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EVALUATION OF BAKING QUALITY OF BREAD FROM COMPOSITE MIXTURE OF WHEAT FLOUR AND P-GLABRA SEED FLOUR

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ABSTRACT

Pachira glabra is one of the abundant underutilized plants in the tropics. The seeds were processed into flour. A sample of the flour were evaluated for physicochemical composition, functional properties, baking test and the bread produced were subjected to sensory analysis. The results of proximate analysis showed that P. glabra flour had significantly higher total fat content, Crude fiber and total ash content (P>0.05), but with lower values of other components when compared with the white wheat flour. The anti – nutrient properties of P. glabra flour such as; Tannins, Phytates, Oxalates and Alkaloids were obtained to be; 3.29, 6.99, 3.74 and 1.98 mg/100g respectively. The functional properties of *P. glabra* flour had significantly higher in WAC, and swelling capacity (P>0.05), but with lower values of forming capacity and OAC, both the two samples had the same value of bulk density. P. glabra flour may find its use in food industry. The volume of the bread obtained after baking test showed a decrease of bread volume with an increase in P. glabra flour substitution. The results of Sensory evaluation gotten from the panelist were statistically analyzed using ANOVA and there was significant difference in colour, aroma and overall acceptability but no significant difference in taste, and texture.

Keywords: *Pachira glabra*, functional properties, anti-nutritional properties, proximate composition, bread and baking quality

INTRODUCTION

Bread is defined as a bakery product made from cereal and other starchy flour moistened and kneaded into dough and then baked (IFIS, 2009). Bread is the major wheat flour product consumed by majority of Nigerians as breakfast, lunch and sometimes dinner (Sanful and Darko 2010), the fourmajor essential ingredients for bread baking are; flour, water, yeast and salt (Ihekoronye, 1985). The consumption and price of bread is steady and increasing in Nigeria, being made from foreign wheat as the major ingredient (Sanful and Darko 2010). A lot of research has been made and still being made to promote the use of composite flours in which a portion of imported wheat flour were replace with a locally grown crops in bread production, thereby decreasing the quantity demanded for imported wheat and increasing the demand of locally grown crops (Sanful and Darko 2010). Advances in food science and Technology has made it possible to produce bake product through partial substitution of wheat flour with other non-wheat flour from cereals, legumes, fruits or vegetables and root or tubers (Arowolo, et.; al 2011).

Wheat (Tritium alstium) is the common cereal grain widely cultivated and utilized in different countries of the world (Nair 2002). Wheat is among the main cereal grains for human consumption, wheat production and demand have continuously increased worldwide which is approximately heading to 770 million tonnes annually, whereas the world trade in this cereal amounts to approximately 190 million tonnes (Collier 2022). The forecasts of wheat production and consumption by the year 2030, According to the Organisation for Economic Co-operation and Development/Food and Agriculture Organization (OECD/ FAO 2021), will amount to approximately 840 million tonnes, and its trade will amount to 220 million tonnes. Research shows wheat as the vital aspect of human diet accounting for 20% of daily calories and protein, its indeed the second most powerful food crop in ensuring food security in underdeveloped countries after rice (Iqbal*et al.*, 2022).It is normally grown on more land area than any other crops, world trade in wheat is greater than for all other crops combines. (Norman 2008).

Pachiraglabra is cheap and readily available fruit, belongs to the family*Bombacaceae*it has long been recognized as a flowering plant with about 28 genera and 200 species (Refaat *et al*., 2013). *P. glabra* is Commonly called Brazil nut, French peanut, Malabar chestnut, Guinea peanut, Money tree, and Lucky tree from different tribes (Sunday *et al.*,2019).*Pachiraglabra*, tree can grow up to 18m with smooth, green capsule, 8 to 20cm in length that splits open naturally when ripe. The fruits are round in shape about 4 to 5cm long, but irregular, which embedded with spongy and fibrous pericarp (Ogunlade*et al*., 2011).

