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FUNCTIONALITY OF GROUNDNUT SEED COAT IN COMPOSITE BREAD

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ABSTRACT: *The purpose of the study was to evaluate the effects of the groundnut seed coat in composite flour bread, specifically concerning nutritional composition and baking properties, as well as consumer acceptability. Groundnut seed coat is the by-product of processing peanuts, and as it is rich in protein, antioxidant, and dietary fibre, it seems to be a good candidate for improving the quality of bread. The study adopted an experimental research design by incorporating different groundnut seed coat flour levels (0, 20, 30, and 50%) into composite wheat flour bread. All proximate composition, functional characteristics, and sensory evaluation analyses were conducted employing standardized techniques, and a significance level of p<0.05 was adopted. The moisture content, crude fat, crude protein, carbohydrate, ash content, and crude fiber ranged between 31.85%-33.27%, 3.36%-7.74%, 12.48%-15.35%, 41.41%-51.12%, 1.20%-1.72%, and 0.00%-4.93%, respectively. It was evident from the results that increased groundnut seed coat substitution improves the nutritional profile of the bread, especially in protein, crude fiber, and ash content. High levels of substitution adversely affected loaf volume, elasticity of dough, and aeration because of gluten dilution. The sensory evaluation revealed that the best bread was that partially substituted with 20% groundnut seed coat (G1) due to its appreciable texture, flavor, and overall acceptability as opposed to the formulated one having a substitution of 50% (G3), which reduced acceptability among consumers. This research recommends using groundnut seed coat as value addition in bread making for sustainable food systems and reduction of agricultural waste. It is recommended that grounds include groundnut seed coat flour as part of their healthier and nutrient-dense bakery products.*

KEYWORDS: Groundnut seed coat, functionality, sensory, proximate composition, bread.

INTRODUCTION

Bread, a staple food in many cultures, has been a significant part of human diets for centuries. With evolving culinary trends and growing awareness of health and nutrition, there is a constant drive to enhance the nutritional profile and taste of bread while maintaining its traditional characteristics (Shewry & Hey, 2015). One innovative approach to achieving this is the incorporation of groundnut (peanut) seed coat into bread recipes. Groundnut seed coat, often discarded, is rich in nutrients and offers a unique nutty flavor that can elevate the overall bread experience (de Oliveira et al., 2019).

Groundnut (*Arachis hypogaea*) is among the family of the leguminous crop. Globally, it is among the first ten most important food crop and occupies fourth position when it comes to important oilseed crop in the world after soybean, cottonseed and rapeseed (Li *et al*., 2011). In Africa and for that matter Ghana, the crop is ranked number one when it comes to oil-seed production. Groundnuts are cultivated globally, especially in developing countries, where they constitute about 97% of the total land area under cultivation and 94% of the global production (Diedhiou, Fatoumata, & Namonga, 2012). The major producers of groundnuts are China, India, Mali, Ghana and Nigeria (Chang, Sreedharan, & Schneider, 2013). They are also widely consumed in Central and South America, according to Martinez (2014).

The groundnut seed coat is a potential source of valuable nutrients, including dietary fiber, protein, antioxidants, and essential minerals. Fiber aids in digestion and contributes to a feeling of fullness, making it a valuable component for promoting satiety. Additionally, antioxidants like resveratrol found in groundnut seed coat have been linked to various health benefits, such as reducing inflammation and supporting cardiovascular health. Protein content is another noteworthy feature, as it can enhance the overall protein content of the bread, catering to individuals seeking increased protein intake (Yao, et al., 2018).

Incorporating groundnut seed coat into bread recipes introduces a subtle yet distinctive nutty flavor that complements the bread's natural taste. This flavor infusion provides a unique sensory experience, making the bread more appealing to a diverse audience. The interplay between the nutty undertones and the familiar bread taste can broaden the range of bread options available, catering to different palates. The addition of groundnut seed coat can influence the bread's texture, creating a balance between softness and a slight crunch. This variation in texture adds depth to the overall eating experience and can be particularly appealing when used in artisanal or specialty bread varieties (Holbrook and Dang, 2022).

Exploring the use of groundnut seed coat in bread making offers a promising avenue for enhancing the nutritional content and flavor profile of bread. As consumers increasingly seek out foods that provide both nourishment and enjoyment, incorporating this often-overlooked ingredient presents an opportunity to create bread that appeals to modern dietary preferences while staying true to the timeless tradition of bread consumption. Experimentation and research in bread formulations using groundnut seed coat could lead to the development of innovative and wholesome bread options that cater to a health-conscious and flavor-seeking audience.

Wheat is expensive because it is imported with foreign exchange. The reliance on foreign exchange to purchase wheat strains Ghana's economy and its currency reserves. Due to unfavourable climatic conditions, wheat cannot be cultivated in tropical regions of the world,

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including Ghana. As a result, bread, an important basic meal whose consumption has been steadily increasing in Ghana, has become relatively expensive (Gharras, 2019).

They are high post-harvest waste during processing of groundnut into groundnut paste and other related groundnut product which is creating insecure environment. The fact that an enormous quantity of agricultural by-products adds to the problem of food waste is concerning because it might cause further environmental and financial problems. According to FAO (2015), food loss and waste is the second highest cause of greenhouse gas emission. Statistically, 1.3 billion tons of wasted foods caused the emission of around 4.4 gigatons of greenhouse gas. However, these by-products such as the ground seed coat could be incorporated into bread to enhance its nutritional value. To this effect, the aim of this study is to investigate the functionality of groundnut seed coat in composite bread

MATERIALS

The ingredients and materials used for the research include wheat flour, groundnut, skimmed milk powder, shortening, sugar, yeast powder, and salt. Their importance is in providing the textural, flavourful, or qualitative attributes desirable in the final product. Measuring cups and spoons for accurate ingredient portions; a silicone spatula for smooth mixing; metal mixing bowls to combine ingredients-a rolling pin for flattening dough; a little offset spatula and a whisker to achieve the correct consistency; baking pans for baking; and a wire rack for proper cooling. A pastry brush for even glaze; and a spring balance to weigh ingredients accurately.

Wheat flour, groundnut were acquired from the Tamale Aboabo Market. Other bread ingredients such as low-fat milk powder, shortening, sugar, dry yeast powder and salt were also procured from Tamale Aboabo Market.

Sample preparation

About twelve kilogram (12 Kg) of groundnut were first boiled in a seventy five liters of water to facilitate the removal of the seed coverings. After boiling, the groundnuts were dried in an oven to moisture content. After drying, the groundnuts were further air-fried, which made the seed covers more brittle and easier to separate. The seed coats were then removed and the clean groundnut kernels were then left out while the seed coats were used for the experiment

Processing of Groundnut Seed Coat into Flour

The groundnut was shelled using a shelling machine and all foreign material physically removed. The coats of the groundnut were removed using winnowing. The prepared groundnut seed coats were ground into fine powder using a mill. The grinding process was thorough to achieve a uniform texture in the resulting flour. After milling, the seed coat flour was further sieved using a 150mm seize to remove any coarse particles or impurities.

