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Assessment of Nutritional, Functional, and Sensory Characteristics of Bread Produced with Wheat, Cowpea Bran, and Prekese (*Tetrapleura tetraptera*) Flour Composites

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Abstract

Incorporating legume bran and indigenous functional ingredients into wheat-based bread offers a pathway to improve nutritional quality, but their effects on product characteristics require empirical evaluation. This study evaluates the nutritional, functional, mineral, physical, and sensory properties of bread produced from wheat, cowpea bran, and *prekese* flour blends. Cowpea bran was cleaned, soaked to rehydrate, dried, milled, and sieved prior to blending, and wheat–cowpea bran–*prekese* formulations were prepared at ratios of 100:0:0, 95:5:5, 90:10:5, 85:15:5, and 80:20:0. Proximate, functional, mineral, physical, and sensory characteristics were determined using standard analytical methods. Proximate analysis showed significant differences ($p < 0.05$), with moisture, ash, fat, fiber, protein, and carbohydrate contents ranging from 5.26–10.13%, 1.75–3.03%, 8.08–8.70%, 0.14–6.71%, 9.12–12.22%, and 75.72–59.85%, respectively. Functional properties—bulk density, swelling capacity, water absorption, oil absorption, and foaming capacity—varied from 0.62–0.73, 3.31–4.21, 2.06–2.81, 1.25–1.40, and 5.30–12.51, while mineral contents of calcium, iron, zinc, and potassium ranged from 335.34–375.28, 16.63–52.58, 6.57–54.06, and 485.14–505.13, respectively. Sensory scores for appearance, flavor, color, mouthfeel, and overall acceptability ranged from 5.35–8.55, 5.33–7.83, 5.45–8.34, 4.75–8.38, and 4.45–8.58, with the 100% wheat formulation showing the highest overall acceptability, while the 80:20:5 blend was the least preferred due to its higher cowpea bran content despite improved nutritional attributes. Overall, the findings highlight the potential of cowpea bran and *prekese* flour as functional ingredients for enhancing the nutritional profile of wheat-based bread, while underscoring the need for optimal formulation strategies to balance nutritional benefits with desirable sensory and functional properties for consumer acceptance and product development.

Keywords: Cowpea Bran; *Prekese*; Wheat Flour; Nutritional Composition; Sensory Evaluation.

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an ancient crop originating from West Africa, specifically from the savannas and grasslands of sub-Saharan Africa (Fuller *et al.,* 2016). Cowpea was first domesticated from its wild ancestor, *Vigna unguiculata* sub specie *dekindtiana* (Singh *et al.,* 2014). From West Africa, cowpea spread to other parts of Africa, Asia, and eventually the Americas through trade and migration (Baudouin *et al.,* 2017). There are several varieties of cowpea such as white, brown, and black cowpea (Osipitan *et al.*, 2021).

Cowpea Bran

Cowpea bran, a byproduct of cowpea (Vigna unguiculata) processing, is increasingly valued for its nutrient density and health-promoting properties. Rich in dietary fiber, protein, essential vitamins, and minerals, cowpea bran offers an economical and nutritious alternative for enhancing food products (Ene-Obong & Uwaegbute, 2020). Its nutrient profile is unique, containing significant levels of fiber, specifically insoluble fiber, which supports digestive health and helps maintain bowel regularity (Akande *et al.,* 2021). Additionally, cowpea bran is a notable source of plant-based protein, containing essential amino acids that contribute to muscle repair and immune function, making it particularly beneficial in plant-based or protein-supplemented diets.

Prekese (*Tetrapleura tetraptera*), is a tropical plant native to West Africa, commonly cultivated in Ghana, Nigeria, and other regions. It thrives in humid environments with well-drained soil. While often harvested from wild trees, there is growing interest in commercial cultivation due to its economic and medicinal benefits (Adebayo et al., 2020). The utilization of herbs and spices like prekese, lemongrass, ginger, and cloves has seen a significant rise in family meals, herbal teas, and traditional medicine due to their high nutritional and phytochemical content. These plant-based alternatives have been widely used in certain parts of the world, particularly in Asian countries and rural areas where access to chemical products is limited. This practice is associated with better health outcomes, as these populations have a lower prevalence of non-communicable diseases (Nuguanchoo et al., 2023).