Pachiraglabra plant has wide range of uses, especially for its edible seeds and the seeds are good source of lipids, proteins, carbohydrates and other nutrients that are essential for good health;it could be eaten raw, boiled, fried or roasted. The roasted seeds can be blend/ground to make hot drink similar to hot chocolate. The bark is used for the treatment of stomach problems and headaches, it can also be used in purifying blood (Ogunlade*et al*., 2011). According to Makinde *et al.*, (2016).The oil extracted from the seed is good source of both mono and polyunsaturated fatty acids which are associated with healthimprovement. Processing methods such as, germination, dehulling, boiling, soaking, blanching, roasting, and fermentation have been used to enhance the nutritional quality of food and also reduce the anti-nutrient composition (Makindeet al., 2016).

Pachira glabra is cheap and readily available source of fat, protein and carbohydrate, yet grossly

Underutilized. It is therefore imperative to determine the acceptable ways of utilizing the seed in order to effectively determine its usefulness in the food system, and also understand how some processing methods i.e milling, germination, roasting baking etc. can improve the bio availability of it's nutrients and lastly enhance its usefulness in food system entirely.

(a) (b) (c) (d)

Figure 1**:** Brazil nut (*P. glabra*) fruit (a), pulp (b), fresh seeds (c) and oven-dried seed flour (d).

MATERIALS AND METHODS

Materials

Pachira glabra (Brazil nuts) fruits used for this study was obtained from Akure of Ondo State, Nigeria. The wheat flour was obtained from Kaura Namoda of Zamfara State, Nigeria.

Pre-Processing of the Seeds

Mature fruits were plugged and decorticated manually using a knife. The collected seed were sun dried sliced, shelled and milled using motar and pestle and then stored in a labeled, air tight and sealed plastic bottles until required for analysis (Alhassan and Dajal, 2023)

Determination of functional properties of raw *P.glabra* seeds flour and wheat flour

The water and oil absorption capacity (WAC, OAC) of the flours were determined as described by Fagbemi *et al*. (2012). Distilled water (ρ=1 g/ml) and Executive Chef vegetable oil (ρ=0.92 g/ml) were used for WAC and OAC determinations, respectively. Briefly, to 1.0 g of the flour sample 10 ml of water (for WAC) of oil (for OAC) was added in a beaker and stirred using magnetic stirrer for 5 min. the resulting suspension was centrifuged for 30 min at 2,500 × *g*. The supernatant was decanted and the volume measured. The water or oil absorbed was calculated as the difference between the initial volume of water or oil used and the final volume of the decanted supernatant. The result was expressed in percentages (g/g basis) (Fagbemi *et al*., 2012).

Bulk density was determined as described by Ige *et al.* (1984). Briefly some quantity of the flour sample was transferred to a pre-weighed measuring cylinder (WI) and the new weight (W2) was recorded. The volume occupied by the flour in the measuring cylinder was recorded as V. the bulk density was expressed by the equation below:

$$\text{Bulk density (g/ml)} = \frac{W1-W2}{Volume\ of\ sample} \quad (1)$$

Swelling power and solubility of flour were determined by a method as described by Leach *et al*. (1959). Eight grams (8) of dried sample was mixed with 100 ml of distilled water and heated at varying temperatures between 65 and 95 °C at 5°C interval respectively; in a temp-controlled water bath for 30min with intermittent stirring. After heating, the slurry was centrifuged, the clear supernatant drawn off and evaporated and dried on steam bath to obtain a measure of the dissolved solids. The sediment flour obtained after centrifugation was similarly weighed to get the weight of the swollen flour particle

Calculations:

Swelling power =

$$\frac{Wt\ of\ sedimented\ flour - Wt\ of\ original\ flour\ (8g) \times 100}{Weight\ of\ original\ flour\ (8g)} \quad (2)$$

$$\text{Solubility (\%)} = \frac{Weight\ of\ dissolve\ solids\ in\ the\ supernatant \times 100}{Weight\ of\ original\ flour\ (8g)} \quad (3)$$