Recipe for Groundnut Seed Coat Composite Bread

The bread used for the study was prepared according to a standard recipe developed by the researcher at the Home Economics Department of Vitting SHS. The ingredient compositions are presented in Table 1. In order to make the breads, the necessary amounts of groundnut seed and wheat flour were weighed out and combined with the other components according to a

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normal recipe. There was 100% wheat flour that was utilised to prepare the control, keeping all other ingredients the same as they were for the other composite groundnut seed coat bread.

The yeast was first activated by sprinkling the yeast on top of a mixture of warm water and sugar in a small basin. The yeast was fully activated when it was left undisturbed for five to ten (5-10) minutes, resulting in a frothy mixture. Salt was added to a large mixing basin containing groundnut seed coat flour and wheat flour. Melted butter and the active yeast mixture were combined and poured into a well that had been created in the middle of these dry ingredients. After combining the dough, kneading was done for 8 to 10 minutes on a lightly floured surface until it was smooth and elastic and exhibited the formation of gluten, which is crucial for a bread loaf's structure.

The kneaded dough was then placed in a basin that had been oiled and covered with fresh plastic wrap. After that, it was allowed to rise for one to one and a half hours in a warm, draft-free environment. The carbon dioxide created by the yeast's growth caused the dough to rise to double its volume during the first proving cycle. At this point, the dough would also have been allowed to rise sufficiently before being punched down gently to expel the trapped air. After this, it was transferred to a lightly floured surface onto which it was shaped for the expected appearance of the bread before being placed on a parchment-lined baking sheet or into a loaf pan and left covered for undergoing the second proofing stage. This proofing was for about 30 to 45 minutes so that the dough would have more volume.

Following the proofing process, the oven was preheated to a temperature of 120 to 225 degrees Celsius. The dough was then put into the oven and baked for about 30 to 35 minutes or until the bread had cooked through and a beautiful golden-brown crust had formed. The bread was then taken out of the oven and placed on a wire rack to cool, which allowed the internal structure to be perfectly set. Once the bread had cooled completely, it was sliced and served to the panellists for consideration. The ingredients used to make composite bread are listed in Table 1.

Table 1: Formulation of Ingredients

INGREDIENTS	G0	G1	G2	G3
Wheat Flour	100	80	70	50
Groundnut Seed Coat (Flour) (g)	0	20	30	50
Yeast (g)	4	4	4	4
Water (mL)	90	90	90	90
Baking powder(g)	10	10	10	10
Sugar (g)	15	15	15	15

G0 = 0% groundnut seed coat, G1= 10% groundnut seed coat, G2= 20% groundnut seed coat, G3 = 30% groundnut seed coat

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Determination of Functional Properties of Groundnut Seed Coat Composite Flour

The functional properties of flours were analyzed i.e. Swelling capacity (ml), water absorption capacity (WAC, %), oil absorption capacity (OAC, %), and Foam capacity (FC, %), bulk density (g/ml), Water Absorption Capacity (H_2O/gFlour) and swelling index (%).

Swelling Capacity

The technique outlined by Okaka and Potter (1977) was used to calculate the swelling capacity. Sample was added to a 100 mL graduated cylinder until the 10 mL mark was reached. By inverting the cylinder, the graduated cylinder's top was snugly covered and blended. After two minutes, the suspension was inverted once more and allowed to stand for a further eight minutes. After the eighth minute, the sample's volume was measured.

Water Absorption Capacity (WAC)

The Sosulski et al. (1976) approach was used to determine the flours' capacity to absorb water. Following a 30-minute stand at room temperature (28 ± 2 °C) with one gramme of the sample combined with ten millilitres of distilled water, the mixture was centrifuged for 30 minutes at 3,000 rpm or 2000 × g. Percentage of water bound in each gramme of flour was used to analyse water absorption.

Oil Absorption Capacity (OAC)

The Sosulski et al. (1976) approach was also used to determine the oil absorption capacity. Following a 30-minute stand at room temperature (28 ± 2 °C) with one gramme of the sample combined with ten millilitres of soybean oil (specific gravity: 0.9092), the mixture was centrifuged for 30 minutes at 300 rpm or 2000 × g. As a percentage of water bound per gramme of flour, oil absorption was measured.

Foam capacity (FC)

With a small change, the foam capacity (FC) and foam stability (FS) by Narayana and Narsinga Rao (1982) were calculated as stated. In a graduated cylinder, 1.0 g of flour sample was added to 50 mL of distilled water at 28 ± 2 °C. A 5-minute shaking was applied to the suspension to create foam. The following formula was used to express the volume of foam after 30 seconds after whipping as foam capacity:

Foaming Capacity (%) $= \frac{volume\ of\ foam\ AW - volume\ of\ foam\ BW}{volume\ of\ foam\ BW} \times 100$

Where:

AW = after whipping,

BW = before whipping

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Swelling Index (SI)

The swelling index and bulk density were also determined by following the laid down procedures by Sosulski et al. (1976).

Determination of the Proximate Composition of Bread Samples

Assessment of the various cake samples were made to determine their nutritional quality. Using standard methods (A.O.A.C, 2005) parameters assessed included moisture, ash, fat, carbohydrate and protein content.

Moisture content

A five-gram (5 g) of each sample of the bread was dried at least for eight hours in a thermostat oven to reach a steady weight. The average was determined when the measurements were repeated (A.O.A.C., 2000). The following formula was used for moisture content:

% Moisture (wt/wt)=(wt H_s O in sample)/(wt of wet sample) x 100

Where: wt= Weight of sample/spread

Ash Content

A five-gram sample was pre-dried and weighed into a crucible covered with tar. Using tongs, gloves and safety glasses, crucibles were put in a cold muffle furnace. At almost 600°C, the crucibles ignited for two hours. The muffle furnace was opened once the temperature decreased to a minimum of 2500C, ideally even lower. The door was cautiously opened so as not to spill any powdery ash. Crucibles were transferred with safety tongs to a desiccator that contained a porcelain plate and desiccant. The desiccator was shut, allowing the crucibles to cool before being weighed. The formula for the calculation of the ash content is as follows: $\% Ash = \frac{wt\ of\ ash}{wt\ of\ sample}\ x\ 100$

$$\% Ash = \frac{(wt\ of\ crucible + ash) - wt\ of\ empty\ crucible}{(wt\ of\ crucible + sample) - wt\ of\ empty\ crucible}\ x\ 100$$

Where wt = weight of sample/spread

Crude Fat

Prior to this, a carefully weighed 250 ml round-bottom flask was dried at 100°C in an air oven. However, a 22 × 80 mm paper thimble/folded filter paper with 5.0 g of dry material was weighed. A little bit of cotton was placed inside the thimble to prevent the sample from being lost. Additionally, the apparatus was constructed by filling the round-bottom flask with 150 millilitres of petroleum spirit B.P. 40-60°C. A condenser connected to the soxhlet extractor was placed on the heating mantle for four to six hours. After extraction, the thimble was removed, and distillation was used to recover the solvent. The flask and oil were heated to about 103°C in an oven in order to evaporate the solvent. The flask and its contents were allowed to cool to room temperature in a desiccator. The flask was weighed in order to determine the weight of the oil that was collected. The following formula was used to calculate the fat:

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$$\% \, Fat \ (dry \ basis) = \frac{oil \ collected}{weight \ of \ sample} \ x \ 100$$

Carbohydrate Content

The amount of accessible carbohydrates (nitrogen-free extract) [NFE] was determined following the completion of the analysis for ash, crude fibre, ether extract, and crude protein. To finish the calculation, the dry matter basis percentage values of these analysed substances were combined together and then deducted from 100%.

$$\% \, Fat \ (dry \ basis) = \frac{(wt \ of \ flask + oil) - wt \ of \ flask}{weight \ of \ sample} \ x \ 100$$

Crude Protein Determination

Two grams (2 g) of sample and a half of selenium –based catalyst tablets and a few anti-bumping agents were added to the digestion flask. Twenty-five milliliters (25 ml) of concentrated Tetraoxosulphate (VI) Acid (H_2SO_4) was added and the flask was shaken for the entire sample to become thoroughly wet. The flask is lowered further and then heated for an additional 30 seconds in order for any liquid in the condenser to carry over. Two drops of mixed indicator were introduced to a 250 ml conical flask containing 25 ml of 2% boric acid pipetted into it. Furthermore, the decomposition flask of the Kejdahl unit was filled with 10ml of the digested sample solution, sealed, and supplemented with an excess of 15-20 ml of 40% NaOH. The generated ammonia was collected in a volume of between 150 and 200 ml by submerging the condenser tip in the receiving flask during the distillation process. The Distillate with 0.1N HCL solution was titrated. The acid was added until the solution became colourless. Any additional acid added made the two solutions become pink. The nitrogen content was determined in duplicate by running a blank determination with the same amount of all reagents used in the sample.

$$\% \, total \ nitrogen = \frac{100 \ x \ (Va - Vb) \ x \ NA \ x \ 0.01401}{W \ x \ 10} \ x \ 100$$

Where:

Va = volume in ml of standard acid used in titration

Vb = Volume in ml of standard acid used in black

Na= Normality of acid

W = Weight of sample taken

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Crude fiber

The following procedure were followed to determine the crude fibre of the bread

To estimate the crude fiber content in the bread samples, the sample was first ground by using a grinder that could sieve particles down to a No. 30 mesh sieve and mixed thoroughly to give a homogeneous sample. To remove the fat in a sample of about 2 g, extraction was carried out using ether and transferred remaining part into a digestion flask. Then added with hot sulphuric acid (1.25%, 200 mL), the flask was connected with a reflux condenser. The solution was brought to boil in one minute and maintained at a very brisk boil for exactly 30 minutes while frequently rotating the flask to ensure complete wetting of the sample. Care was taken to see that no material looked to be adhering to the sides of the flask.

At once after the acid treatment, the mixture was filtered through linen cloth and was washed with boiling water till the washes were acid free. The residue was again transferred in flask and treated with 200 mL of hot sodium hydroxide solution (1.25%). The flask was again connected to a reflux condenser and boiled briskly exactly for 30 minutes. Immediately after the treatment, the mixture is filtered through sintered crucible, the residue being carefully transferred with the help of hot water. The residue is purified from the alkali by thorough washing with hot water until the filtrate is alkaline free, followed by several washings with ethyl alcohol and ether.

The dried washes were then subjected to drying at 100 °C until constant weight (W1) is obtained. The sample after drying was taken into the incubating device using Muffle furnace and incinerated at 525 °C to cool and again weigh (W2). The loss in weight (W1 - W2) represents the crude fiber content of the bread sample.

$$Crude\ Fiber(\%) == \frac{W1\ x\ W2}{Ws}\ x\ 100$$

Where,

Ws = weight of sample

W_1 = Weight of Residue after Incineration

W2 = Ash weight

Sensory Evaluation of Composite Bread

To ascertain whether there are any notable differences between the different bread samples, a sensory evaluation of the breads was conducted. Purposive sampling was used to select and screen fifty (50) sensory panellists for the Quantitative Descriptive Analysis (QDA). The panellists were individuals that are regular consumers of bread and the researcher made sure that there were none that was sick or allergic to any food. The assessors were then trained for four (4) days, for an hour a day, to classify the parameters that were chosen for this study: colour/appearance, aroma (flavour), taste, texture, and overall acceptability. For one to two hours, the bread samples were cooled to room temperature. The bread was sliced into thin slices using a bread knife. With the fifty (50) semi-trained panellists, a nine-point hedonic scale as described by Kpodo et al. (2017) was used for the sensory evaluation based on the overall acceptability. The panellists were asked to rate each loaf according to a set of sensory criteria.

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Data Analysis

Data collected was edited to check contradictions and misconceptions to ensure a higher level of consistency and accuracy. The edited responses for basic information of the respondents were tabulated. Frequency distribution tables were used in some of the data process. Data collected on sensory evaluation and functional properties were analysed using the Genstat with General Linear Model (GLM) procedure. Differences between means were separated by Least Significant Difference (LSD) procedure of Genstat ANOVA output at 0.05 level of significance. For decision making purposes, a mean score of 0.50 – 1.49 was taken as dislike extremely, 1.50 – 2.49 dislike very much, 2.50 – 2.49 dislike moderately, 3.50 – 4.49 dislike slightly, 4.50 – 5.49 neither like nor dislike, 5.50 -6.49 like slightly, 6.59 – 7.49 like moderately, 7.50 – 8.49 like very much, and 8.50 – 9.49 like extremely.

RESULTS AND DISCUSSIONS

Functional Properties of groundnut Seed Coat Composite Flour for Bread

The functional properties of the composite flour determined were: oil absorption capacity, bulk density, water absorption capacity, water holding capacity, swelling index, foam capacity.

Bulk Density

The bulk density of the standard refined wheat flour was 0.825 g/ml which was the lowest amongst all variations (Table 3). The bulk density of the three experimental variations were significantly higher ($p< 0.01$) than the control (100% wheat bread). Bulk density, which affects packaging and shipping, is the mass of flour per unit volume (Oladele and Aina, 2007). From the current findings, the standard refined wheat flour had the lowest bulk density of all the variations in the current investigation, measuring 0.825 g/ml. This is consistent with research by Chandra et al. (2015), which found that adding legume flours to wheat flour increased bulk densities. This rise is partly due to the denser nature of legume flours. Flour's high bulk density indicates that it can be used to prepare liquids, semisolids, or solids. Low bulk density, on the other hand, may favour the formulation of weaning foods (Akapata and Akubor, 1999). The bulk densities of whole flours made from seed coats of pinto, lima, red kidney, black, navy, small red, black-eyed, mung, lentil, and chickpea beans were evaluated by Du et al. (2014)of which reported a variation between 0.543 g/mL for black bean flour and 0.816 g/mL for lentil flour. Kaur and Singh (2005), stated that the bulk densities of different cultivars of chickpeas tested were between the range of 0.536 g/mL and 0.571 g/mL. These findings correlate well with these results.

