022). Social and cultural influences on food choices: A review. *Critical Reviews in Food Science and Nutrition*, 62(13), 3698-3704.
- Enyiukwu, D. N., Chukwu, L. A., & Bassey, I. N. (2020). Nutrient and anti-nutrient compositions of cowpea (*Vigna unguiculata*) and mung bean (*Vigna radiata*) seeds grown in humid Southeast Nigeria: A comparison. *International Journal of Tropical Drylands*, 4(2).

- Iwe, M. O. (2010). *Handbook of Sensory Methods and Analysis. 2nd edition*. Rojoint Communications Services Ltd, Enugu
- Johnson, W. O., Tijani, S. A., Anaegbo, B. U., & Adebisi, T. T. (2023). Sensory Attributes and Proximate Composition of Enriched Cookies Made from Blends of Maize, Millet and Crayfish. *Journal For Family & Society Research*, 2(1).
- Ma, S., Wang, Z., Liu, H., Li, L., Zheng, X., Tian, X., Sun, B. & Wang, X. (2022). Supplementation of wheat flour products with wheat bran dietary fibre: Purpose, mechanisms, and challenges. *Trends in Food Science & Technology*, 123, 281-289.
- Mba, J.C., Paes, L.T., Viana, L.M., Ferreira, A.J.C., Queiroz, V.A.V., Martino, H.S.D., Azevedo, L., de Carvalho, C.W.P., Felisberto, M.H.F. & de Barros, F.A.R. (2023). Evaluation of the physical, chemical, technological, and sensorial properties of extrudates and cookies from composite sorghum and cowpea flours. *Foods*, 12(17): 3261.
- Naiker, T. S., Gerrano, A., & Mellem, J. (2019). Physicochemical properties of flour produced from different cowpea (*Vigna unguiculata*) cultivars of Southern African origin. *Journal of Food Science and Technology*, 56(3), 1541-1550.
- Obayomi, O.V., Olaniran, A.F. & Owa, S.O. (2024). Effects of bioprocessing on elemental composition, physicochemical, techno-functional, storage and sensorial properties of gluten-free flour from fonio and date fruit. *Food Bioscience*, 62:105143.
- Obinna-Echem, P. C., Amadi, A. O., & Ogan, S. A. (2024b). Evaluation of the quality characteristics of cookies produced from blends of tigernut and soybean flour. *IPS Journal of Nutrition and Food Science*, 3(1), 86–93. <https://doi.org/10.54117/ijnfs.v3i1.38>.
- Obinna-Echem, P. C., Amadi, A. O., Ekuma, C. C., & Fyne-Akah, H. (2024a). Quality Attributes of Wheat-Tigernut Flour Blends and Chin-Chin Produced from the Blends. *IPS Journal of Nutrition and Food Science*, 3(1), 102–109. <https://doi.org/10.54117/ijnfs.v3i1.39>
- Obinna-Echem, P. C., Wachukwu-Chikaodi, H. I., & Dickson, O. A. (2020). Functional properties of tigernut and cowpea flour blends. *European Journal of Agriculture and Food Sciences*, 2(6).
- Obinna-Echem, P.C., Enente, U.J., Amadi, A.O & Fyne-Akah, H. (2023). Effect of Processing Methods on the Quality Characteristics of Ogi from two Varieties of Millet. *Research Journal of Food Science and Quality Control (RJFSQC)*, 9 (3) 1-18.
- Ohanenye, I. C., Ekezie, F.-G. C., Sarteshnizi, R. A., Boachie, R. T., Emenike, C. U., Sun, X., Nwachukwu, I. D., & Udenigwe, C. C. (2022). Legume Seed Protein Digestibility as Influenced by Traditional and Emerging Physical Processing Technologies. *Foods*, 11(15), 2299. <https://doi.org/10.3390/foods11152299>
- Olusina, O.S., Olabisi, A.J., Adewale, G.A & Meka, M.M. (2024). Chemical and sensory evaluation of chin-chin and biscuits developed from blends of rice and cowpea flours. *Research Journal for Food Science and Quality Control*, 10(5), 80-101.
- Olosunde, W. A., Assian, U. E., & Banjo, R. N. (2025). Evaluation of proximate, functional, and physical properties of composite flours from plant-based ingredients. In Proceedings of the 3rd Faculty of Engineering and Technology Conference (FETiCON 2025), 3(2), 324–332. <https://doi.org/10.63748/FETiCON2025.v3i2p139>
- Onwuka, G.I. (2018). *Food Analysis and Instrumentation- Theory and Practice (second edition)*. Naphtali Prints, Lagos, Nigeria. (Pp. 256-257).
- Orisa, C.A., Amadi, A.O. & Owuno, F. (2023). Physicochemical and sensory properties of cookies produced from blends of wheat and defatted African elemi pulp flours. *International Journal of Food Science and Nutrition*, 8(4) :16-24.
- Orisa, C.A., Amadi, A.O., Achinewhu, S.C. & Owunna, R.N. (2023). Effect of selected spices on the proximate composition, shelf life and sensory properties of cashew nut butter. *Research Journal of Food Science and Nutrition*, 8(3): 40-47 <https://doi.org/10.31248/RJFSN2023.162>

- Panghal, A., Chhikara, N., & Khatkar, B. S. (2018). Effect of processing parameters and principal ingredients on quality of sugar snap cookies: a response surface approach. *Journal of food science and technology*, 55(8), 3127-3134.
- Puspitasari, E.D. & Kok, T. (2025). Nutritional and Sensory Profile of Conventional, Gluten-Free, and Plant-Based Cookies. *Keluwih: Jurnal Kesehatan dan Kedokteran*, 7(1).
- Queiroz, V.A.V., Dizlek, H., de Barros, F.A.R., Tardin, F.D., Figueiredo, J.E.F. & Awika, J.M. (2022). Baking process effects and combined cowpea flour and sorghum bran on functional properties of gluten-free cookies. *Plant Foods for Human Nutrition*, 77(4): 552-559.
- Ranasinghe, M., Manikas, I., Maqsood, S. & Stathopoulos, C. (2022). Date components as promising plant-based materials to be incorporated into baked goods—A Review. *Sustainability*, 14(2):605.
- Ugwuona, F., Ukom, A., Ejinkeonye, B., Obeta, N. & Ojinnaka, M. (2023). Exploring the possibilities of some selected flour blends for the development of bakery products: Comparison with some physicochemical and functional properties of wheat flour. *Food Science and Technology International*, 29(2), 105-114.
- Ujong, A. E., Emelike, N. J. T., Ofiks, A., Ohanehi, H. A., & Olumide, B. A. (2024). Effect of drying methods and variety on the chemical composition, functional, and microbial properties of date flour. *JSFA Reports*, 4(12), 398-405.
- Zou, X., Wang, X., Li, L., Peng, P., Ma, Q., Hu, X., & Appels, R. (2022). Effects of composition and strength of wheat gluten on starch structure, digestion properties and the underlying mechanism. *Foods*, 11(21), 3432.