Bread is a staple food globally, valued for its convenience, versatility, and potential for nutritional enhancement through ingredient modification (Agu *et al.,* 2020). Traditionally, wheat flour serves as the primary ingredient in bread production, contributing to its favorable baking qualities and palatable texture (Eneche & Gernah, 2021). However, wheat-based bread lacks sufficient dietary fiber, certain micronutrients, and protein diversity, prompting researchers to explore composite flour formulations (Adeyemi *et al.,* 2022). The blending of wheat with nutrient-rich, non-conventional flours, such as those derived from legumes and medicinal plants, can increase the nutritional value of bread, enhancing both macro- and micronutrient

The incorporation of prekese into bread, presents a promising opportunity to enhance its sensory and nutritional profile. However, there is limited information on their combined which will be addressed in this work to obtain an optimal blend that maximizes nutritional benefits without compromising the sensory qualities and consumer acceptability of bread. The study is to evaluate the nutritional ,functional and sensory evaluation of bread produced from wheat, cowpea bran and Prekese flour blends

MATERIALS AND METHODS

Materials

Cowpea were collected from a local food processor vendor at Wukari, Taraba State, prekese was purchase from old market at Wukari Tarabe State. Wheat flour (Golden Penny Plc., Lagos, Nigeria), Margarine (Simas Limited, Kano, Nigeria), salt and sugar (Dangote

Refinery Plc., Lagos Nigeria), potable water, and instant dry yeast (STK Royals) were purchase at Wukari New Market, Taraba State.

Preparation of prekese flour

Prekese (*Tetrapleura tetraptera*) is a spice commonly used in West African cuisine. Preparing prekese flour involves drying and grinding the prekese seeds. the basic process include:

i. Harvesting: Collect mature prekese pods from the plant.
ii. Drying: Dry the pods in the sun to reduce the moisture content.
iii. Removal of seeds: Open the dried pods and remove the seeds.
iv. Cleaning: Clean the seeds to remove any impurities or debris.
v. Soaking for three days in water.
vi. Dry the seed
vii. Sifting: Sift the powder to remove any lumps or large particles
viii. Prekese flour

Preparation of cowpea bran flour

The cowpea bran was clean to remove impurities, soaked in water to rehydrate before use, dried the bran to remove moisture, milled into a fine flour using a blender, sift the bran to remove any lumps or large particles.

Cowpea bran

↓

Sorting

↓

Cleaning

↓

Drying (45°C for 48 h)

↓

Milling

↓

Sieving (250 µm)

↓

Cowpea bran flour

Figure 1: production of cowpea bran flour (Zhong, 2019)

Table 1. Blends formulation of wheat, cowpea bran and prekese flours

Sample	wheat (g)	cowpea bran (g)	prekese (g)
A	100	_	_
B	95	5.0	5.0
C	90	10	5.0
D	85	15	5.0
E	80	20	5.0

Production of bread

Bread was produce from the flour blends according to the straight dough (Method 10-10.3, AACC, 2000) with modification in terms of fermentation/proofing time used. The bread ingredients used include sugar (25 g), fat (15 g), dry yeast (5 g), salt (1.0 g), and prekese extract (5 g). The dry ingredients were manually mix. Water was added and carefully mix to form well developed dough. The five bread samples were allowed to rest for 30 min at 30ºC (first proofing). After first proofing, the dough was knead back to expel carbon dioxide and molded into greased pans and allowed to rest for 30 min at 30ºC (second proofing). The dough samples were then bake in an oven at 220ºC for 30 min to obtain the different bread samples. The obtained bread samples were allowed to cool prior to subsequent analysis.

Raw materials (wheat flour, prekese flour and cowpea bran)
↓
Mixing ingredients (salt, sugar, fat)
↓
Addition of water containing yeast
↓
Kneading (20 min.)
↓
First Proofing (30 min)
↓
Second Kneading
↓
Filling in greased pans
↓
Second Proofing (30 min.)
↓
Baking (220ºC for 30-35 min.)
↓
Cooling (1 hour)
↓
Bread

Figure 2: Production of Bread (AOAC, 2020)

Analysis of Cowpea Bran Flour, Prekese Flour and Wheat Flour Blends

Proximate composition of cowpea bran flour and wheat flour blends

a. Moisture

Moisture content was determined by the hot air oven method described by AOAC (2019). Two grams of the sample were weighed into the crucible of known weight and placed in the oven at 105ºC for 4 hours. The samples were then remove from the oven and placed in a desiccator to cool before weighing. The crucible was put back into the oven and weighed again until constant weight was recorded. The loss in weight from the original sample weight was calculated as the moisture content.