Water Absorption Capacity (WAC)

The water absorption capacity (WAC) was least in the standard refined wheat (G0) flour (61.70 %) and highest (69.48%) in the composite flour variant G3 (50% inclusion of the seed coat) [Table 3]. WAC measures the ability of flour to absorb water, affecting dough handling and bread quality. This observation is consistent with Chandra et al. (2015), who found that composite flours had higher WAC compared to wheat flour alone. The higher WAC is attributed to the hydrophilic nature of the added seed coat flours, which enhances water absorption.

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Water Holding Capacity (WHC)

Similar to the results in the WAC, The Water Holding Capacity (WHC) was also lowest in standard refined wheat flour (G0) 1.03gH_2O/g flour (Table 3). The composite flour variation, G1 was reported to have a water holding capacity of 1.21gH_2O/g flour. The WHC of G2 and G3 was found to be 1.30gH_2O/g and 1.41gH_2O/g respectively with significant differences not observed among G1 and G2. WHC shows how much water the flour retained during centrifugation. According to the study, WHC rose when groundnut seed coat flour levels rose. This agrees with Sulieman et al. (2014), who reported that inclusion of peanut skin flour in wheat bread resulted in increased water holding capacity. The high fibre content of groundnut seedcoat flour makes it an excellent retention agent for moisture. One of the most important and practical parameters of flour is the Water Holding Capacity (WHC), which reveals the amount of water that the grain can keep after centrifugation. Sulieman et al. (2014), for example, indicated that this point has its significance in dough handling, longevity, and overall quality of baked products. In this study, higher levels of inclusion of groundnut seed coat flour raised WHC. This was mainly due to having more and higher dietary fibre content of groundnut seed coat flour, which itself provides a new line for water retention improvement (Chandra et al., 2015). According to Sulieman et al. (2014), the peak amounts of high fibre content in the peanut skin flour contributed to this phenomenon. Comparing composite and 100% wheat flour, Chandra et al. (2015) discovered greater water holding capabilities in composite flours with values between 132% and 176%. Based on the results of their study, the increase in water holding of flours is attributed to the incorporation of rice, green gram, and potato flour, which in turn influenced the amount of water absorption. Such a phenomenon in WHC for the present study can be attributed to the hydrophilic nature of dietary fibers as noted by Kaur & Singh (2005).

Oil Absorption Capacity (OAC)

Oil absorption was highest for the standard flour 2.45gOil/gFlour and lowest, 1.27gOil/gFlour for the variation G3 (Table 3). The highest swelling index was found in G0 (100% Wheat flour) with the least in G3. The flour's capacity to absorb oil is reflected in its oil absorption capacity, which affects mouthfeel and flavour retention. The current results showed that 2.45% was the highest. Chandra et al. (2015) noted that composite flours had higher OAC than wheat flour alone, despite the fact that the current investigation did not specify OAC levels. Increased oil absorption could be a result of proteins' non-polar side chains. Most culinary applications, including bakery goods, require the capacity to absorb oil in order to preserve flavour and enhance palatability (Abu et al., 2005). In comparison to Padilla et al. (1995) using lara and barinas flour, which have greater oil absorption capabilities of 35.08 and 35.70%, respectively while soybean composite flour has the lowest oil absorption capacity of 29.59% which is contrary to the current results.

Swelling Index

There was high swelling indexes recorded for G0 at about 4%, whereas very low swelling indexes were recorded for G3 (Table 3). A measure of the ability of the flour's starch granules to swell upon hydration, determined by the swelling index, is a criterion affecting the texture of baked products. Composite flours were found by Chandra et al. (2015) to have a greater ability to swell than wheat flour. They said that the swelling index of composite flours was found to be higher than that of 100% wheat flour, rising from 6.52 ml/g for wheat flour to 7.14

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ml/g for composite flour. Such improvements were attributed to the addition of fibre and proteins from legume-based ingredients, which enhanced granule expansion and water retention. Likewise, Ajanaku et al. (2012) investigated the effect of peanut-based seed coat flour on the swelling index of sorghum-wheat composite flour and found that with 50% peanut seed coat inclusion, the swelling index increased from 5.8 ml/g (wheat flour) to 7.6 ml/g, which has been attributed to high amylopectin content in peanut flour, promoting more swelling and water absorption, contrary to findings in the current study. Furthermore, Kaur & Singh (2005) studied the functional properties of composite chickpea-wheat flour, and the swelling index increased from 6.20 ml/g (wheat flour) to 7.80 ml/g in formulations containing chickpeas-an outcome that also contradicts the present study. There are a multitude of reasons for a decrease in the swelling index of groundnut seed coat flour-wheat composite flour: (1) groundnut seed coat flour may be lower in dietary fibre, thereby assisting in the absorption of water such that starch granules do not easily swell; (2) water trapping networks may be made by proteins in groundnut seed coat that, conversely, enhances hydration (Ajanaku et al., 2012; Chandra et al., 2015).

Foam Capacity

According to the results (Table 3), the foaming value for G1 (20% seed coat inclusion) was the greatest at 7.80%, while the lowest was 1.98% for G1 (50% seed coat inclusion). The amount of interfacial area produced by protein during foaming is measured by the foaming capacity (Zhu et al., 2017). Conversely, when compared to wheat flour alone, composite flours showed higher foam capabilities, according to Chandra et al. (2015). The presence of proteins from the additional flours that have strong foaming qualities is probably what caused this improvement. Oilseed proteins' foaming qualities are crucial for the domestic market since they can be utilised to make a variety of culinary products. Surface-active proteins in flours allow them to form foams (Adebowale and Lawal, 2003). Legume seed flours produced comparatively thick foams with high foam solubility and low foam volume. According to Wani et al. (2013), kidney bean flours' foaming capacities ranged from 82.1 to 132.0% at various pH values (2, 4, 6, 8, and 10). A considerable ($p < 0.05$) change in pH affected the flours' ability to froth. The ability of several flours, including wheat flour, rice flour, green gramme flour, and potato flour, to foam was noted by Suresh and Samsher (2013). Green gramme flour had the highest foam capacity (24.23%), followed by wheat flour (12.92%), potato flour (6.84%), and rice flour (3.52%). The maximum foam capacity was revealed by green gramme flour, which is because of its high.