Foaming capacity and stability were determined according to the method reported by Coffman and Garcia (Coffman, 1977). A measured quantity of the flour was dispersed in 100 mL distilled water and mixed thoroughly with magnetic stirrer at 1, 500 rpm for 5 min. The foaming mixture was immediately transferred into 250 ml graduated measuring cylinder and the foam volume was measured. The forming capacity was expressed as percentage volume increase (*v/v*, %) as shown below:

Forming Capacity (%) =

$$\frac{volume\ after\ homogenisation - volume\ before\ homogenisation}{volume\ before\ homogenisation} \times 100 \quad (4)$$

Determination of proximate composition and energy value

The proximate composition (moisture content, crude fibre, crude fat, total ash, and crude protein contents) of both grains (wheat and millet) and the flour were determined using standard methods as described by (AOAC, 2012). Carbohydrate content will be determined by difference thus:

Carbohydrate (%)

$$= 100 - (\%\ protein + \%\ fat + \%\ fibre + \%ash + \%\ moisture) \quad (5)$$

Estimation of energy value
The energy value (kca/100 g) was calculated using Atwater factor method described by (Obiegbuna, 2005). The fat, protein, and carbohydrate were multiplied by their physiological fuel values of 9.0, and 4.0 respectively and taking the sum of the products.
Energy value = (4 × P) + (9 × F) + (4 × C) (6)
Where; P = Protein (%), F = Fat content (%),
C = Carbohydrate content (%)

Sensory Evaluation
Sensory evaluation of the bread produced was according to the method described by Iwe (2002), in which 10 panelists on a 9 point hedonic scale for different parameters such as taste, texture, appearance, aroma and general acceptability was employed

Statistical analysis
Except otherwise stated, all determinations were carried out in triplicates, subjected to analysis of variance ANOVA and the means were separated by New Duncan Multiply Range Test (NDMRT). Mean and standard deviation of all the samples were calculated and compared. SPSS for Windows program version 21.0 was used to analyze the results obtained.

RESULTS AND DISCUSSION

Table 1: Proximate composition and energy value of wheat and *Pachiraglabra* flour

Samples	*Pachira glabra flour*	Wheat Flour
Moisture(%)	8.77±0.02[a]	12.88±0.03 [b]
Ash(%)	8.64±0.02[a]	0.67±0.02 [b]
Protein(%)	11.34±0.01[a]	12.56±0.02[b]
Fat(%)	16.38±0.02[a]	1.03±0.01[b]
Fibre(%)	7.08±0.02[a]	0.88±0.02[b]
Carbohydrate(%)	52.78±0.02[a]	72.26±0.03[b]
Energy Value (Kcal/100g)	403.9	348.55

Values are mean ± standard deviation of three determinations. Values with different superscripts in a column are significantly different at p<0.05.