$$\%\text{Moisture content} = \frac{\text{Weight loss}}{\text{Weight of sample}} \times \frac{100}{1}$$

b. Ash

Ash content was determined by the method of AOAC (2019). The ash content was determined after incineration of 2 g of the sample in a muffle furnace at 550ºC for 2 hours until a light gray ash was obtained. It was then cool in a desiccator, weighed and calculated using the formula

$$\%\text{Ash} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times \frac{100}{1}$$

c. Crude fat

Crude fat content was determined by the method outlined by Sampson (2020). 2g of sample was transferred into a 22 x 80 mm paper thimble and capped with wool, dropped into a thimble holder and attached to a pre-weighed 500 m round bottom flask containing 200 ml hexane and assembled on a semi-continuous Soxhlet extractor. The content of the thimble was refluxed for 16hours. The hexane was recovered on a steam water bath and the flask was heated for 30mins in an oven at 103˚C. The flask containing the fat was weighed after being cooled in a desiccator. Increase in weight was calculated as percentage crude fat.

$$\%\text{Fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times \frac{100}{1}$$

d. Protein

Protein content was determined by the method outlined by Sampson (2020). 2 g of the samples in a kjedahl flask was added 25 ml concentrated H_2SO_4 and digested till the colour of the solution turned clear. The solution was transferred into a volumetric flask and the volume made up to 100 ml mark with distilled water. 10ml of the solution was distilled and titrated against 0.1 M HCL against a blank. titer values sample was recorded and percentage nitrogen calculated. %Nitrogen = $\frac{Vs-Vb \times N \times 14}{1000 \times \text{Weight of sample}} \times \frac{100}{1}$

Where:

Vs = volumes of acid required to titrate the sample and the blank, respectively.

N = Normality of the acid

The protein content will be calculated as:

% Protein = % N x 6.25

Where 6.25 is a conversion factor.

e. Determination of crude fiber content

The crude fiber was determined according to the method of AOAC (2019). Petroleum ether will be used to defat 2g of sample. This was put in a beaker containing 200 ml of 1.25 % H_2SO_4, boiled for 30 minutes, filtered through muslin cloth on a fluted funnel and washed with boiling water until it was free of acid. The residue was returned to 200 ml boiling NaOH and allowed to boil for 30 minutes. It was washed with 1 % HCl and then with boiling water to free it of acid. The final residue was drained and transferred to a silica ash crucible (porcelain crucible) dried in the oven to a constant weight and cooled. The crude fiber content will be calculated.

% Crude fiber = loss in weight after ignition x 100.

f. Carbohydrate

carbohydrate content of the samples was estimated as the difference obtained after subtracting the values of organic protein, ash content, fat or oil, , and moisture content from 100.

%CHO= 100- (protein + ash + oil + crude fiber + moisture content).

G is energy value

Mineral composition of cowpea bran flour and wheat flour blends

The samples were ashed at 550 ºC and the ash was boiled with 10ml of 20% hydrochloric acid in a beaker and then filled into a 100 ml standard flask. This was made up to the mark with deionized water, the minerals were determined from the resulting solution.

a. Calcium

Calcium was determined by Atomic Absorption Spectroscopy (AAS) method. Weigh 5 g of the sample and extract calcium using hydrochloric acid and water, aspirate the filtered extract into the AAS instrument and measure the absorbance at 422.7 nm. Compare with standards to calculate the calcium content using equation

Calcium= $As \times Css \times Df / Ass \times Sv \times 100$

Where

A*s* is absorbance of sample

C*ss* is concentration of standard solution

D*f* - dilution factor

A*ss* is absorbance of standard solution

S*V* - sample volume

b. Zinc

Zinc was determined by Atomic Absorption Spectroscopy (AAS) method. Weigh out a sample and dissolve it in a suitable solvent (such as acid), Prepare standards with known concentrations of zinc and measure their absorbance, Measure the absorbance of the sample and compare it to the calibration curve to determine the zinc concentration. Calculate the zinc concentration in the sample using the absorbance value and the calibration curve.

C = (A / S) x B

C = Concentration of zinc in the sample (mg/L or ppm)

A = Absorbance of the sample

S = Slope of the calibration curve (absorbance per unit concentration)

B = Blank correction (absorbance of the blank sample)

c. Potassium

A 2ml sample was treated with sodium cobalt nitrate, then centrifuged and mixed with ethanol. After boiling and cooling, choline hydrochloride, potassium ferricyanide, and water were added. The absorbance was measured at 620nm using a colorimeter, allowing for the determination of potassium content using equation. A calibration graph was created from the readings.