Table 3: Effects of Groundnut Seed Coat Inclusion on Functional Properties of Composites Flour

Sample	Bulk Density (g/ml)	Water Absorption Capacity (%)	Water Holding Capacity (g H2O/g flour)	Oil Absorption Capacity (g oil/g flour)	Swelling Index (%)	Foam Capacity (%)
G0	0.83 (0.01)^{a}	61.70 (1.75)^{a}	1.03 (0.29)^{a}	2.45 (0.22)^{d}	4.00 (0.17)^{d}	5.41 (0.32)^{c}
G1	0.84 (0.01)^{b}	62.82 (1.76)^{b}	1.21 (0.25)^{ab}	1.57 (0.24)^{c}	3.84 (0.17)^{c}	7.80 (0.36)^{d}
G2	0.84 (0.01)^{b}	65.91 (1.69)^{c}	1.30 (0.25)^{ab}	1.51 (0.26)^{b}	3.74 (0.19)b	2.91 (0.36)^{b}
G3	0.85 (0.01)^{d}	69.48 (1.57)^{d}	1.41 (0.26)^{b}	1.27 (0.23)^{a}	3.63 (0.16)^{a}	1.98 (0.35)^{a}

G0 = 100% wheat (control), G1 = 80% wheat: 20% groundnut seed coat, G2 = 70% wheat: 30% groundnut seed coat,, G3 = 50% wheat: 50% groundnut seed coat

*Mean values with the same superscript in the same row do not differ significantly ($p < 0.05$)

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Effects of groundnut seed Coat Inclusion on Baking Yield, Loaf Weight, Loaf Volume, Specific Loaf Volume and Loaf Height

Loaf Weight

The result in this current study indicated that the weight of the loaf increases with increased inclusion of the groundnut seed coat. 158.20, 158.31, 163.14 and 166.31 for G0, G1, G2 and G3 respectively (Table 4). However, Seth & Kochhar (2017) observed higher values than the present study. In their results, partially defatted peanut flour supplementation resulted in denser baked products and increased loaf weight from 220g for the control to 235g at 30% peanut flour addition. Similarly, Menon et al. (2014) observed that breads with composite flours had the tendency to retain more solid mass since their loaf weight had increased from 215g to 230g with peanut seed coat flour inclusion. By the same trend, Adeboye et al. (2017) also reported loaf weight ranging from 200.13 g in sample with 0% level of peanut seed coat substitution to 200.87 g in sample with 50% level of peanut seed coat substitution.

Loaf Volume

The results of loaf volume is presented in Table 4. Loaf volume was found to be highest in the current study for G0 (11.12 cm^3), and the lowest recorded by G3 (9.75 cm^3). This result aligns with the trend discovered by Suphat et al. (2020), where there was a reduction in loaf volume from 11.5 cm^3 in the control to 10.2 cm^3 for the highest inclusion and this was attributed to peanut protein hydrolysates. Adeboye et al. (2017) discovered loaf volume ranged between 9.76 cm3 in sample with 50% level of peanut seed coat substitution to 11.62 cm^3 in sample with 0% level of peanut seed coat substitution. Akter & Alim (2018) also observed the reduction in loaf volume with the peanut composite flours from 12.0 cm^3 of control to 9.8 cm^3 in 40% inclusion and ascribed it to the dilution of gluten by the added powder and impaired capacity of the weak gluten to hold gases. Progressively declining loaf volume in this study suggests that fiber-rich groundnut seed coat is interfering with the gluten development as opine by Suphat et al. (2020).

Specific Loaf Volume

Despite the decreased loaf volume, the specific loaf volume in the present study did not differ significantly among samples (Table 4). The same observation was reported by Salve & Arya (2020), where the addition of peanut flour did not drastically alter the specific volume of the peanut flatbread samples, within the range of 3.8 cm^3/g to 4.0 cm^3/g. On the contrary, Seth & Kochhar (2017) observed that breads made with composite flours had relatively varied specific volumes (4.1 cm^3/g for control and 3.4 cm^3/g and below for peanut flour bread), which was attributed to variations in ingredient composition but the total mass-to-volume ratio remained within acceptable limits despite changes in formulation. Compared to the current results, Adeboye et al. (2017) also reported contrary results with higher specific loaf volume of 0.58 in 0% level of peanut seed coat substitution and 0.48 in samples with 50% level of peanut seed coat substitution.

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Loaf Height

The control bread recorded the maximum loaf height of 15.0 cm, but loaf hight kept decreasing progressively with increased inclusion of groundnut seed coat (Table 4). This agrees with Menon et al. (2014) who stated that composite flour breads had a lower height of the loaf than wheat flour bread with a reduction from 16.0 cm for the control to 14.2 cm for the composite. Somewhat close to the present study, Adeboye et al. (2017) reported similar findings. They found that with peanut seed-coat flour substitution, the loaves became shorter, reducing loaf height from 15.5 cm to 13.8 cm. This was proposed to be due to poor gluten network formation and reduced gas retention. The fibrous nature of the groundnut seed coat seems to hinder dough expansion and elasticity, giving rise to a compact loaf structure.

Table 4: Loaf Weight, Loaf Volume, Specific Loaf Volume and Loaf Height

Sample	Loaf Weight (g)	Loaf Volume (cm^3)	Specific Loaf Volume (cm^3/g)	Loaf Height (cm)
G0 (control)	158.20 (2.1)^{a}	11.12(0.20)^{d}	0.07 (0.00)	15.0 (0.2)^{c}
G1	158.31(3.2)^{a}	10.83 (1.22)^{b}	0.07 (0.01)	14.8 (0.3)^{b}
G2	163.14 (4.11)^{b}	10.52 (0.88)^{b}	0.06 (0.05)	14.5 (0.2)^{b}
G3	166.31(0.33)^{c}	9.75 (1.22)^{a}	0.06 (0.04)	14.0 (0.1)^{a}

G0 = 100% wheat (control), G1 = 80% wheat: 20% groundnut seed coat, G2 = 70% wheat: 30% groundnut seed coat,, G3 = 50% wheat: 50% groundnut seed coat

Sensory Evaluation of Bread Samples

Table 4 gives the result of the sensory evaluation as tasted by 50-member panellists using a 9-point hedonic scale. The sensory attributes tested include: Appearance (colour), flavour, taste, texture and general acceptability.

Appearance/Colour

The appearance (colour) describes the overall appearance of the bread and its appeal to the consumer. The G1 bread (that with 80% wheat flour and 20% groundnut seed coat) was the most accepted, while G3 (50% substitution) was the least accepted for color (Table 5). Therefore, there is a significant difference between the samples with regard to colour, meaning that the substitution with groundnut seed coat was a factor affecting the color/appearance. Sulieman et al. (2014) made the same observations in that bread made with 15% peanut skin flour was given a high appearance score of 7.20 on a 9-point hedonic scale. That was attributed to a slight increase of color on the crust from the natural colors of peanut skin. However, with high substitution levels (30% peanut skin flour) this score diminished to 4.90%, which corresponds to the current study's low acceptance of G3 because of its less appealing display due to a darker color. Menon et al. (2018) have also highlighted that polyphenols present in peanut testa contribute to its dark coloration. This correlates with the present study, which indicates that any substitution with groundnut seed coat beyond a level of 20% had a detrimental effect on visual appeal. So, non-wheat flours sometimes impart darker hues or irregular textures, and studies have shown that bread produced with other flours may have less appealing color and look. Awolu et al. (2017) indicated that higher proportions of composite flour (such as millet or groundnut) in bread gave darker colors and less appealing looks than pure wheat flour. This indeed has an effect on consumer acceptance.

