





Phytochemical, Proximate, Vitamin, and Mineral Composition of Pawpaw (*Carica papaya*) Seed Extract

Nebechi Jane Ezeofor^{1,2}, Andrew Chibuzo Nwaka^{1*}, and Irene Ngozi Okafor¹

¹Department of Biochemistry, Faculty of Natural Sciences, Chukwuemeka Odumegwu Ojukwu University, Anambra State, Nigeria.

²Department of Food Technology, Federal Polytechnic, Oko, Anambra State.

*Corresponding author email: ac.nwaka@coou.edu.ng

Abstract	Article History
<p>Pawpaw (<i>Carica papaya</i>) is a tropical herbaceous plant whose seeds have attracted increasing attention due to their phytochemicals, minerals, and associated health benefits. This study evaluated the phytochemical, proximate, vitamin, and mineral compositions of pawpaw seed extract using standard analytical methods. Quantitative phytochemical analysis revealed high concentrations of alkaloids ($19.91 \pm 0.00\%$), phenols ($7.34 \pm 0.00\%$), flavonoids ($6.17 \pm 0.09\%$), steroids ($6.14 \pm 0.00\%$), saponins ($4.77 \pm 0.00\%$), tannins ($4.63 \pm 0.00\%$), anthocyanins ($4.37 \pm 0.06\%$), cyanogenic glycosides ($3.18 \pm 0.00\%$), cardiac glycosides ($1.34 \pm 0.00\%$), phytate ($0.53 \pm 0.00\%$), and oxalate ($0.18 \pm 0.00\%$). Proximate analysis showed that the seeds contained high levels of carbohydrates ($64.62 \pm 0.54\%$), moisture ($13.09 \pm 0.09\%$), crude protein ($9.43 \pm 0.40\%$), ash ($8.54 \pm 0.03\%$), crude fiber ($2.35 \pm 0.03\%$), and crude fat ($1.12 \pm 0.03\%$). Vitamin analysis indicated that vitamin C (68.90 ± 0.02 mg/kg) was the most abundant, followed by vitamin A (29.34 ± 0.05 mg/L) and vitamin E (9.22 ± 0.02 mg/L). Mineral composition revealed zinc as the most predominant (0.98 ± 0.00 ppm), followed by iron (0.47 ± 0.00 ppm), manganese (0.19 ± 0.00 ppm), copper (0.08 ± 0.00 ppm), nickel (0.02 ± 0.00 ppm), while lead was not detected. Overall, pawpaw seed extract was shown to be rich in phytochemicals, vitamins (A, C, and E), and essential minerals, all of which are known for their antioxidant properties and potential to scavenge free radicals.</p> <p>Keywords: Pawpaw seed extract, Phytochemicals, Proximate composition, Vitamins, Minerals.</p>	<p>Received: 13 Sept 2025 Accepted: 27 Sept 2025 Published: 04 Oct 2025</p>  <p>Scan QR Code to view¹</p> <p>License: CC BY 4.0²⁴</p>  <p>Open Access article.</p>
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1. Introduction

Pawpaw (*Carica papaya* Linn.), a tropical fruit belonging to the family Caricaceae, has gained global attention due to its nutritional value and therapeutic potential. Various parts of the plant, including the leaves, fruits, and seeds, are rich in bioactive compounds with reported antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective properties (Odoh *et al.*, 2022). These attributes make pawpaw an important candidate for both nutritional and pharmacological applications.

The pawpaw plant is a fast-growing, herbaceous tree that can reach heights of up to 10 m in natural conditions (Tona *et al.*, 2018). It is believed to have originated from the lowlands of Eastern Central America (Nakasone and Paull, 2018). In Nigeria, it is commonly known as *Ibepe* (Yoruba), *Gwanda* (Hausa), *Okwuru Beke* (Igbo), and *Ohuo* (Bini). The Caricaceae family comprises four genera worldwide, with *Carica papaya* Linn. being the most widely cultivated and economically important species (Krishna *et al.*, 2008; Otoe *et*

al., 2023). The plant is soft-wooded and short-lived, with a productive lifespan of less than 10 years, necessitating regular replanting in commercial cultivation (Otoe *et al.*, 2023). Morphologically, it is typically erect, unbranched, and topped with a large crown of leaves (Dick, 2003). The trunk is soft, hollow, and cylindrical, measuring about 30 cm at the base and tapering to 5 cm at the top (Otoe *et al.*, 2023).

