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**ORIGINAL ARTICLE**

# Quality Evaluation of Bread Produced with Aqueous Extract of Pawpaw Leaves

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**Abstract**

The chemical, mineral, vitamin and phytochemical composition as well as texture, colour and sensory properties of bread samples produced with extracts of pawpaw (*Carica papaya*) were investigated. The results revealed that the phytochemical content of the bread samples ranged from 0.014 – 0.030mg/100g, 0.965 – 2.560% and 1.100 – 2.035% for glycosides, alkaloid and saponin content respectively. The chemical composition of the bread ranged from 24.10 – 32.38%, 7.74 – 10.18%, 6.94 – 8.69%, 0.36 – 0.65%, 0.55 – 0.99% and 49.42 – 57.21% for moisture, protein, crude fat, crude fibre, total ash and carbohydrate content respectively and increased significantly ($p<0.05$) with addition of pawpaw leaf extracts. The physical properties of the bread samples ranged from 261 – 315.00g, 3.40 – 6.20cm, 350.00 – 671.00 $cm^3$, 1.23 – 2.16 $cm^3/g$ for loaf weight, loaf height, loaf volume and specific loaf volume respectively. Mineral composition of the bread samples ranged from 55.05 – 74.38mg/100g, 3.66 – 5.67 mg/100g, 87.11 – 111.74%, 299.82 – 417.17%, 0.56 – 0.63mg/100g, 36.57 – 39.86 mg/100g for calcium, iron, potassium, sodium, manganese, magnesium and zinc respectively while vitamin content ranged from 10.50 – 22.14mg/100g, 0.07 – 1.09mg/100g and 0.08 – 0.47mg/100g for ascorbic acid, thiamine and riboflavin content respectively. Texture profile of the samples ranged from 464.00 – 2065N,6.45 – 8.49, 118.00 -774.00, 0.08 – 0.19, 216 – 1020, 0.54 – 0.76 and 0.27 – 0.54 for hardness, stringiness, chewiness, resilience, gumminess, springiness and cohesiveness respectively, while colour characteristics ranged from 1.49 – 13.99, 11.68 – 2.40 and 15.21 – 21.88 for lightness (l), redness (a) and yellowness (b) respectively. Sensory rating of the samples ranged from 2.42 – 8.32, 2.21 – 7.00, 2.68 – 6.89, 2.00 – 7.89 and 1.89 – 8.05 for taste, colour, texture, flavour and overall acceptability respectively. The bread sample produced from pawpaw leaves extracted by soaking was highly preferred. Hence, this research shows that pawpaw leaf extracted by soaking could be beneficial for bread production.

***Practical application***

The findings of this research work will not only create more varieties of breads but also ensure provision of functional breads with higher nutrient impact to consumers without limiting the availability of pawpaw fruits.

**Key words:** Anti-oxidants, Bread, Extract, Pawpaw leaves, Wheat flour



## 1. Introduction

Bread is one of the most widely embraced food products consumed daily by most people in different countries (Kaim & Goluch, 2023). It is a vital source of easily consumed and digestible carbohydrate. More recently, common foods are increasingly being considered or modified to become functional foods (Siro *et al.,* 2008). Bread has been an ideal matrix in which functional nutrients can be delivered to the consumer in an acceptable form (Czajkowska-González *et al.*, 2021; Kaim & Goluch, 2023).

Pawpaw (*Carica papaya* Linn) is a tropical fruit that is highly appreciated worldwide for its nutritional value, flavour and digestive properties. It is a rich source of some natural antioxidants such as vitamins A, B, C, E and β-carotene and some minerals such as potassium (K) and magnesium (Mg). In addition, Varastegani *et al.* (2015) indicated that dried pawpaw contained bioactive components that are beneficial to human health, thus recommending its addition to wheat flour as composite flour. The presence of numerous phytochemicals (saponin, phenol, terpene, oxalate, tannin, steroid, phytate and alkaloids) in pawpaw leaves have been documented (Sharma et al., 2022; Olumide et al., 2023). The extracts of these pawpaw leaves have also been reported to have significant health benefits including anti-inflammatory activity (Owoyele *et al.,* 2008), antioxidants and anticancer activities (Maisarah *et al.* 2014, Sharma *et al.,* 2022). It is also therapeutic against dengue fever and dengue heamorragic fever (Saiful et al. 2023) and preventing many other diseases (Sharma *et al.,* 2022).

The relative abundance and all year availability of pawpaw provided a great advantage to explore its potentials beyond raw consumption of the fruit.

Previous studies have reported the inclusion of pawpaw puree in baked products including cookies and breads (Ansari *et al.,* 2014; Varastegani *et al.* 2015; Bolarinwa *et al.* 2020) Nowadays, pawpaw is used in baked products in special diets for consumers concerned about weight reduction (Varastegani *et al.,* 2015). Pawpaw based products can also be used as carbohydrate-based and fat-reducing agents in baked food recipes. When pawpaw puree is used in the preparation of baked foods, it leads to a decrease in trans-fatty acid, total fatty acid, caloric content while increasing the overall nutritional value (Ansari *et al.,* 2014; Bolarinwa *et al.,* 2020). However, these may create undue unavailability of the whole fruit for direct consumption if adopted, hence the need to look other parts of the pawpaw tree which are often considered a waste.

The leaves, seeds and peels are often regarded as waste (Lira *et al.,* 2023), but they could be explored for further utilization with great interest in unlocking their nutraceutical benefits. Extracting the bioactive components from these materials may reduce the waste from the pawpaw fruits industry while tapping into the various aforementioned ethnomedical benefits.

Sharma *et al.* (2022) documented the utilization of pawpaw leaves in herbal juice beverages and herbal green tea while Lira *et al.* (2023) reported the production of bread with pawpaw seed flour but literature is dearth of the incorporation of pawpaw leaves extract in bread despite the elucidated potential benefits. Thus, the quest for foods with functional properties using pawpaw leaves which have lesser competitive advantage served as the basis for this study. The study therefore aims to evaluate the quality of bread produced with extracts of pawpaw leaves obtained by different methods.