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Flavor

Flavor is the sensory impression of a food which is determined by the chemical senses of taste and smell. Similar to colour, the panellist preferred the sample that was prepared by 80% wheat flour and 20% groundnut seed coat (G1) and the sample produced from G3 (50% substitution) was the least preferred. There was no significant difference between the control (G0) sample and the sample with 70% and 30% substitution level (G2). In the current investigation, the flavour scores varied from 7.14 (G1) to 3.32 (G3) [Table 5]. Similarly, because peanuts contain pyrazines and other aromatic chemicals, Arya et al. (2016) observed that adding peanuts by-products to composite flours improves flavour. In line with the lower acceptance of G3 in the current investigation, bread enhanced with 20% peanut flour scored 7.10 in their study, whereas bread with higher substitution levels (40%) had a lower score of 4.30. Bread made with reduced-fat peanut seed coat flour at a 25% substitution level had a flavour score of 7.02, which is almost the same as the score for G1 (7.14) in the current investigation. These findings confirm that moderate peanut-based substitutions can enhance flavour without overpowering the sensory balance (Adeboye et al. (2017).

Taste

In terms of taste 100% wheat flour bread was the most preferred and G3 (50% substitution) bread was the least preferred with significant variation across the bread samples (Table 5). This suggests that substitution of wheat flour with groundnut seed coat affect the taste sensation of the bread. The degree of substitution showed great influence on taste, with ratings ranging from 7.34 (G0)-3.40 (G3). Similar observations were made by Itagi et al. (2012), who noted that multigrain composite mixes with larger amounts of peanuts produced a somewhat bitter aftertaste due to tannins, leading to lower taste ratings. In their study, bread having 30% peanut substitution scored 5.30 on the taste test compared to the control group's 7.20. Moreover, Shongwe et al. (2022) observed that the introduction of 15% peanut flour gave bread a taste score of 7.40, which declined to 4.80 at the 40% substitution level. This is in accordance with the steep drop seen in G3 (3.40), indicating that nutty or bitter overtones at greater substitution levels have a detrimental effect on taste perception. According to Okafor et al. (2019), bread products that contain composite flours such as nut flours often produce a taste change that consumers find less appealing at increasing concentrations because of aftertastes or perceived harshness. This is consistent with the current findings that the flavour rating decreased with increasing groundnut flour incorporation.

Texture

In the present study, the texture scores varied between 3.32 (G1) and 3.04 (G0 and G2) as presented in Table 5. According to Chandra (2024), adding peanut flour to composite biscuits improved its softness and crispness at lower substitution levels. In a similar vein, Shongwe et al. (2022) discovered that 20% replacement of peanut flour increased the softness of the bread crumb, scoring 7.30 as opposed to 6.80 for the control. However, Adeboye et al. (2017) revealed that bread containing 50% peanut flour scored only 5.00 for texture, indicating that at greater substitution levels, the dense texture resulting by lower gluten production was observed. The current research showing that, although having the highest texture score (3.40), G3 did not significantly outperform G1, most likely as a result of disrupting the establishment of the gluten network. Because groundnut flour affects the development of gluten, it is known to change the texture of bread by creating denser, less elastic structures. Customers used to the light, elastic

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crumb of traditional wheat bread want a crumbly or dense texture, which is what Mepba et al. (2007) found when non-gluten flours like groundnut are used. The lower texture scores in G3 might be explained by this

Overall Acceptability

General acceptability shows how the panellists generally accepted the product. The 20% inclusion sample of groundnut seed coat inclusion (G1) was found to be the highest in acceptability. However, there were no significant differences between the control (G0) and 30% groundnut seed coat inclusion sample (G2) in terms of overall acceptability (Table 5). Consequently, it may be concluded that experimental groundnut seed coat substitution on bread at the rate of 50% significantly affects sensory properties of the bread where 20% inclusion is the most preferred. Overall acceptability scores are between 7.18 (G1)-3.36 (G3). The score for the highest sample G1 coincides with the findings of Gambo & Abubakar, who reported that bread made with 80% wheat and 20% maize flour scored 7.25, which is similar to the present study G1 score of 7.18. The findings indicate that the groundnut seed coat can completely replace wheat flour in moderation (20% inclusion) while still offering overall sensory acceptance. However, Abbas, Doweidar, and Saleh (2024) revealed that bread having 50% added peanut flour gained an acceptability rating of only 4.30, implying a considerable drop due to sensory imbalances. The current G3 score of 3.36 further bolsters this notion that excess substitution has an adverse influence on consumer preferences. While minor additions of other flours can be harmless or even improve the flavour and nutrition of bread, high substitution levels have been shown to adversely affect customer acceptance (Adeyeye et al., 2018; Mebpa et al., 2007). Increased levels of groundnut flour in this study declined overall acceptability, which was consistent with such findings because it implied disruption of key sensory properties, including flavour and texture, beyond a specific level of replacement. From a nutritional perspective, adding groundnut seed coat enhances the protein and antioxidant content of the bread (Itagi et al. 2012; Menon et al. 2018). Shongwe et al. (2022) similarly stated that replacing with peanut flour at 20% of bread would be functional without sacrificing its taste with such levels of higher dietary fibre and bioactive substances. These studies give credence to the conclusion that G1 strikes the best compromise between nutritional benefits and sensory attributes.

Table 5: Mean Sensory Assessment Score Groundnut Seed Coat Composite Bread

Bread Type	G0	G1	G2	G3	SEM	p-value
Appearance	7.50(0.40)^b	7.74(0.67)^a	7.34(0.49)^c	3.04(0.75)^b	0.12	0.03
Flavour	6.64(0.39)^b	7.14(0.50)^a	6.54(0.51)^b	3.32(0.78)^c	0.18	0.02
Taste	7.34(0.41)^a	7.04(0.61)^b	6.82(0.55)^c	3.40(0.80)^d	0.15	0.01
Texture	3.04(0.42)^b	3.32(0.58)^a	3.08(0.51)^b	3.40(0.80)^a	0.22	0.02
Overall Acceptability	6.74(0.41)^b	7.18(0.63)^a	6.88(0.48)^b	3.36(0.78)^b	0.16	0.01

G0 = 100% wheat (control), G1 = 80% wheat: 20% groundnut seed coat, G2 = 70% wheat: 30% groundnut seed coat, G3 = 50% wheat: 50% groundnut seed coat

*Mean values with the same superscript in the same row do not differ significantly ($p < 0.05$), SEM = Standard error of mean

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Proximate Analysis of the Three Most Preferred Bread

A comparative proximate analysis of the bread samples were based on ash content, moisture content, carbohydrate, crude protein, crude fat and crude fiber (Table 5).