The result of proximate analysis of the wheat flour and *P-glabra* flour samples were presented in table 1. The moisture content of *P-glabra* and wheat flour were 8.77±0.02 and 12.88±0.03 respectively, There was significant difference (p< 0.05) on the moisture content of the two samples. High moisture content of samples indicates higher susceptibility to spoilage and thus lowered the shelf life (FAO, 2003). The higher the moisture content the lower the shelf stability of the products, hence, low moisture content ensures higher shelf stability in dried products. It also has significant impact on product in terms of; taste, texture, appearance, shape and weight (Moore, 2020).
The fat content of *P-glabra* and wheat flour were16.38±0.02 and 1.03±0.01 respectively, there is much significant difference (p< 0.05) in the fat content of the two samples *P-glabra* was observed to have high fat content, the value of the fat content of the *p-glabra* flour obtained in this research is lower than the value (32.27-41.62)g/100g as reported by (Ayodele, 2021). Wheat flour had significantly high protein content (p< 0.05) when compared with the *P-glabra* flour sample. The value of *P-glabra* flour obtained in this research (11.34±0.01) is higher than the value of earlier report of 10.38 g/100gfor *Pachiraglabra* seeds (Ogunlade*et al.,* 2011).
Crude fibre content of (*p glabra* and wheat flour) ranged from 7.08±0.02 to 0.88±0.02 respectively, the result showed much significant different (p< 0.05) between the two samples. The value obtained in this research is higher than the value (5.03±0.04) as reported by (Ayodele, 2021). A lower fibre diet is a risk factor for chronic childhood constipation (Soile 2011). Several research showed the significant role of dietary fibre on the human body i.e prevention of several diseases such as cardiovascular diseases, diverticulosis, constipation, irritable colon, cancer and diabetes (Slavin, 2005).
Ash is the inorganic (mineral) residue remaining after the combustion (Harris, 2017). The ash content of (*P-glabra* and wheat flour) were 8.64±0.02 and 0.67±0.02 respectively, *P-glabra* had significantly high ash content (p< 0.05). The value of *P-glabra* flour obtained in this research is higher than the value (4.61±0.01) of full fatted *P-glabra* flour obtained as reported by (Ayodele, 2021).

Table 2: Functional properties of properties of Wheat flour and *P. glabra* flour

Samples	*Pachiraglabra flour*	Wheat Flour
Bulk density (g/ml)	0.63.	0.63
W.A.C(g/ml)	280.0	0.00
O.A.C(g/ml)	180.0	250.0
Swelling Index (%)	3.43	1.29
Forming Capacity (%)	12.0	22.0

Values are mean ± standard deviation of three determinations. Values with different superscripts in a column are significantly different at p<0.05.

Functional Properties of the raw, germinated and roasted *P. glabra* flours
Forming capacity of the *P-glabra* and wheat flour were 12.01% and 22.0%, *P-glabra* had significantly higher percentage Forming capacity (p< 0.05). The value obtained for forming capacity of *P-glabra* flour were lower than the value (18.2 – 20%) reported for pumpkin (Adawy and Taha 2001). The value obtained was also in close agreement with *P-glabra* nut reported by (Ogunlade *et al*., 2011), suggesting that the flour may not be rich in flexible tension to give a good foaming ability. Oil seed protein (particularly soybean) is used as aerating agent to complements egg white in whipped toppings and frozen desserts as reported by Omowaye *et al.,* (2014).
The *P-glabra* and wheat flour samples for WAC are 280 and 0.00 (g/ml) respectively, *P-glabra* had significantly high WAC (p< 0.05). WAC value of *P-glabra* flour obtained in this research was within the ranged of value (288) obtained in

germinated full fat (GFF) sample as reported by (Ayodele, 2021). WAC is very important in food system because of their effects on flavor, texture and mouth feels of foods product like baked foods, puff-puff, doughnut, pancakes etc. The seed flours may be used to replace some legumes and oil seeds as thickeners used in some liquid and semi-liquid foods (Moore, 2020).

Both the *P-glabra* and wheat flour have the same Bulk density of 0.63 (g/ml), the value of bulk density of all the two samples obtained in this research are lower when compared with the value (2.52g/ml) in Raw full fatted (RFF) flour sample as reported by (Ayodele, 2021). Bulk density value is important in packaging determination, low bulk density of a given products will not offer packaging advantage.

Table 3: Anti- nutritive content of *Pachira glabra* seed flour and wheat flour

Samples	*Pachira glabra flour*	Wheat flour
Tanin (mg/g)	3.29	0·00
Pytate (mg/g)	6.99	2·86
Oxalate (mg/g)	3.74	37.0
Alkaloid (mg/g)	1.98	1.24

Values are mean ± standard deviation of three determinations. Values with different superscripts in a column are significantly different at $p<0.05$.