Potassium= $As \times Cs \times df \,/\, As \times Sv$ x 100

Where,

As is absorbance of sample

Cs is concentration of standard solution

df is dilution factor

Ass is absorbance of standard solution

Sv is sample volume

d. Iron

Iron was determined by Atomic Absorption Spectroscopy (AAS) method. Weigh out a sample and dissolve it in a suitable solvent (such as acid). Prepare standards with known concentrations of iron and measure their absorbance, Measure the absorbance of the sample and compare it to the calibration curve to determine the iron concentration. Calculate the iron concentration in the sample using the absorbance value and the calibration curve.

C = (A / S) x B Where:

C = Concentration of iron in the sample (mg/L or ppm)

A = Absorbance of the sample

S = Slope of the calibration curve (absorbance per unit concentration)

B = Blank correction

Functional properties of cowpea bran wheat and Prekese flour blends

a. Bulk density

Determination of bulk density in date kernel flour was carried out using the method outlined by Wang *et al.*, 2019). 10g of the test flour was place in a 25mL graduated cylinder and packed by gentle tapping of the cylinder on the bench top, ten times, from a height of 5-8cm. The final volume of the test flour was measured and expressed in g/ml. Bulk density was calculated using Equation 4.3. The loose bulk density was determined by introducing 10g of flour sample into 25mL graduated cylinder without tapping.

$$\text{Pb} = \frac{mass\ of\ flour}{volume\ of\ cylinder}$$

b. Swelling capacity

The method described by Ayo *et al.* (2015) with slight modifications was adopted in the determination swelling power of the germinated date flour. The flour (1 g) was mixed with 10 ml of distilled water in a centrifuge tube and heated to 80°C and held for 15 min. The heated suspension was centrifuged at 2000rpm for 15 min. The weight of the sediment after decanting was taken. Swelling capacity (g/g) was expressed as weight of sediment divided by the weight of the sample.

c. Oil absorption capacity

Oil absorption capacity was determined using the method modified by Adebowale *et al.,* (2020); where 10ml of oil was added to 1.0g of the sample in a beaker. The suspension was stirred using magnetic stirrer for 5min. The suspension obtained was then centrifuged at 3500 rpm for 30 min and the supernatant measured into a 10 ml graduated cylinder. Oil absorbed was calculated as the difference between the initial volume of oil added to the sample and the volume of the supernatant.

$$\text{OHC (mL/g)} = \frac{m_2}{m_1}$$

d. Determination of water absorption capacity

This was determined by the methods described by Onwuka (2018). 1 g of the flour. Was mixed with 10 ml distilled water in a pre-weighed 20 ml centrifuge tube. The slurry was agitated for 2 min and allowed to stand at 28°C for 30 min and then centrifuged at 500 rpm for 20 min. The clear supernatant will be decanted and discarded. The adhering drops of water in the centrifuge tube was wiped with cotton wool and the tube weighed. Percentage water absorption capacity was calculated.

e. Determination of foam capacity

The method described by Abbey and Ibeh (2017) was used for the determination of foam capacity and foam stability. 2 g of flour sample was added to 50 mL distilled water at 30 ± 2 °C in a 100 mL measuring cylinder. The mixture was stirred and the volume was noted. The suspension was blended using a warring blender at 160 × g for 5 min to create foam, then returned to the measuring cylinder and the volume of the foam after 30 s was recorded.

Sensory Evaluation

Sensory evaluation of the bread was carried out using 20-member trained panel selected from the Department of Food Science and Technology, Federal University Wukari. The samples were randomly presented to sensory panel in white plastic plates. The bread was evaluated for color, taste, texture, aroma and overall acceptability. Each sensory attribute were rated on a 9-point hedonic scale (where 1 = disliked extremely while 9 = liked extremely).

Statistical analysis

Data was expressed as mean ± standard deviations of duplicate scores. The significant differences between the groups was assess by one way analysis of variance (ANOVA) and Ducan Multiple Range Test was use to separate the means at ($p < 0.05$). This was done using the Statistical Package for Social Science (SPSS) software version 23:00.

RESULTS AND DISCUSSION

Proximate Composition of Wheat, Cowpea Bran and Prekese Flour Blends

Proximate composition of wheat, cowpea bran and Prekese flour blends is presented in Table 4.1. The moisture content of the flour blends increased significantly from (5.26 -10.13%), with each incremental addition of cowpea bran and prekese flour. The increase in moisture content with higher proportions of cowpea bran and Prekese flour can be attributed to the hygroscopic nature of these ingredients, which have a high affinity for water due to their fiber and protein content. According to a study by Adeyemi *et al.* (2019), the incorporation of legume flours and plant-based additives can significantly increase the moisture content of composite flours due to their ability to absorb and retain water. These components form hydrogen bonds with water, increasing the flour's water-holding capacity. However, excessive moisture can lead to clumping and reduced flowability, as noted by Oladipo *et al.* (2020).