The fruits of pawpaw vary in appearance depending on maturity. Unripe fruits are hard, with thick greenish flesh, while ripe fruits develop smooth yellow-orange skin, typically 1.5–4 cm thick, and are sweet and juicy. Mature fruits contain numerous black spherical seeds, approximately 5 mm in diameter, each surrounded by a gelatinous membrane (Nakasone and Paull, 1998). Fruit-bearing typically begins within 18 months of planting (Krishna *et al.*, 2008).

Beyond its nutritional role, pawpaw has long been used in traditional medicine across Asia and Africa. Different plant parts (seeds, leaves, stems, and roots) are employed in

ethnomedicine for managing a wide range of ailments (Odoh *et al.*, 2022). Studies have documented its efficacy in alleviating allergic conditions, serving as an immune adjuvant in vaccine therapy, and demonstrating anti-tumor and anti-inflammatory activities (Ojewole *et al.*, 2010). Pawpaw leaf extracts have shown antimicrobial effects against fungi, yeasts, and Gram-positive and Gram-negative bacteria (Ekong *et al.*, 2011). The seeds have also been utilized in the treatment of urinary tract infections (Alhodieb *et al.*, 2025). Furthermore, annonaceous acetogenins isolated from the leaves, bark, and twigs have been reported to exhibit potent antitumor and pesticidal properties (Baskaran *et al.*, 2012).

Despite the wide recognition of pawpaw as a medicinal and nutritional plant, much of the research has focused on its fruit and leaves, while the seeds remain underutilized and often discarded as waste. However, emerging evidence suggests that pawpaw seeds are a rich source of phytochemicals, essential vitamins, and minerals that could contribute significantly to health promotion through their antioxidant and therapeutic properties. Comprehensive evaluation of these bioactive components is therefore essential for establishing their nutritional and medicinal relevance. This study was designed to investigate the phytochemical, proximate, vitamin, and mineral compositions of pawpaw seed extract, thereby providing scientific evidence to support its potential applications in nutrition, medicine, and functional food development.

2. Methodology

The pawpaw seeds used were obtained from whole pawpaw fruit which was purchased from a local market and identified by a botanist, Mr. Felix Ifeanyi Nwafor, University of Nigeria, Nsukka, Enugu state, Nigeria before usage in the laboratory.

Preparation of Plant Extract

Three hundred (300g) of pawpaw seed was macerated in 1.5L of 70% ethanol and allowed to stand for 24hrs for complete extraction. The mixture was stirred at two hours interval. At the expiration of 24hrs, the mixture was sieved using muslin cloth and thereafter filtered with Whatman filter paper. The yield after extraction weighed 15.2g.

Quantitative Phytochemical Analysis Methods

Flavonoid determination

Flavonoid determination was by the method of Boham and Kocipai-Abyazan (1974). Exactly 10 g of the plant sample was extracted with 100 ml of 80% aqueous methanol at room temperature and allow to stand for like 5 to 10 minutes. The whole solution was filtered through Whatman filter paper No. 42 (125 mm). The filtrate was later transferred into a crucible and evaporated to dryness and weighed to a constant weight. The percentage flavonoid was calculated by difference.

$$\% \text{ flavonoids} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where,

W_1 = Weight of empty crucible.

W_2 = Weight of crucible + residue.

Determination of alkaloids

Five (5) grams of the plant sample was placed in a 250ml beaker and 200ml of 10% acetic acid ($\text{CH}_3\text{CO}_2\text{H}$) in ethanol ($\text{C}_2\text{H}_5\text{OH}$) was added. The mixture was covered and allowed to stand for 4 hours at 25°C i.e. at room temperature. It was then filtered with filter paper No. 42 and the filtrate was concentrated on a water bath until it reaches a quarter of its original volume. Concentrated NH_4OH was added drop wise until precipitation was complete. The mixture was allowed to settle and the precipitate collected on a weighed filter paper and washed with dilute NH_4OH . The precipitate, alkaloid, was dried and weighed. The percentage alkaloid was calculated by difference (Harborne, 1973; Obadoni and Ochuko, 2001).

$$\% \text{ Alkaloids} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where,

W_1 = Weight of empty filter paper.