Anti-nutritional properties (mg/g) and Mineral Phytate Milimolar Of the meals

Table 3: Showed the anti-nutritional properties of *P-glabra* and wheat flour. Anti-nutritional factors are the compounds found in most food substances which are poisonous to humans or in some ways limit the availability of nutrient to the body (Thakur, 2019**)**. The tannin and phytate content of *P-glabra* (3.29 and 6.99 mg/g) are significantly ($p< 0.05$) higher than that of wheat flour (3.29 and 6.99 mg/g). The oxalate content of *P-glabra* flour (3.74 mg/g) is significantly ($p< 0.05$) lower than that of wheat flour (37.0 mg/g). While 1.98 and 1.24 mg/g of the alkaloid content of all the two samples *P-glabra* and wheat flours 1.98 and 1.24 (mg/g) respectively. Phytate lecithin tannins and saponin have been shown to reduce the blood glucose and insulin responses to starchy foods and / or the plasma cholesterol and triglyceride (Gemede and Ratta, 2014).

The low content of antinutrient could be due to the processing method applied to the samples during processing. Phytic acid, tannins, alkaloids, saponins etc. are Heat-stable group and lectins (Thakur, 2019). The presence of several anti-nutritional factors in legumes makes it to possess low protein digestibility and Most of the toxic and anti-nutrient effects of these compounds in plants could be removed by several processing methods such as soaking, germination, boiling, autoclaving, fermentation, genetic manipulation and other processing methods, but extensive research is still needed to discover elimination methods for heat stable anti-nutrients present in various food without altering the nutritional value of food (Thakur, 2019).

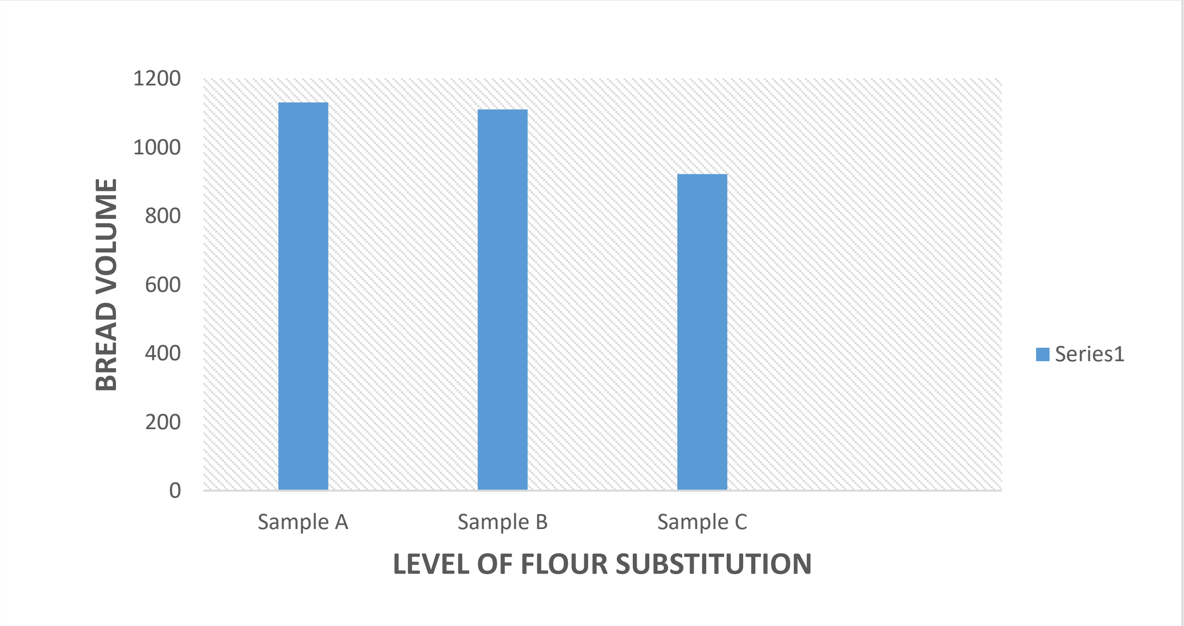

Figure 1: Effect of *P. glabra* seed flour substitution on bread Volume. A = 100 % wheat flour, B =10 % *P-glabra* and 90 % wheat flour and C = 20 % *p glabra* and 80 % wheat flour.
Values are Mean ± SEM; Bars with same alphabet are not significantly different (P<0.05)