## 2. Materials and Methods

### *2.1. Materials*

Matured leaves of male pawpaw tress were obtained from a farm at First gate in Ikorodu Local government area of Lagos State, Nigeria while wheat flour, margarine, yeast, sugar, egg, salt and milk were obtained from a local market in Ikorodu metropolis of Lagos State.

### *2.2. Production of pawpaw leaves extracts*

#### *Extraction by soaking*

The method described by Handa *et al.* (2008) was employed. Five hundred grams (500 g) of the pawpaw leaves were washed, sliced and then soaked in a stoppered container containing 500ml of distilled water for 12 h with frequent agitation. The mixture was filtered using Whatman filter paper No. 4 to obtain the extract which was labelled OFA.

#### *Extraction by boiling*

Papaya leaves extract was obtained by boiling as described by Kandil *et al.* (1994). Briefly, 500g of pawpaw leaves were cleaned, washed and shredded into pieces in 500 ml of distilled water at 100°C, after which they were boiled for 15min. The mixture was then filtered using Whatman filter paper No. 4 and the obtained extract was labelled PAC.

#### *Extraction by blending*

Extract of papaya leaves was obtained by blending; adopting the method described by Hasmila *et al.* (2019). For this, 500g of pawpaw leaves were washed thoroughly in tap water and then cut into pieces. The pawpaw leaves were crushed using a blender in 500ml of water. The mixture obtained was filtered through Whatman No. 4 filter paper and labelled PCA.

### *2.3. Production of bread*

Bread was produced using the method described by Chase (2014) with minor modifications. The ingredients (flour (200 g), sugar (25g), salt (5g), yeast (using 0.5 Mc Farland standard), water (pawpaw leaves extract) (100ml) and fat (40g)) were mixed using a Kitchen Aid TM mixer (Kitchen Aid Inc., St. Joseph, Michigan) fitted with a paddle attachment to form a dough. The dough was molded, oiled and placed into an already oiled pan before proofing for 30mins. This was then baked at 200°C for 15 min, the baked bread was cooled to room temperature before subjecting to laboratory analysis. Each bread sample was appropriately labelled with the extract used in the production while the control (without extract) was labelled FBF.

### *2.4. Analysis*

#### *2.4.1. Phytochemical Analysis of Papaya Leaf Extract and Bread*

The phytochemical compositions of the pawpaw leaves extracts as well as that of produced bread were determined using the method of Harborne (1973) for alkaloids, Brunner (1984) for saponin and Sofowora (1993) for glycosides.

#### *2.4.2. Chemical Composition*

The freshly baked bread samples were analysed for proximate composition according to AOAC (2005) methods.



#### *2.4.3. Determination of Mineral and Vitamin content*

Mineral composition was done using Atomic Absorption Spectrophotometer (AAS) as described by AOAC (2005). Vitamins B1 and B2 were assayed using SKALAR Analyzers (2000) while ascorbic acid was analyzed using the method of AOAC (2005).

#### *2.4.4. Physical properties*

Loaf volume and loaf weight were measured using Rapeseed displacement method (AACC, 2000), and a laboratory scale (CE- 410I, Camry Emperors, China) respectively. Specific loaf volume was calculated as volume to mass ratio ($cm^3/g$) while loaf height was measured using a meter rule.

### *2.4.5. Texture Analysis*

Loaf texture was evaluated using texture analyzer (Model CT310K Texture Analyzer, USA). Texture profile analysis was performed on the central bread slices by TPA test with a 3mm cylindrical stainless steel TA44 probe, with the following characteristics: Downward speed was 0.5 mm/s and upward speed 0.5 mm/s with a trigger load of 4.0 g. Texture TA-RT-KI/ Load cell: 10 kg). The TPA parameters such as hardness (g) springiness (mm) cohesiveness, resilience, chewiness and gumminess were evaluated according to Guinee (2003).

### *2.4.6. Sensory Evaluation*

The sensory properties of bread samples were evaluated using twenty self-consenting panelists consisting of staff and students of the Department of Food Technology, Lagos State Polytechnic, Lagos, Nigeria. Samples were evaluated for crust colour, flavour, texture, appearance and overall acceptability using ninepoint Hedonic scale (where 1 = disliked extremely and 9 = liked extremely) Bread was considered acceptable by consumers if their mean scores of acceptability were at least 5 or higher (Lazaridou *et al.,* 2007). A slice of bread from each huge chunk was presented to panelists. Each panelist was provided with a glass of tap water to rinse the mouth between evaluations. Panelists were given questionnaires to record scores (degree of likeness) during the tasting sessions.

### *2.4.7. Statistical Analysis*

Data obtained were subjected to analysis of variance (ANOVA). Duncan Multiple Range Test (DMRT) was used in separating the means using Statistical Package (SPSS) 19 version 2011. Significant differences were expressed at $p < 0.05$.

## 3. Results and discussion

### *3.1. Phytochemical Compounds of Pawpaw Leaf Extracts*

The result of some phytochemical compounds in the pawpaw leaves extracts is presented in Table 1. The glycosides content ranged from 0.01 – 0.07 mg/100g. The highest was found in PAC (extracted by boiling) while the lowest was occurred in OFA (extracted by soaking). There was significant difference ($p<0.05$) among the samples except sample OFA. Alkaloids, a secondary metabolite observed in the extracts have toxicity against cells of foreign organisms. Its activities have been widely studied for their potential use in the elimination and reduction of human cancer cell line (Ugo *et al.,* 2019). Saponins which are produced as plant defense mechanism against foreign pathogens, thus acting as natural antibiotics (Okwu & Emenike, 2006) were not detected in all the extracts. This is contrary to previous studies (Owoyele *et al.,* 2008; Maisarah *et al.,* 2014; Saiful *et al.,* 2023).This observation could be attributed to the method and conditions of extraction. The medium of extraction affects plant constituents and respective concentrations. Juárez-Rojop *et al.* (2014) reported varying concentrations of plants constituents in hexane, chloroform and ethanol extracts of pawpaw leaves. However, this study did not employ the use of chemicals in the extraction of plant constituents due to safety consideration. Water is generally deemed the safest and the most environmentally friendly solvent. These bioactive phytochemicals found in pawpaw have been reported to possess a wide range of biological activities that can be of valuable therapeutic index (Saiful *et al.,* 2023).