The ash content of the flour blends increased significantly from 1.75 -3.04%, reflecting the mineral content contributed by cowpea bran and prekese flour. According to a study by Adelekan *et al.* (2020), the incorporation of legume flours and plant-based additives can enhance the mineral content of composite flours, improving their nutritional profile. The results suggest that the incorporation of cowpea bran and prekese flour can significantly enhance the ash content of flour blends, addressing nutritional deficiencies.

TABLE 2. Proximate Composition of Wheat, Cowpea Bran and Prekese Flour Blends

SAMPLES	MOISTURE%	ASH%	FAT%	FIBRE%	PROTEIN %	CARBOHYDRATE %
100:0:0	5.26^{a}±0.01	1.75^{b}±0.01	8.08^{d}±0.01	0.14^{a}±0.00	9.12^{c}±0.01	75.72^{d}±0.01
95:5:5	5.74^{b}±0.01	1.61^{a}±0.01	5.83^{a}±0.00	1.13^{b}±0.01	5.54^{a}±0.01	81.67^{e}±0.70
90:10:5	6.88^{c}±0.01	1.83^{c}±0.01	6.06^{b}±0.01	3.99^{c}±0.01	7.43^{b}±0.71	73.83^{c}±0.81
85:15:5	9.38^{d}±0.01	2.83^{d}±0.01	7.02^{c}±0.01	4.27^{c}±0.01	9.57^{d}±0.01	66.92^{b}±0.08
80:20:5	10.13^{e}±0.01	3.04^{e}±0.01	8.70^{e}±0.01	6.71^{e}±0.01	12.22^{e}±0.01	59.85^{a}±0.09

Values are means ± SD of 2 replications. Means within a row with the same superscripts are not significantly different ($p>0.05$).

Sample A = wheat 100%, B= wheat 95%; cowpea bran 5%; prekese 5g, C= wheat 90%; cowpea bran 10%; prekese 5g, D= wheat 85%; cowpea bran 15%; prekese 5g, E= wheat 80%; cowpea bran 20%; prekese 5g.

The fat content of the flour blends varied significantly ($p< 0.05$), with 100:0:0 (8.08%) and 80:20:5 (8.70%) having the highest values, while 95:5:5 (5.83%) had the lowest. Fat content is an important parameter that influences the energy density and sensory properties of flour. The higher fat content in 100:0:0 and 80:20:5 can be attributed to the natural fat content of wheat and cowpea bran, respectively. Cowpea bran is known to contain higher levels of unsaturated fats, which contribute to its nutritional value. According to a study by Adetunji *et al.* (2021), the incorporation of legume flours can alter the fat content of composite flours due to their unique lipid profiles. The increase in fat content suggest that the incorporation of cowpea bran and prekese flour can enhance the fat content of flour blends, improving their energy density and flavor. This is supported by research from Oluwajuyitan *et al.* (2022), who emphasized the importance of optimizing fat content to achieve balanced nutritional profiles in composite flours.

The fiber content of the flour blends increased significantly ($p < 0.05$), from 0.14-6.71%, reflecting the high fiber content of cowpea bran and prekese flour. The higher fiber content in 85:15:5 and 80:20:5 can be attributed to the significant proportion of cowpea bran, which is rich in both soluble and insoluble fibers. According to a study by Olaoye *et al.* (2022), the incorporation of legume flours can significantly increase the fiber content of composite flours, improving their functional and nutritional properties.

The protein content of the flour blends increased significantly ($p < 0.05$), from 9.12-12.22%, reflecting the high protein content of cowpea bran. The higher protein content in 85:15:5 and 80:20:5 can be attributed to the significant proportion of cowpea bran, which is rich in plant-based proteins. According to a study by Adeyemi *et al.* (2023), the incorporation of legume flours can significantly increase the protein content of composite flours, improving their nutritional profile. This findings suggest that the incorporation of cowpea bran and prekese flour can significantly enhance the protein content of flour blends, addressing protein malnutrition, agrees to the research by Oladipo *et al.* (2023), who emphasized the potential of composite flours as a strategy for improving protein intake.