W_2 = Weight of filter paper + Alkaloid.

Determination of total saponins

Saponin was determined by the method of Obadoni and Ochuko (2001). Exactly 20 g of sample was weighed into a conical flask and 100 ml of 20% aqueous ethanol was added. The sample was subjected to a hot water bath at 55°C for 4 h with continuous stirring. The mixture was filtered and the residue re-extracted with another 200 ml 20% ethanol. The combined extract was concentrated to 40 ml over water bath at about 90°C. The concentrate was transferred into a 250 ml separatory funnel and 20 ml of diethyl ether added and shaken vigorously. This was allowed to settle and the aqueous layer collected while the ether layer was discarded. The purification process was repeated with 60 ml of n-butanol. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated on a water bath to evaporate the solvents and dried in the oven to a constant weight. The saponin content was calculated as a percentage.

$$\% \text{ Saponins} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where, W_1 = Weight of filter paper.

W_2 = Weight of filter paper + residue.

Determination of total phenols by spectrophotometric method

The fat free sample was boiled with 50 ml of diethylether ($\text{CH}_3\text{CH}_2)_2\text{O}$. A 5 ml of the boiled extract was pipetted into a 50 ml flask, then 10 ml of distilled water was added. After the addition of distilled water, 2 ml of ammonium hydroxide solution and 5 ml of concentrated amylalcohol ($\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{OH}$), were also added. The samples were made up to mark and left to react for 30 min for colour development. This was measured at 505 nm (Edeoga *et al.*, 2005).

Conc. of Sample (mg/l)

$$= \frac{\text{Absorbance of Sample} \times \text{Conc. of Sample}}{\text{Absorbance of Standard}}$$

Determination of total tannin by titration

The Folin–Denis titration method as described by Pearson (1974) was used. Twenty grams of the crushed sample were placed in a conical flask, and 100 ml of petroleum ether was added. The flask was covered and left for 24 hours. The sample was then filtered and allowed to stand for 15 minutes to enable the petroleum ether to evaporate. It was subsequently re-extracted by soaking in 100 ml of 10% acetic acid in ethanol for 4 hours. The mixture was filtered, and the filtrate was collected. To the filtrate, 25 ml of NH_4OH were added to precipitate the alkaloids. The alkaloid residue was heated on an electric hot plate to remove residual NH_4OH . The remaining volume was measured to be 33 ml. From this, 5 ml was taken, and 20 ml of ethanol was added. The mixture was then titrated with 0.1 M NaOH using phenolphthalein as the indicator until a pink endpoint was reached. The tannin content was calculated as a percentage using the formula $C_1V_1 = C_2V_2$, where C_1 = concentration of tannic acid, C_2 = concentration of base, V_1 = volume of tannic acid, and V_2 = volume of base.

Proximate Analysis of pawpaw seed

The proximate analysis of pawpaw seed was carried out using the analytical methods of (AOAC, 2009).

Mineral Analysis

The mineral analysis of the pawpaw was carried out using Atomic Absorption Spectrophotometer (AAS).

Determination of vitamin content

Vitamin E was estimated in the sample using the Emmeric-Engel reaction, following the procedure described by Rosenberg (1992).

Vitamin A was determined according to the method outlined by Bayfield and Cole (1980).

Vitamin C was analyzed by the titrimetric method as described by Osborne and Voogt (1976).

Statistical Analysis

Results obtained were subjected to statistical tests using the Statistical Package for Social Sciences (SPSS).

3. Results

Quantitative Phytochemical Analysis

The results obtained from the quantitative analysis of the ethanol seed extract of pawpaw are presented in Table 1. The findings revealed the presence of several phytochemicals in pawpaw seeds, including alkaloids, phenols, flavonoids, steroids, saponins, tannins, anthocyanins, cyanogenic glycosides, cardiac glycosides, phytate, and oxalate.