**Table 1.** Phytochemical composition of aqueous extract of pawpaw leaves

| Sample | Glycosides (mg/100g) | Alkaloids (%) | Saponin (%) |
|---|---|---|---|
| FBF | — | — | — |
| PAC | $0.07 \pm 0.02^{b}$ | $1.07 \pm 0.04^{a}$ | ND |
| OFA | $0.01 \pm 0.00^{a}$ | $1.21 \pm 0.04^{b}$ | ND |
| PCB | $0.03 \pm 0.00^{ab}$ | $1.10 \pm 0.02^{a}$ | ND |

*Values are means of two replicates. Mean values ± standard deviation followed by different superscripts across columns are significantly different ($p \leq 0.05$); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending. ND= Not Detected

### *3.2. Phytochemical composition of bread samples*

The phytochemical composition of bread samples produced with pawpaw leaves extracts is as presented in Table 2. Sample PCB had the highest concentration of all the phytochemical components investigated. Glycosides content ranged from 0.014 – 0.030 mg/100g with no significant difference ($p<0.05$) among the samples except in sample PCB. Alkaloid and saponin content differed significantly ($p<0.05$) in the bread samples ranging from 0.965 – 2.560% and 1.100 – 2.035% respectively. The highest was found in PCB (extracted by blending) while the lowest was observed in PAC (extracted by boiling). There was significance difference ($p<0.05$) among the samples. The increased saponin content in the bread samples may be attributed to additive effect of saponin from the wheat flour utilized in the bread making process. Further, the reduction in the cardiac glycoside in the bread after baking might be due to the application of heat. Overall, bread produced with pawpaw leaf extracts using the various extraction techniques had phytochemical (glycosides, alkaloids and saponin) content greater than the raw extracts, suggesting that the pawpaw leaf extracts retained the phytochemicals, even after subjecting to baking while the wheat flour used also contributed. Serventi (2011) confirmed stability of saponins during bread making. According to Akubor *et al.* (2017), wheat flour contained 0.8 mg/100g saponins, 0.5 mg/100g alkaloids, 0.8 mg/100g glycosides, amongst others.

### *3.3. Proximate composition of bread produced with aqueous extracts of pawpaw leaves*

The proximate composition of bread produced with pawpaw leaf extract is presented in Table 3. The moisture content ranged from 24.10 – 32.38%. The highest was found in PAC (extracted by boiling) while the lowest was observed in PCB (extracted by blending). There was significant difference ($p<0.05$) among the samples except samples FBF (extracted by soaking) and PAC. The moisture content obtained in this study is lower than values (31.04-36.39%) reported by Peluola-Adeyemi *et al.* (2021) for bread made

**Table 2.** Phytochemical composition of bread samples

| Sample | Cardiac glycosides (mg/100g) | Alkaloid (%) | Saponin (%) |
|---|---|---|---|
| FBF | 0.017±0.00$^{a}$ | 0.000±0.00$^{a}$ | 0.000±0.00$^{a}$ |
| PAC | 0.014±0.00$^{a}$ | 0.965±0.02$^{b}$ | 1.100±0.00$^{b}$ |
| OFA | 0.014±0.00$^{a}$ | 1.375±0.06$^{c}$ | 1.675±0.04$^{c}$ |
| PCB | 0.030±0.02$^{b}$ | 2.560±0.09$^{d}$ | 2.035±0.08$^{d}$ |

*Values are means of two replicates. Mean values ± standard deviation followed by different superscripts along columns are significantly different (p≤0.05); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending

from wheat flour and different proportions of avocado paste. The crude protein content of the bread ranged from 7.74 – 10.18% with significant difference (p<0.05) existing among the samples. The highest was found in PAC (extracted by boiling) while the lowest was observed in FBF (control). This is in line with the findings of Ugo *et al.* (2019) who reported that pawpaw leaf extract could be used to supplement other sources of protein. Bolarinwa *et al.* (2020) did not observe significant increase in the protein content of bread produced with pawpaw pulp. The crude fat content ranged from 6.94 – 8.69% with the highest found in PCB (extracted by blending) while the lowest was observed in PAC (extracted by boiling). There was no significant difference (p>0.05) among the samples except sample PCB. The higher fat content in the supplemented bread may suggest higher calorific value and may also serves as a lubricating agent that improves the quality of the product, in terms of flavour and texture. The crude fibre content ranged from 0.36 in FBF (control) to 0.65% in sample PCB There was no significant difference (p>0.05) among the samples except samples OFA and PCB. The presence of high fibre in food products is essential, owing to its ability to facilitate bowel movement (peristalsis), bulk addition to food and prevention of many gastro intestinal diseases in humans. Total Ash content ranged from 0.55 – 0.99% with the highest found in sample OFA while the lowest was observed in PCB. Only samples OFA and PCB differed significantly (p<0.05). Ash content of a food material is an indication of the mineral constituent present. The carbohydrates content ranged from 49.42 – 57.21%. The highest was found in PCB (extracted by blending) while the lowest was observed in PAC (extracted by boiling). There was significant difference (p<0.05) among the samples except samples FBF and OFA. In general, the nutritional composition of the bread samples produced with pawpaw leaves extracts is higher than the recommended nutritional composition for white bread by United State Department of Agriculture (USDA). According to USDA (2019), white bread must contain 6.67% protein, 4.4% fat, 42% carbohydrate and 2.2% fibre. This indicates that consumption of bread enriched with extracts of pawpaw leaves will increase the nutrient intake of consumers and may reduce the prevalence of malnutrition in many developing countries.