The carbohydrate content of the flour blends decreased significantly from 100:0:0 (75.72%) to 80:20:5 (59.85%), reflecting the dilution effect of cowpea bran and prekese flour. According to a study by Adelekan *et al.* (2023), the incorporation of legume flours can reduce the carbohydrate content of composite flours, improving their nutritional profile. This reduction in carbohydrate content can be due to the displacement of starch by proteins and fibers, which can influence the dough's texture and functionality.

Functional Properties of Bread Produced from Wheat, Cowpea Bran and Prekese Flour Blends

The result for the functional properties of bread produced from wheat , cowpea bran and prekese flour blends are presented in Table 4.2. The bulk density of the bread samples showed significant differences ($p < 0.05$), with 100:0:0 (0.73 g/mg) and 95:5:5 (0.75 g/mg) having the highest values, while 85:15:5 (0.59 g/mg) and 80:20:5 (0.62 g/mg) had the lowest. The higher bulk density in 100:0:0 and 95:5:5 can be attributed to the dominance of wheat flour, which forms

TABLE 3. Functional Properties of Bread Produced from Wheat, Cowpea Bran and Prekese Flour Blends

SAMPLES	B D(g/mg)	S C(ml/g)	W A(g/g)	O A(g/g)	F C(%)
100:0:0	$0.73^{c}\pm0.02$	$4.21^{d}\pm0.01$	$2.06^{a}\pm0.01$	$1.25^{a}\pm0.10$	$12.51^{a}\pm2.12$
95:5:5	$0.75^{c}\pm0.03$	$5.43^{e}\pm0.04$	$2.29^{b}\pm0.04$	$1.32^{a}\pm0.05$	$9.75^{a}\pm3.88$
90:10:5	$0.65^{b}\pm0.02$	$3.53^{b}\pm0.02$	$2.65^{c}\pm0.12$	$1.47^{b}\pm0.01$	$7.75^{a}\pm3.88$
85:15:5	$0.59^{a}\pm0.01$	$3.92^{c}\pm0.01$	$3.09^{d}\pm0.06$	$1.48^{b}\pm0.05$	$6.60^{a}\pm3.67$
80:20:5	$0.62^{a}\pm0.06$	$3.31^{a}\pm0.01$	$2.81^{c}\pm0.05$	$1.40^{a}\pm0.03$	$5.30^{a}\pm3.25$

Values are means ± SD of 2 replications. Means within a row with the same superscripts are not significantly different ($p>0.05$).

Sample A = wheat 100%, B= wheat 95%; cowpea bran 5%; prekese 5g, C= wheat 90%; cowpea bran 10%; prekese 5g, D= wheat 85%; cowpea bran 15%; prekese 5g, E= wheat 80%; cowpea bran 20%; prekese 5g

A well-structured gluten network that traps air and maintains a compact crumb. As the proportion of cowpea bran and prekese flour increased, the bulk density decreased, likely due to the disruption of the gluten network by non-gluten proteins and fibers. According to a study by Adebowale *et al.* (2015), the incorporation of legume flours can reduce bulk density by interfering with starch gelatinization and protein interactions, leading to a less compact crumb structure. This is supported by research from Oladipo et al. (2018), who emphasized the importance of optimizing ingredient ratios to achieve the desired crumb structure. Furthermore, the findings underscore the potential of cowpea bran and prekese flour as functional ingredients for modifying bread texture, provided that their incorporation levels are carefully controlled.

The swelling capacity of the bread samples varied significantly ($p< 0.05$), with 95:5:5 (5.43 ml/g) exhibiting the highest value, followed by 100:0:0 (4.21 ml/g), 85:15:5 (3.92 ml/g), 90:10:5 (3.53 ml/g), and 80:20:5 (3.31 ml/g). The notable high swelling capacity of 95:5:5 can be attributed to the optimal balance between wheat flour and cowpea bran, which likely enhanced starch gelatinization and water absorption. As the proportion of cowpea bran increased further, the swelling capacity decreased, possibly due to the competition for water between starch and non-starch components, such as fibers and proteins. This is consistent with findings by Oladele *et al.* (2017), who reported that high levels of dietary fibers can limit starch swelling by absorbing water and forming gels.

Results of present study showed increase in water absorption capacity from 100:0:0 (2.06 g/g) to 85:15:5 (3.09 g/g), with 80:20:5 (2.81 g/g) showing a slight decrease.According to a study by Adelekan *et al.* (2018), the incorporation of legume flours can enhance water absorption due to their high fiber and protein content, which form gels and complexes with water molecules. This increase highlights the potential of cowpea bran and prekese flour as functional ingredients for improving the hydration properties of dough. The trends in water absorption have significant scientific implications for the development of composite flours. The results suggest that the incorporation of cowpea bran and prekese flour can enhance water absorption, improving dough hydration and bread texture.