Fig. 1 showed the effect of *p.glabra* substitution on the bread bread volume. The results showed the decrease in bread volume with an increase in *P-glabra* flour substitution. There is no much significant difference among all the samples ($p<0.05$). Several research confirmed the production of acceptable bread by replacement of some portion of wheat flour with other non-wheat flour.

Loaf Volume of bread is an important indicator of knowing the characteristics of bread, because it provided the quantitative measurement of baking performance (Krishnan *et al.*, 1987). A small decrease of loaf volume of bread was exhibited in bread sample with 20 % *P-glabra* substitution of this research. The decrease in the bread volume was attributed to the gluten dilution effect (Krishnan *et al.*, 1987), and it was associated with the low protein network of the dough (Rosell *et al.*, 2001). Which resulted in weak gluten interactions with the starch (Oates, 2001). The occurrence of lower loaf volume of the bread was as the result of higher amount of amylopectin of the flour which increased the water retention and decreased the gas retention of loaf during baking and finally resulting in reduced loaf volume of the bread (Lee *et al*., 2001).

Figure 3: Baking Test

Table 4: Sensory Profile of Bread

Sample	Aroma	Colour	Mouthfeel	Texture	O/ Accept.
AA	7.42 ±1.31[b]	7.43 ± 5.65[a]	7.22 ± 1.31[a]	7.05 ± 1.34[a]	7.44 ±1.28[a]
AB	7.23 ±1.12[b]	6.27 ± 1.56[b]	7.25 ± 18[a]	6.88 ± 1.25[a]	7.01 ± 1.42[ab]
AC	6.90 ± 44[a]	6.01 ± 1.21[bc]	6.14 ±1.60[ab]	6.62 ± 1.13[a]	6.30 ± 1.22[c]

Keys: AA = 100 % wheat flour, AB = 10 % *P-glabra flour*, and AC = 20 % *P- glabra flour*. Means with the same letter along the column showed no significant difference (at $p \leq 0.05$). Values are means ± standard deviation.

The results of the sensory analysis of the bread was presented in table 4. Above, There is no significance in all the bread sample produce at 100% wheat flour, 10% and 20% *P-glabra* flour substitution in terms of the Mouthfeel and texture ($p<0.05$). This suggests that the level of substitution does not show much effect on the bread in terms of dough rising and yeasts activities. This is in line with Corriher (2001) statement which stated that, the dough rising due to the carbon dioxide produced by yeasts during fermentation leads to a characteristics porosity and texture of baked products. No significant difference among the bread produce at 100% wheat flour and 10% *P-glabra* flour substitution in terms of the aroma and overall acceptability ($p<0.05$). The bread produce with 20% *P-glabra* flour substitution was significantly different with other two samples in terms of aroma and overall acceptability ($p<0.05$), but bread produced with 100% wheat flour was significantly different with the other two samples in terms of colour ($p<0.05$).
All the bread samples produced were generally accepted by the consumers in relation to their organoleptic properties. The result showed that bread samples were accepted by the panelists. This result agrees with the report of Cheng-Chang*et al*., (2010) where they had a similar result that higher value presents, higher consumer's acceptability.

CONCLUSION

The use of locally available flours i.e non gluten flours from fruits (*P.glabra*) with high nutritional content can be used to produce a composite flour for the production of an acceptable bread with high stability, volume, nutritional status, comparatively good loaf and sensory attributes that could lead to the cost reduction job and wealth creation, reduction on importation bills and enhancement of the food security. It is recommended to use locally available underutilized crops i.e *P.glabra* seed to produce a composite flour for the production of an acceptable bread.

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