**Table 3.** Proximate composition of bread samples (%)

| Sample | Moisture | Crude protein | Crude fat | Crude fibre | Total ash | Carbohydrate |
|---|---|---|---|---|---|---|
| **FBF** | $32.20\pm0.16^{c}$ | $7.74\pm0.09^{a}$ | $7.02\pm0.17^{a}$ | $0.36\pm0.01^{a}$ | $0.70\pm0.00^{ab}$ | $51.99\pm0.08^{b}$ |
| **PAC** | $32.38\pm0.27^{c}$ | $10.18\pm0.06^{d}$ | $6.94\pm0.78^{a}$ | $0.40\pm0.04^{a}$ | $0.70\pm0.00^{ab}$ | $49.42\pm0.95^{a}$ |
| **OFA** | $27.60\pm0.65^{b}$ | $9.80\pm0.04^{c}$ | $7.68\pm0.00^{ab}$ | $0.47\pm0.01^{b}$ | $0.99\pm0.12^{b}$ | $53.47\pm0.79^{b}$ |
| **PCB** | $24.10\pm0.54^{a}$ | $8.81\pm0.03^{b}$ | $8.69\pm0.48^{b}$ | $0.65\pm0.02^{c}$ | $0.55\pm0.21^{a}$ | $57.21\pm0.20^{c}$ |

*Values are means of two replicates. Mean values ± standard deviation followed by different superscripts across columns are significantly different ($p\leq0.05$); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending.

### *3.4. Physical properties of bread produced with extracts of pawpaw leaves*

The physical properties of bread produced with extracts of pawpaw leaves are presented in Table 4. Generally, the physical properties of the bread loaves containing the extracts are lower than the control. According to Pycia *et al.* (2022), this is due to the weakening of the gluten network and or inhibition of the activity of baker's yeast by the functional ingredients in the extract. In a report by Baiano *et al.* (2015), this effect of the extract could be in acidifying, which would denature the gluten network. The loaf weight ranged from 261.00 to 315.00 g. The highest was found in **FBF** (control) while the lowest was observed in **PAC** (extracted by boiling) and this varied significantly ($p<0.05$) among the samples. Loaf weight is basically determined by the quantity of dough baked gluten functionality and the amount of moisture and carbon dioxide diffused out of the loaf during baking (Menon *et al.,* 2015). Reduction of loaf weight is an undesirable quality attributes as consumers are often attracted to bread with high weight and volume believing it has more substance for the same price. The loaf height ranged from 3.40 – 6.20 cm. The highest was found in **FBF** (control) but not significantly different ($p>0.05$) from **PCB**, while the lowest was observed in sample OFA (extracted by soaking). The decrease in height of bread could be attributed to the addition of the pawpaw leaves extracts. According Baiano *et al.* (2015) additon of bioactive ingredients may physically modify the development of bread dough.



The loaf volume ranges from 350.00 – 671.00 $cm^3$. The highest was found in **PCB** (extracted by blending) while the lowest was observed in OFA (extracted by soaking) and this varies significantly ($p<0.05$). Loaf volume is affected by the quality and quantity of protein in the flour (Ragaee & Abdel-Aal, 2006). This may suggest that more protein is extracted by blending of the pawpaw leaves than other methods of extraction used in this study. The specific loaf volume ranged from 1.23 – 2.16 $cm^3$ /g. The specific loaf volume varied significantly amongs the samples with the highest found in **PCB** (extracted by blending) while the lowest was observed in OFA (extracted by soaking). The specific loaf volume, which is the ratio of loaf volume to loaf weight has been generally adopted as a more reliable measure of loaf size and determines consumers' preference. The quality and quantity of protein in the dough may cause differences in the rate of gas retention, thus affecting the specific loaf volume. Baiano *et al.* (2015) recorded a decrease in specific volume with the addition of aqueous extract of vegetable waste.

**Table 4.** Physical properties of bread produced with extracts of pawpaw leaves

| Samples | Loaf weight (g) | Loaf height (cm) | Loaf volume ($cm^3$) | Specific loaf volume ($cm^3$/g) |
|---|---|---|---|---|
| FBF | $315.00^d$ | $6.20^c$ | $594.00^c$ | $1.89^c$ |
| PCB | $310.00^c$ | $5.90^c$ | $671.00^d$ | $2.16^d$ |
| OFA | $285.00^b$ | $3.40^a$ | $350.00^a$ | $1.23^a$ |
| PAC | $261.00^a$ | $3.80^b$ | $379.00^b$ | $1.45^b$ |

*Values are means of two replicates. Mean values ± standard deviation followed by different superscripts across columns are significantly different ($p \leq 0.05$); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending.