Oil absorption showed a slight increase from 100:0:0 (1.25 g/g) to 90:10:5 (1.47 g/g) and 85:15:5 (1.48 g/g), with 80:20:5 (1.40 g/g) showing a slight decrease. The higher oil absorption in 95:5:5 to 85:15:5 can be attributed to the presence of cowpea bran, which contains proteins and fibers that can interact with oil molecules. Prekese flour, with its bioactive compounds, may also contribute to increased oil absorption by forming complexes with lipids. According to a study by Adetunji *et al.* (2019), the incorporation of legume flours can enhance oil absorption due to their high protein and fiber content, which can bind to oil molecules. This highlights the potential of cowpea bran and prekese flour as functional ingredients for improving the lipid-binding properties of dough.

Foaming capacity decreased significantly ($p< 0.05$), from 12.51-5.30%), with no significant differences .As the proportion of cowpea bran and prekese flour increased, the foaming capacity decreased, likely due to the disruption of the gluten network and the presence of non-gluten proteins and fibers. According to a study by Olaoye et al. (2016), the incorporation of legume flours can reduce foaming capacity by interfering with protein-protein interactions and destabilizing air bubbles.

Mineral Contents of Wheat, Cowpea Bran and Prekese Flour Blends

The result for mineral contents of wheat, cowpea bran and prekese flour blends are presented in Table 4.2. In this study calcium content in the flour blends showed no significant differences ($p> 0.05$), among the samples, with values ranging from 235.22 mg (85:15:5) to 375.28 mg (100:0:0). Calcium is an essential mineral for bone health and cellular functions, and its presence in the flour blends can be attributed to the natural mineral content of wheat, cowpea bran, and prekese flour. The relatively high calcium content in 100:0:0 suggests that wheat is a significant source of this mineral. However, the addition of cowpea bran and prekese flour did not significantly alter the calcium content, indicating that these ingredients do not contribute substantially to calcium levels. According to a study by Adeyemi *et al.* (2018), the mineral content of composite flours is influenced by the inherent mineral composition of the individual components and their interactions during processing. More also, calcium in flour blends is typically bound to proteins and fibers, which can affect its bioavailability. Cowpea bran, with its high fiber content, may form complexes with calcium, reducing its solubility and absorption. Prekese flour, with its bioactive compounds, may also influence calcium bioavailability by interacting with mineral-binding agents. These modifications can affect the nutritional quality of the flour blends, as noted by Oladipo *et al.* (2020).

The iron content in the flour blends showed no significant differences ($p > 0.05$), among the samples, with values ranging from 6.35 mg (95:5:5) to 52.58 mg (100:0:0). The relatively high iron content in 100:0:0 suggests that wheat is a significant source of this mineral as described by Obafemi *et al.* (2021).

Table 4. Mineral Contents of Wheat, Cowpea Bran and Prekese Flour Blends

SAMPLES	CALCIUM 100/MG	IRON 100/MG	ZINC 100/MG	POTASSIUM 100/MG
100:0:0	$375.28^{a}\pm176.74$	$52.58^{a}\pm67.14$	$54.06^{a}\pm64.99$	$505.13^{b}\pm7.08$
95:5:5	$275.85^{a}\pm0.00$	$6.35^{a}\pm0.01$	$5.42^{a}\pm0.00$	$477.35^{a}\pm0.01$
90:10:5	$290.03^{a}\pm0.01$	$9.77^{a}\pm0.00$	$7.45^{a}\pm0.01$	$594.33^{c}\pm0.01$
85:15:5	$235.22^{a}\pm0.00$	$12.33^{a}\pm0.00$	$8.56^{a}\pm0.01$	$635.87^{d}\pm0.00$
80:20:5	$335.34^{a}\pm70.71$	$16.63^{a}\pm0.01$	$6.57^{a}\pm0.01$	$485.14^{a}\pm0.02$

Values are means ± SD of 2 replications. Means within a row with the same superscripts are not significantly different ($p>0.05$).

Sample A = wheat 100%, B= wheat 95%; cowpea bran 5%; prekese 5g, C= wheat 90%; cowpea bran 10%; prekese 5g, D= wheat 85%; cowpea bran 15%; prekese 5g, E= wheat 80%; cowpea bran 20%; prekese 5g.