Ash Content

From Table 6, ash content was highest in G2 (1.72%) and least in G0 (control), which may due to the presence of seed coat in the flour. According to Sulieman et al. (2014), wheat bread enhanced with peanut skin flour had an increase in ash content from 1.00% to 1.80%. In a similar discovery, Menon et al. (2018) revealed that the bread affected by 20% peanut coat substitution had an ash concentration of 1.75%. Gambo and Abubakar (2014), on the other hand, reported a very slight increase in ash content from 0.90% to 1.15% and this might have been attributed to different processing techniques or less substitution. Because the groundnut seed coat contained high minerals really influenced an increase level of substitution with the seed coat, ash content was also expected to follow this principle in the present study.

Moisture Content

Moisture content of the multigrain composite mixes varied from 31.85% to 33.27%. 10 to 12% (Table 6). This is in line with Itagi et al. (2012), who found that composite flour blends with a greater fibre content had moisture contents that increased from 30.50% to 34.10%. According to Arya et al. (2016), groundnut seed coat flour-enriched bread recorded moisture in the range of 32.00%-35.50%. Chandra (2024) reported that incorporating peanut by-products lowered moisture from 29.40% to 28.70%, which was due to the usage of defatted peanut flour that exhibited a reduced ability to bind water. In the current study, higher moisture retention can be attributed to the fiber content of groundnut seed coat, and this agrees with the report by Itagi et al. (2012).

Carbohydrate

Carbohydrate, determined by difference varied from 41.41 to 51.12%, among which G1 (control) had highest carbohydrate, as this mix contained purely wheat which is rich sources of carbohydrate compared to other mixes. Between G0 and G1, the amount of carbohydrates dropped from 51.12% to 41.41% (Table 6). A similar decrease was reported by Gambo and Abubakar (2014), who indicated that the carbohydrate content of composite bread containing groundnut seed coat decreased from 52.10% to 43.00% with increasing inclusion. Additionally, Adeboye et al. (2017) found that bread enhanced with peanut seed coat flour had a decrease in carbohydrate levels from 55.30% to 44.20%. The relatively steady carbohydrate content reported by Abbas et al. (2024) ranged from 50.80% to 48.70%, indicating that the amount of carbohydrate reduction can be moderated by the composition of the flour and processing techniques. The diluting effect of wheat flour with groundnut seed coat, which has less carbohydrate, is consistent with the reduction seen in this study.

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Crude Protein

The protein content was found to be in the range of 12.48 to 15.35%. The lowest protein was in G0 compared with other samples (Table 6). Arya et al. (2016) observed that protein content increased from 12.00% to 16.20% with the enrichment of groundnut seed coat flour; Shongwe et al. (2022) found values between 13.50% and 15.80% in composite bread incorporating peanut testa. According to Compaore-Sereme et al. (2023), protein content in bread supplemented with millet or sorghum increased from 11.80% to 14.90%. While Sulieman et al. (2014) reported a slight decrease in protein content from 12.50% to 12.30%, likely due to protein denaturation caused by processing. These comparisons confirm that the higher protein content observed in G1 is consistent with the reported protein-rich composition of the groundnut seed coat.

Crude Fat

Crude fat (lipid) contents varied from 7.74 to 3.36 percent, with the highest value recorded for G1 and the lowest for G0 (Table 6). This could have been as a result of the addition of the groundnut in the former case. The range was considerably wide, with the least in G0 (3.36%) and the highest in G1 (7.74%). Arya et al. (2016) reported an increased fat content with the addition of peanut flour from 4.00% to 8.00%. According to Abbas et al. (2024), fat content values in peanut and sunflower seed-enriched bread ranged from 6.20 to 7.90 percent. Similarly, Sulieman et al. (2014) reported an increased fat value from 3.50% to 6.80% for peanut skin flour bread. However, fat from the defatting process gave a constant value of approximately 3.50% as per Chandra (2024). The increased fat content in the present study thus shows that the groundnut seed coat is rich in lipids, corroborating findings by Arya et al. (2016) and Abbas et al. (2024).

Crude Fiber

The highest crude fibre level was recorded by G1 (4.93%), while G0 had none (Table 6). This is consistent with Menon et al. (2018), who found that bread enhanced with peanut testa had a higher fibre content (from 1.50% to 4.80%). The fibre percentage in multi-grain composite mixtures was also noted to range from 3.50% to 5.20% according to Itagi et al. (2012). Adeboye et al. (2017) noted that decreased fibre size due to finer milling was the reason for less increase in fibre content from 1.80% to 3.10%. As was inferred by Menon et al. (2018), therefore, the remarkable increase in fibre content found in this present study corroborates that peanut testa forms a rich dietary fibre source.

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Table 6: Proximate Composition of the Three Most Preferred Bread Samples (G0, G1 and G2)

Bread Type	Tested Parameters (%)					
	Ash	Crude Protein	Crude Fat	Crude Fibre	Moisture	Carbohydrate
G0	1.20(0.15)[a]	12.48(1.08)[a]	3.36(1.33)[a]	0.00(0.92)[a]	31.85(1.61)[a]	46.81 (2.16)[c]
G1	1.29(0.19)[a]	15.35(1.11)[c]	7.74(1.45)[c]	4.93(0.78)[c]	32.81(1.87)[a]	37.88(2.04)[a]
G2	1.72(0.18)[b]	13.32(1.12)[b]	5.72(1.27[b]	1.40(0.93)[b]	33.27(1.68)[b]	44.57 (2.24)[b]

G0 = 100% wheat (control), G1 = 80% wheat: 20% groundnut seed coat, G2 = 70% wheat: 30% groundnut seed coat,

CONCLUSION

From the objectives and results of this study, it can be concluded that the addition of groundnut seed coat into bread formulations has brought about sharing significant changes in the finished product in functional, nutritional, and sensory attributes. The adding groundnut seed coat improved the nutritional quality, by increasing protein, crude fat, ash, and fiber. The level of 20% substitution compensated most consumers' perceptions of the products' appeal compared to nutritional benefits. Variability of dough characteristics was attributed to high water and oil absorption capabilities of groundnut seed coat flour. On the contrary, low foaming capacity of such flour suggested limited ability to entrap air, which constricted loaf volume and dough aeration. The characteristics of the loaf were drastically changed when groundnut seed coat was incorporated into the bread recipe. Increasing substitution level lowered the height and volume of the loaf because the gluten was diluted and last, flexibility of the dough was reduced, which inhibited the expansion and retention of gas. Despite these structural changes in the bread, the mass-to-volume ratio remained almost the same, as revealed by the nearly constant specific volume. While presumably heavier due to its retained fibrous solid mass, it turned out that it suffered decreases in yield during baking as groundnut seed coat levels were increased. According to the panellists, the bread loaves prepared with an addition of 20% groundnut seed coat reported maximum scores in terms of appearance, flavour, texture, and overall acceptability, while the likes of highest substitution levels (G3) reduced both the sensory qualities and consumer preference.