### *3.5. Mineral composition of bread produced with extracts of pawpaw leaves*

Generally, the mineral contents of the bread samples increased with the addition of extracts of pawpaw leaves, indicating that the extracts had an effect on the mineral composition of the fortified bread samples especially the extract obtained by blending. The mineral composition of bread produced from pawpaw leaves extract is presented in Table 5. Calcium content varied significantly ($p<0.05$) from 55.05 – 74.38 mg/100g. The highest was found in PAC (extracted by boiling) while the lowest was observed in FBF (control). This is similar to the report (52.66 to 87.54 mg/100g) by Bolarinwa *et al.* (2020) for Pawpaw Fortified Pan Bread. Adebayo-Oyetoro *et al.* (2016) also reported higher calcium contents (21.00 - 24.20 mg/100g) for pawpaw fortified milk. Calcium is an important constituent of bone and teeth and it is actively involved in the regulation of nerve and muscle functions (Soetan *et al.,* 2010). The Iron content of the bread varied from 3.66 – 5.67 mg/100g and this was significantly different ($p<0.05$). The highest was found in OFA (extracted by soaking) while the lowest was observed in FBF (control). Iron is an essential mineral required in the diet of pregnant women, nursing mothers, infant, convoluting patients and elderly people. The highest potassium content 111.74% was found in PAC (extracted by boiling) while the lowest 87.11% was observed in FBF (control) with significant difference ($p<0.05$) existing among the samples. These findings are in agreement with the report of Bolarinwa *et al.* (2017) who reported increased in potassium content (272.5 – 327 mg/100 g) of moringa fortified bread as moringa concentration increased in the blends. The sodium content varied significantly ($p<0.05$) between 299.82% and

**Table 5:** Mineral composition of breads produced with extract of pawpaw leaves (mg/100g)

| Sample | Calcium | Iron | Potassium | Sodium | Manganese | Magnesium | Zinc |
|---|---|---|---|---|---|---|---|
| **FBF** | 55.05±0.05$^{a}$ | 3.66±0.08$^{a}$ | 87.11±0.00$^{a}$ | 327.10±0.16$^{b}$ | 0.60±0.01$^{b}$ | 36.57±0.08$^{a}$ | 1.67±0.06$^{b}$ |
| **PAC** | 74.38±0.19$^{d}$ | 4.15±0.06$^{b}$ | 111.74±1.05$^{d}$ | 299.82±0.41$^{a}$ | 0.58±0.00$^{ab}$ | 39.15±0.42$^{bc}$ | 1.84±0.01$^{c}$ |
| **OFA** | 57.88±0.80$^{b}$ | 5.67±0.01$^{d}$ | 91.03±0.32$^{b}$ | 417.17±0.06$^{d}$ | 0.63±0.00$^{c}$ | 39.86±0.66$^{c}$ | 1.75±0.02$^{c}$ |
| **PCB** | 64.00±0.30$^{c}$ | 4.52±0.04$^{c}$ | 94.89±0.30$^{c}$ | 377.84±0.71$^{c}$ | 0.56±0.02$^{a}$ | 38.72±0.03$^{b}$ | 1.11±0.01$^{a}$ |

Values are means of two replicates. Mean values ± standard deviation followed by different superscripts across columns are significantly different ($p \leq 0.05$); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending

417.17% in PAC (extracted by boiling) and OFA (extracted by soaking) respectively. Manganese and magnesium content ranged from 0.56 – 0.63mg/100g and 36.57 – 39.86 mg/100g respectively with the highest found in OFA (extracted by soaking). Manganese was lowest in PCB (extracted by blending) while magnesium was lowest in FBF (control). There was significant difference (p<0.05) among the samples with respect to each mineral except sample PAC. The concentrations of calcium, magnesium, and iron obtained in this study are below the values 811.1, 564.9, 10.9 mg/100g respectively reported by Maisarah *et al.* (2014) for green pawpaw leaves. This could be due to decomposition of these minerals during the baking process.

### *3.6. Vitamin content of bread samples produced with pawpaw leaves extracts*

The vitamin content of bread produced with extracts of pawpaw leaves is presented in Table 6. Vitamin C content varied significantly (p<0.05) and ranged from 10.50 mg/100g in PCB (extracted by blending) to 22.14 mg/100g in OFA (extracted by soaking). Vitamin B1 and B2 content of the fortified bread ranged between 0.07 – 1.09 mg/100g and 0.08 – 0.47 mg/100g respectively, with the highest found in PCB (extracted by blending) while the lowest was recorded in FBF (control) and these differed significantly (p<0.05). This study shows the bread samples generally have higher vitamin content than the control especially in the bread produced with extracts obtained by blending. Maisarah *et al.* (2014) reported highest ascorbic acid in pawpaw leaves (85.16 mg/100g) compared to unripe pawpaw, ripe pawpaw and seed. This value is also higher than values obtained in this study. Olumide *et al.* (2023) reported higher vitamin C content (26.9 mg/100g). This could be attributed to the baking process as vitamin C is known to suffer degradation during heating (Amorim *et al.*, 2012).

### *3.7. Texture profile of bread produced with pawpaw leaves extracts*

Bread texture is one of the main parameters of quality and consumers' acceptance of bread is strongly based on its texture which is often seen as a measure of bread freshness (Ahlborn *et al*., 2005). The texture profile of breads produced with extracts of pawpaw leaves is presented in Table 7. All samples differed significantly ($p<0.05$) in all the textural parameters investigated. Hardness which indicates loss of soft texture due to the low moisture content and or retrogradation of starch (Cauvain, 2004) ranged between 464.00 to 2065.00 g. Only sample PAC had hardness within the range (429.60 - 473.43) g reported by Bolarinwa *et al.* (2020) for bread produced with pawpaw puree. Increased in bread hardness may be attributed to staling of bread (Tsai *et al.,* 2012). Chewiness of the bread ranged from 118.00 – 774.00 mm. The highest was

**Table 6.** Vitamin content of bread produced with extracts of pawpaw leaves

| SAMPLE | Vitamin C (mg/100g) | Vitamin B1 (mg/100g) | Vitamin B2 (mg/100g) |
|---|---|---|---|
| FBF | 15.30±0.03$^{c}$ | 0.07±0.00$^{a}$ | 0.08±0.00$^{a}$ |
| PAC | 12.03±0.12$^{b}$ | 0.53±0.00$^{b}$ | 0.27±0.00$^{b}$ |
| OFA | 10.50±0.04$^{a}$ | 0.77±0.01$^{c}$ | 0.30±0.00$^{c}$ |
| PCB | 22.14±0.38$^{d}$ | 1.09±0.00$^{d}$ | 0.47±0.00$^{d}$ |

*Values are means of two replicates. Mean values ± standard deviation followed by different superscripts across columns are significantly different ($p\leq0.05$); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending.