The zinc content in the flour blends showed no significant differences ($p > 0.05$), among the samples, with values ranging from 5.42 mg (95:5:5) to 54.06 mg (100:0:0).

Prekese flour, with its bioactive compounds, may also influence zinc bioavailability by interacting with mineral-binding agents. These modifications can affect the nutritional quality of the flour blends, as noted by Oladipo *et al.* (2021). This is supported by research from Akinola *et al.* (2022), who emphasized the importance of optimizing mineral content in composite flours to address nutritional deficiencies.

The potassium content in the flour blends showed significant differences ($p > 0.05$), among the samples, with values ranging from 477.35 mg to 635.87 mg. The relatively high potassium content in 85:15:0 (85% wheat, 15% cowpea bran, 5g prekese) suggests that cowpea bran is a significant source of this mineral. The addition of prekese flour may also contribute to increased potassium levels, as it is known to contain bioactive compounds that can enhance mineral retention. According to a study by Olaoye *et al.* (2021), the mineral content of composite flours is influenced by the inherent mineral composition of the individual components and their interactions during processing.

Sensory Evaluation of Bread Produced from Wheat, Cowpea Bran and Prekese Flour Blends

The result for the sensory evaluation of bread produced from wheat, cowpea bran and prekese flour blends are showed in Table 4.5.The appearance of the bread samples showed significant differences, with 100:0:0 (100% wheat) scoring the highest (8.55), followed by 95:5:5 (7.83), 90:10:5 (7.08), 85:15:5 (5.73), and 80:20:5 (5.35). The superior appearance of 100:0:0 can be attributed to the uniformity and consistency of the wheat flour, which produces a well-structured crumb and crust. As the proportion of cowpea bran and prekese flour increased, the appearance scores declined, likely due to the darker color and denser crumb structure associated with these ingredients. Cowpea bran contains pigments and fibers that can alter the visual appeal of bread, while prekese flour may contribute to uneven browning due to its bioactive compounds.

Table 5: Sensory Evaluation of Bread Produced from Wheat, Cowpea Bran and Prekese Flour Blend.

Samples	Appearance	Flavour	Colour	Mouth feel	General Acceptability
100:0:0	$8.55^{e}\pm0.07$	$7.83^{e}\pm0.03$	$8.34^{d}\pm0.03$	$8.38^{e}\pm0.03$	$8.58^{e}\pm0.03$
95:5:5	$7.83^{d}\pm0.03$	$6.67^{d}\pm0.11$	$6.75^{c}\pm0.07$	$7.85^{d}\pm0.07$	$7.88^{d}\pm0.03$
90:10:5	$7.08^{c}\pm0.11$	$6.25^{c}\pm0.07$	$6.18^{b}\pm0.03$	$6.67^{c}\pm0.03$	$6.88^{c}\pm0.11$

Samples	Appearance	Flavour	Colour	Mouth feel	General Acceptability
85:15:5	$5.73^{b}\pm0.03$	$5.68^{b}\pm0.03$	$6.14^{b}\pm0.10$	$6.18^{b}\pm0.07$	$6.45^{b}\pm0.07$
80:20:5	$5.35^{a}\pm0.07$	$5.33^{a}\pm0.03$	$5.45^{a}\pm0.07$	$4.75^{a}\pm0.07$	$4.45^{a}\pm0.07$

Values are means ± SD of 2 replications. Means within a row with the same superscripts are not significantly different ($p>0.05$).

Sample A = wheat 100%, B= wheat 95%; cowpea bran 5%; prekese 5g, C= wheat 90%; cowpea bran 10%; prekese 5g, D= wheat 85%; cowpea bran 15%; prekese 5g, E= wheat 80%; cowpea bran 20%; prekese 5g.

CONCLUSION

The analysis of bread produced from wheat, cowpea bran, and prekese flour blends revealed significant improvements in the nutritional and functional properties of the composite flours. The incorporation of cowpea bran and prekese flour increased the protein, fiber, and mineral content, particularly potassium, while reducing carbohydrate levels, making the blends more nutrient-dense. However, the addition of these ingredients also influenced functional properties such as bulk density, swelling capacity, and moisture content, as well as sensory attributes like flavor and texture. The sensory evaluation of the bread samples revealed a clear preference hierarchy with 100:0:0 being the most favored, followed by 95:5:5, 90:10:5, 85:15:5, and 80:20:5 in order of decreasing preference. Notably, 80:20:5 was the least preferred, primarily due its high content of cowpea bran.

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