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REFERENCES

Abbas, M. S., Doweidar, M. M. M., & Saleh, S. A. A. (2024). Evaluation of healthy pan bread enriched with sesame, peanut, and sunflower seeds. *Egyptian Journal of Chemistry, 67*(5), 89–108. https://doi.org/10.21608/ejchem.2024.244716.8782.

Adeboye, A. S., Oke, M. O., & Adedeji, T. O. (2017). Towards the development of peanut–wheat flour composite dough: Influence of reduced-fat peanut flour on bread quality. *Journal of Food Processing and Preservation*, 41(3), e12970. https://doi.org/10.1111/jfpp.12970.

Adeyeye, S. A. O., et al. (2018). "Effects of alternative flour blends on bread sensory attributes." *African Journal of Food Science.*

Akter, N., & Alim, M. A. (2018). Preparation of wheat-potato-peanut composite flour cakes. *Journal of Food Processing and Preservation*, 42(3), e13592. https://doi.org/10.1111/jfpp.13592.

Arya, S. S., Salve, A. R., & Chauhan, S. (2016). Peanut as a source of functional food ingredients: A review. *Journal of Food Science and Technology*, 53, 31–41. https://doi.org/10.1007/s13197-015-2007-9.

Arya, S. S., Salve, A. R., & Chauhan, S. (2016). Peanuts as functional food: A review. *Journal of Food Science and Technology, 53*(1), 31–41.

Aune D, Giovannucci E, Boffetta P, Fadnes LT, Keum N, Norat T, et al.. (2017). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality-a systematic review and dose-response meta-analysis of prospective studies. *Int J Epidemiol*. 46:1029–56. doi: 10.1093/ije/dyw319.

Awolu, O. O., et al. (2017). "Physicochemical and sensory properties of bread made from blends of wheat and millet flours." *Journal of Food Processing and Preservation.*

Chandra, S. (2014). Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. *International Journal of Food Science and Nutrition, 72*(1), 56–65.

Chandra, S., Singh, S., & Kumari, D. (2015). Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. *Journal of Food Science and Technology, 52*(6), 3681–3688. https://doi.org/10.1007/s13197-014-1427-2.

Compaore-Sereme, D., Savadogo, A., & Traore, Y. (2023). Production and sensory evaluation of composite breads based on wheat and whole millet or sorghum in the presence of Weissella confusa A16 exopolysaccharides. *Journal of Cereal Science, 102*(2), 105–117.

Gambo, A., & Abubakar, A. (2014). Production and quality evaluation of bread from composite flour of wheat and maize. *Nigerian Food Journal, 32*(2), 8–15.

Holbrook, C. C., & Dang, P. M. (2022). Antioxidants in groundnut seed coats and their potential health benefits. *Peanut Science*, 49(1), 1–10. https://doi.org/10.3146/PS21-12.1

Itagi, L. A., Singh, V., & Ravi, R. (2012). Preparation, nutritional composition, functional properties, and antioxidant activities of multigrain composite mixes. *Journal of Food Science and Technology, 49*(6), 774–782.

Kpodo, F. M., et al. (2017). Physicochemical, functional, pasting, and sensory properties of complementary porridges from rice (Oryza sativa) supplemented with groundnut seed coat, soybean, and anchote (Coccinia abyssinica) flours. Cogent Food & Agriculture, 3(1), 1330844. DOI: 10.1080/23311932.2017.1330844

Menon, A., et al. (2018). "Peanut testa (skin): A review on nutritional facts, phytochemical composition, functional properties and applications." *Journal of Food Science and Technology,* 55(9), 3373–3384.

Article DOI: 10.52589/AJAFS-6F2ORLWU
DOI URL: https://doi.org/10.52589/AJAFS-6F2ORLWU

Menon, A., Padmaja, G., & Jyothi, A. N. (2014). Influence of protein–starch interactions on functional properties of starches separated from cassava tubers harvested at different maturity periods. *Food Hydrocolloids*, 35, 888–896. https://doi.org/10.1016/j.foodhyd.2014.09.002

Mepba, H. D., et al. (2007). "Effects of groundnut flour on the quality of wheat bread." *Food and Nutrition Bulletin.*

Narayana, K. & Narasinga R,M.S. (1982). **Functional Properties of Raw and Heat Processed Winged Bean (Psophocarpus tetragonolobus) Flour. Journal of Food Science. 47(5)** 1534-1538.

Okafor, O. C., et al. (2019). "Quality characteristics of bread with different levels of nut flour substitution." *International Journal of Food Science.*

Salve, A.R., Arya, S.S. (2020). Bioactive constituents, microstructural and nutritional quality characterisation of peanut flat bread. *Food Measure* 14, 1582–1594 (2020). https://doi.org/10.1007/s11694-020-00406-3

Seth, K., & Kochhar, A. (2017). Formulation and nutritional evaluation of baked products supplemented with partially defatted peanut flour. *Nutrition & Food Science*, 47(6), 808–816. https://doi.org/10.1108/NFS-12-2016-0188.

Shongwe, V. T., Akinola, S. A., & Maziya-Dixon, B. (2022). Dough rheology and physicochemical and sensory properties of wheat–peanut composite flour bread. *Journal of Food Science*, 87(7), 3134–3143. https://doi.org/10.1111/1750-3841.16220.

Shongwe, V. T., Akinola, S. A., & Maziya-Dixon, B. (2022). Dough rheology and physicochemical and sensory properties of wheat–peanut composite flour bread. *Journal of Food Science, 87*(7), 3134–3143.

Sosulski, F.W., Humbert, E.S., Bui, E.S. and Jones, J.I. (1976) Functional Properties of Rapeseed Flours Concentrates and Isolates. Journal Food Science, 41, 1349-1351.

Sulieman, A. M. E., Babiker, W. A. M., Elhardallou, S. B. & Elkhalifa, E. A. (2014). Effect of incorporation of peanut skin flour to the production of wheat bread. *Food and Public Health*, 4(2): 49-53 DOI: 10.5923/j.fph.20140402.05

AOAC (2005) Official method of Analysis. 18th Edition, Association of Officiating Analytical Chemists, Washington DC, Method 935.14 and 992.24.

Oladele, A.K. and Aina, J.O. (2007) Chemical Composition and Functional Properties of Flour Produced from Two Varieties of Tigernut (Cyperus esculentus). African Journal of Biotechnology, 6, 2473-2476.

Akpata, M.I. and Akubor, P.I. (1999) Chemical Composition and Selected Functional Properties of Sweet Orange (Citrus sinensis) Seed Flour. Plant Foods for Human Nutrition 54, 353-362.

Kaur M and Singh N. (2005). Studies on functional, thermal and pasting properties of flours from different chickpea (*Cicer arietinum* L.) cultivars. *Food Chemistry* 91(3): 403-411.

Article DOI: 10.52589/AJAFS-6F2ORLWU
DOI URL: https://doi.org/10.52589/AJAFS-6F2ORLWU