**Table 7.** Textural parameters of bread with pawpaw leaves extracts

| Sample | Peak force A (N) | Chewiness (N) | Resilience | Gumminess (N) | Springiness | Cohesiveness |
|---|---|---|---|---|---|---|
| FBF | 874.00$^{c}$ | 344.00$^{c}$ | 0.19$^{c}$ | 472.00$^{c}$ | 0.73$^{c}$ | 0.54$^{c}$ |
| PAC | 464.00$^{a}$ | 171.00$^{b}$ | 0.19$^{c}$ | 251.00$^{b}$ | 0.68$^{b}$ | 0.54$^{c}$ |
| OFA | 2065.00$^{d}$ | 774.00$^{d}$ | 0.18$^{b}$ | 1020.00$^{d}$ | 0.76$^{d}$ | 0.49$^{b}$ |
| PCB | 793.00$^{b}$ | 118.00$^{a}$ | 0.08$^{a}$ | 216.00$^{a}$ | 0.54$^{a}$ | 0.27$^{a}$ |

*Values are means of two replicates. Mean values ± standard deviation followed by different superscripts across columns are significantly different ($p\leq0.05$); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending.

found in OFA (extracted by soaking) while the lowest was observed in PCB (extracted by blending). Lower chewiness values recorded for breads produced with extracts obtained by boiling and blending indicate better eating quality and suggest greater acceptability to elderly people and small children who may not have the strength to chew for long period. Resilience ranged from 0.08 – 0.19 while cohesiveness ranged from 0.27 – 0.54. It was observed that samples FBF and PAC did not differ significantly ($p<0.05$) in resilience and cohesiveness, suggesting the bread structure have same ability to resist deformation under the teeth and the functional components in the extract of PAC did not affect these two properties. The absence of significant difference ($p>0.05$) in many of the proximate parameters (moisture, crude fat, crude fibre and ash) in these two samples (FBF and PAC) might have contributed to this observation.

Sample OFA had the highest values for gumminess while sample PCB (extract obtained by blending) had the lowest. Gumminess amongst the samples ranged from 216 – 1020 but this did not follow a regular pattern. Gumminess is the force required to break a semi-solid material ready to devour and is obtained by multiplying hardness and adhesiveness (Chen & Opera, 2013). Springiness of the breads ranged from 0.54 – 0.76. The highest was found in OFA (extracted by soaking) while the lowest was observed in PCB (extracted by blending). Springiness is a measure of the elastic property of bread. It is the ability to recover its original shape after removal of required force to deform. Lower springiness values recorded for the pawpaw leaf extracts bread showed that the bread will flatten after pressing. This may be attributed to the effect of the phytochemicals on the gluten network, leading to reduced carbon dioxide produced during fermentation. Carbon dioxide is responsible for softness and springiness of bread. In the mouth, crumbs of all breads easily become a ball and is needed to chew; this shape of the texture in the mouth is called cohesiveness. Cohesiveness of bread is controlled by moisture content of the bread and strength of gluten network around the air bubbles (Cauvain, 2004). Generally, it has been found that addition of phenolic compounds in many plant extracts may affect several rheological properties of the gluten matrix in the dough, such as gumminess, strength, adhesiveness, elasticity, chewiness, among others (Czajkowska-González *et al.,* 2021).

### *3.8. Sensory evaluation of bread produced with extracts of pawpaw leaves*

The result of the scores of the sensory characteristics (taste, colour, texture, flavour and overall acceptability) of the breads is shown in Table 9. Sample FBF (control) had the highest score of all sensory parameters investigated while lowest score was obtained in sample PCB. Akubor & Nwawi (2019) also recorded highest sensory scores in the control sample set up while investigating bread production with fermented sweet orange peel. Bread samples produced with extracts obtained by boiling and by soaking had scores for overall acceptability greater than five (5), thus indicating their acceptability as opined by Lazaridou *et al.* (2007). Samples PAC (extracted by Boiling) and OFA (extracted by soaking) did not differ significantly ($p>0.05$) with respect to taste and colour, Taste ranged from 2.42 – 8.32 while colour ranged from 2.21 – 7.00 with significant difference ($p<0.05$) existing among the samples except sample PAC and OFA. The texture score ranged from 2.68 – 6.89 while flavour rating ranged from 2.00 – 7.89. According to Czajkowska-González *et al.* (2021), sensory modifications related to texture are largely due to

**Table 8.** Sensory rating of bread produced with extracts of pawpaw leaves

| Sample | Taste | Colour | Texture | Flavour | Overall acceptability |
|---|---|---|---|---|---|
| **FBF** | 8.32±0.48$^{c}$ | 7.00±0.00$^{c}$ | 6.89±0.32$^{d}$ | 7.89±0.32$^{c}$ | 8.05±0.62$^{d}$ |
| **PAC** | 6.32±0.48$^{b}$ | 5.95±0.23$^{b}$ | 5.00±0.00$^{b}$ | 5.37±0.90$^{b}$ | 5.79±0.42$^{b}$ |
| **OFA** | 6.63±0.50$^{b}$ | 6.32±0.16$^{b}$ | 5.79±0.42$^{c}$ | 5.58±0.84$^{b}$ | 6.47±0.51$^{c}$ |
| **PCB** | 2.42±0.51$^{a}$ | 2.21±0.42$^{a}$ | 2.68±0.48$^{a}$ | 2.00±0.00$^{a}$ | 1.89±0.32$^{a}$ |

*Values are means of two replicates. Mean values ± standard deviation followed by different superscripts across columns are significantly different ($p \leq 0.05$); FBF: Control; PAC: Boiling; OFA: Soaking; PCB: Blending.

the interactions of phenolic compounds or other antioxidants present in extracts with gluten proteins, and this is mainly attributed to the ability of these antioxidants to reduce the disulfide bonds that are an essential part of the gluten matrix.

There was decrease in flavour rating in the test sample and this could be due to distinct flavour of pawpaw leaf extract in the bread. The overall acceptability rating ranged from 1.89 – 8.05. Among the test samples, the panelists rated the sample with the extract obtained by soaking as the most acceptable.

## 4. Conclusion

Bread produced with extracts of pawpaw leaves obtained by blending, boiling and soaking were evaluated for phytochemicals, proximate, minerals, vitamins, physical, textural and sensory properties. Bread produced from blended extract had relatively higher phytochemical content with increased protein, fat, crude fibre and mineral content. Bread fortified with pawpaw leaves extract (by boiling) was found to have the highest value in loaf volume, specific loaf volume, calcium and potassium. The addition of pawpaw leaves extracts also affected the vitamin composition and texture of the bread. Bread enriched with blended pawpaw leaves extracts have highest ascorbic acid, thiamine, riboflavin while the bread sample with extract (by soaking) was highly preferred. In general, addition of the extracts strongly modified the physical, chemical and sensory properties of the bread samples. Pawpaw leaves extracts could be an excellent value addition to bread and a good vehicle for delivering nutrients and functional ingredients to consumers. This study suggests the need to further explore more plant extracts as well as part or whole of some medicinal plants in breads.


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## Conflict of interest

The authors declare that they have no competing interests.

## Ethics

This Study does not involve Human or Animal Testing.

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## References

AACC. (2000). Approved methods of the American Association of Cereal Chemists (17th ed.). American Association of Cereal Chemists International, St. Paul, MN.

Abdel-Hameed, S. M., Abd Allah, N. A., Hamed, M. M., & Soltan, O. I. (2023). Papaya fruit by-products as novel food ingredients in cupcakes. *Annals of Agricultural Sciences*, *68* (1), 60-74.

Adebayo-Oyetoro, A.O., Ogundipe, O.O., Adeyemo, I.G., Ogundipe, F.O., Bamidele, F. A., & Adeyeye, S.A.O. (2016). Chemical, sensory and shelf life study of pawpaw juice–milk blend. *Cogent Food & Agriculture*, *2* (1), 1271276.

Ahlborn, G.J., Pike, O.A., Hendrix, S.B., Hess, W.M., & Huber, C.S. (2005). Sensory, mechanical and microscopic evaluation of staling in lowprotein and gluten-free breads. *Cereal Chemistry,* 82, 328-335.

Akubor, P.I, Eze, E.C., Popoola, C.A. 2017. Effect of substituting fat with pawpaw puree on the qualities of cake in storage. *FUW Journal of Agricultural and Life Science,* 1(1), 1-7.

Akubor, P.I., & Nwawi, D.O. (2019) Phytochemical Composition, Physical and Sensory Properties of Bread Supplemented with Fermented Sweet Orange Peel Flour. *Innovare Journal of Food Science,* 7 (4) 1-6

Amorim, K., Lage-Yusty, M. A., & López-Hernández, J. (2012). Changes in bioactive compounds content and antioxidant activity of seaweed after cooking processing. *CyTA-Journal of Food, 10*(4), 321-324.

Ansari, A., Asghar, A., Shehzad, A. & Tanweer, S. (2014). Rheological properties of papaya enriched wheat flour for baked products. *Pakistan Journal of Food Sciences*, 24 (3), 126-131.

AOAC (2005). Association of Official Analytical Chemists (18th ed.). Washington D.C. USA:

Aravind G., B. Debjit, Duraivel, S. & Harish., G. (2013). Traditional and Medicinal Uses of *Carica papaya*. *Journal of Medicinal Plants Studies,*1(1), 7-15.

Baiano A., Viggiani I., & Terracone C., Romaniello R., & Del Nobile M.A. 2015.Physical and sensory properties of bread enriched with phenolic aqueous extracts from vegetable wastes. *Czech Journal of Food Science,* 33, 247–253.

Bolarinwa, I.F., Aruna, T.E., Adejuyitan, J.A., Adeyemo, G.A., & Alabi, O.D. 2020. Chemical, Physical and Sensory Properties of Pawpaw Fortified Pan Bread. *Journal Food Chemistry and Nanotechnology,* 6(2), 65-71.

Bolarinwa, I.F., Tawakalitu, E.A., & Akeem, O.R. 2017. Nutritive value and acceptability of bread fortified with moringa seed powder. *Journal of Saudi Society of Agricultural Science,* 18(2), 195-200.

Brunner, J.H. (1984). Analytical Chemistry. (34), 1314-1326.

Cauvain, S.P. (2004). Improving the texture of bread. *Texture in food, 2*, 432-450.

Chen, L., &Opara, U.L. (2013). Approaches to analysis and modeling texture in fresh and processed foods–A review. *Journal of food Engineering, 119* (3), 497-507.

Czajkowska–González, Y.A., & Alvarez–Parrilla, E., del Rocío Martínez–Ruiz, N., Vázquez–Flores, A.A., Gaytán–Martínez, M., and de la Rosa, L.A. (2021). Addition of phenolic compounds to bread: antioxidant benefits and impact on food structure and sensory characteristics. *Food Production, Processing and Nutrition, 3,* 1-12.

Galindo, E.T., Hernandez, G.R. Mateos, J.D., Sandoval, G.F., Chel-Guerrero, L., Rodriguez, I.B., & Gallegos, S.T. (2009). Proteolytic activity in enzymatic extracts from *Carica papaya* L. cv. Maradol harvest by-products. *Process Biochemistry*, 44, 77-82.

Handa, S.S., & Khanuja, S.P.S, Longo, G., Rakesh, D.D. (2008). Extraction Technologies for Medicinal and Aromatic Plants, (1stedn), no. 66. Italy: United Nations Industrial Development Organization and the International Centre for Science and High Technology.

Harborne, J.B. (1973). Phytochemical methods, Chapman and Hall Ltd., London: 49.

Hasmila, H.N. & Soekamto, N.H. (2019). Phytochemical analysis and antioxidant activity of soursop leaf extract (*Annonamuricata Linn.*). *Journal of Physics: Conference Series*. 1341 (3) 032027

Juárez-Rojop, I.E., A Tovilla-Zárate, C., Aguilar-Domínguez, D.E., Lobato-García, C.E., Blé-Castillo, J.L., López-Meraz, L., Díaz-Zagoya, J.C. & Bermúdez-Ocaña, D.Y., 2014. Phytochemical screening and hypoglycemic activity of *Carica papaya* leaf in streptozotocin-induced diabetic rats. *Revista Brasileira de Farmacognosia*, *24*, (3) 341-347. https://doi.org/10.1016/j.bjp.2014.07.012

Kaim, U. & Goluch, Z.S. (2023). Health Benefits of Bread Fortification: A Systematic Review of Clinical Trials according to the PRISMA Statement. *Nutrients*, *15* (20), 4459.

Kam, P.C.A. & Liew, S. (2002). Traditional Chinese herbal medicine and anaesthesia. *Anaesthesia*, *57* (11), 1083-1089.

Kandil A., Marcus, L. & Sarah A. (1994). Study to find the best extraction solvent for use with guava leaves for high antioxidant efficacy. *Food Science and Nutrition,* 2(2), 174-180.

Khuzhaev, V.U. & Aripova, S.F., 2000. Pseudocarpaine from *Carica papaya*. *Chemistry of Natural Compounds,* 36, 418-420.

Lazaridou, A., Duta, D., Papageorgiou, M., Belc, N. & Biliaderis, C. G. (2007). Effects of hydrocolloids on dough rheology and bread quality parameters in gluten free formulations. *Journal of Food Engineering*, 79, 1033–1047.

Maisarah, A.M., Asmah, R., & Fauziah, O. (2014). Proximate analysis, antioxidant and anti-proliferative activities of different part of *Carica papaya*. *Journal Nutrition Food Science* 4(2), 1-7.

Menon, L., Majumdar, S. D., & Ravi, U. (2015). Development and analysis of composite flour bread. *Journal of food science and technology*, *52*, 4156-4165.

Okwu, D.E. & Emenike, I.N. (2006) Evaluation of phyto-nutrients and vitamins content of citrus fruits. *International Journal of Molecular Medicine and Advanced Science,* 2,1-6.

Olumide, M.D., Akintunde, A.O., Shobo, B.A., & Akinboye, O.E. (2023). Nutrient evaluation and phytochemical analysis of fresh and dry leaves of *Carica papaya* . *Indian Journal of Agricultural Research.* 57(2), 230-234.

Owoyele BV, Adebukola, O .M, Funmilayo, A.A, & Soladoye AO. (2008). Anti-inflammatory activities of ethanolic extract of *Carica papaya* leaves. *Inflammopharmacololy,* 16, 168-173.

Peluola-Adeyemi, O.A., Abdus-Salaam, R.B., Obi, T.E., & Toyiemedo, N.C. (2021) Quality Evaluation of Bread Produced from Wheat Flour using Avocado (*Persea americana*) Paste as Substitute. *Journal of Food Stability,* 4 (1) 1-12

Pycia, K., Pawłowska, A.M., Kaszuba, J., & Żurek, N. (2022). Walnut Male Flowers (*Juglans regia* L.) as a Functional Addition to Wheat Bread. *Foods,* 11(24), 3988.

Ragaee, S., & Abdel-Aal, E-SM. (2006). Pasting properties of starch and protein in selected cereals and quality of their food products. *Journal Food Chemistry,* 95, 9–18.

Serventi, L. 2011. Development of saponin-rich baked goods. Dissertation. Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University. Pgs 1-115.

Sharma, A., Sharma, R., Sharma, M., Kumar, M., Barbhai, M.D., Lorenzo, J.M., Sharma, S., Samota, M.K., Atanassova, M., Caruso, G., & Naushad, M. (2022). *Carica papaya L.* leaves: Deciphering its antioxidant bioactives, biological activities, innovative products, and safety aspects. *Oxidative Medicine and Cellular Longevity.* 2022: 2451733.

Siro, I., Kapolna, E., Kapolna, B., & Lugasi, A. (2008). Functional food. Product development, marketing and consumer acceptance—A review. *Appetite,* 51(3), 456- 467.

Soetan, K.O, Olaiya, C.O, & Oyewole, O.E. 2010. The importance of mineral elements for humans, domestic animals and plants: a review. *African Journal Food Science* 4 (5) 200-222

Sofowora, A. F. (1993). Medicinal Plants and Traditional Medicine in Africa. Screening for Bioactive Agents. Spectrum Books Ltd, Ibadan, Nigeria.

Tsai, C.-L., Sugiyama, J., Shibata, M., Kokawa, M.,Fujita, K., Tsuta, M.,Nabetani, H., & Araki, T. (2012). Changes in the texture and viscoelastic properties of bread containing rice porridge during storage. *Bioscience Biotechnology and Biochemistry, 76,* 331–335.

Ugo, N. J., Ade, A. R., & Joy, A. T. (2019). Nutrient composition of *Carica papaya* leaves extracts. *Journal of Food Science and Nutrition Research, 2*(3), 274-282.

Varastegani, B., Wahidu, Z. & Tajul, A.Y. (2015). Investigation on physiochemical and sensory evaluation of cookies substituted with papaya pulp flour. *Journal of Food Quality,* 38,175-183.

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