Table 1: Quantitative Analysis of Pawpaw Seed Extract

Parameters	Conc. (%)
Flavonoids	6.17±0.09
Alkaloids	19.91±0.00
Saponins	4.77±0.00
Tannins	4.63±0.00
Anthocyanin	4.37±0.06
Cardiac glycosides	1.34±0.00
Cyanogenic glycosides	3.18±0.00
Steroid	6.14±0.00
Phytate	0.53±0.00
Oxalate	0.18±0.00
Phenols	7.34±0.00

Results were presented as mean±SD of triplicate determination.

The Proximate Analysis of Pawpaw Seed

The results of the proximate composition of pawpaw seeds (Table 2) showed that carbohydrates were the most abundant component ($64.62 \pm 0.54\%$), followed by moisture ($13.09 \pm 0.09\%$), crude protein ($9.43 \pm 0.40\%$), ash ($8.54 \pm 0.03\%$), crude fiber ($2.35 \pm 0.03\%$), and crude fat ($1.12 \pm 0.03\%$).

Table 2: Proximate Composition of pawpaw seed

Parameters	% Weight
Moisture content	13.09±0.09
Ash content	8.54±0.04
Crude protein	9.43±0.40
Crude fat (lipid)	1.12±0.03
Crude fiber	2.35±0.03
Carbohydrate	64.62±0.54

Results were presented as mean±SD of triplicate determination.

Vitamin Composition of pawpaw seed

The result of the vitamin content (Table 3) showed that vitamin C (68.90 ± 0.002 mg/kg) was higher followed by vitamin A (29.34 ± 0.046 mg/kg) and Vitamin E (9.22 ± 0.018 mg/kg) in various concentration.

Table 3: Vitamin Composition of pawpaw seed

Parameters	Conc. (mg/kg)
Vitamin A	29.34±0.046
Vitamin E	9.22±0.018
Vitamin C	68.90±0.02

Results were presented as mean±SD of triplicate determination.

Mineral Content of Pawpaw Seed

The result of the mineral content (Table 4) showed that Zinc (0.98 ± 0.00 ppm) was higher followed by Iron (0.47 ± 0.00 ppm), Manganese (0.19 ± 0.00 ppm) while copper (0.08 ± 0.00 ppm), Nickel (0.02 ± 0.00 ppm) and lead was 0.00 ± 0.00 ppm.

Table 4: Mineral Content of pawpaw seed

Parameters	Conc. (ppm)
Iron	0.47±0.00
Copper	0.08±0.00
Zinc	0.98±0.00
Manganese	0.19±0.00
Nickel	0.02±0.00
Lead	0.00±0.00

Results were presented as mean±SD of triplicate determination.

4. Discussion

The phytochemical analysis revealed the presence of flavonoids, alkaloids, saponins, tannins, phenols, terpenoids, steroids, proteins, and cardiac glycosides in *Carica papaya*. A variety of plants and fruits have been reported to protect liver function due to their different phyto-constituents, including phenolics, flavonoids, coumarins, alkaloids, essential oils, glycosides, xanthenes, carotenoids, organic acids, lignins, and monoterpenes (Madrigal-Santillán, 2014). These results are consistent with the findings of Shanta and Puja (2021), who reported the presence of bioactive compounds such as saponins, alkaloids, glycosides, tannins, polyphenols, steroids, and flavonoids in different extracts of pawpaw seeds and leaves.

These bioactive compounds may be responsible for various pharmacological properties, including antimicrobial, anti-

malarial, antithrombotic, antioxidant, anti-diabetic, laxative, hypoglycemic, anti-helminthic, anti-inflammatory, cathartic, anticancer, antifertility, antifungal, and antibacterial activities, among others (Everette, 2003; Akwas *et al.*, 2025). Their presence supports the folk medicinal use of pawpaw in the treatment of upper respiratory tract infections, diarrhea, skin diseases, pneumonia, cough, and conjunctivitis (Casas-Grajales & Muriel, 2015).

Flavonoids, a beneficial group of naturally occurring compounds, are known for their anti-hepatic inflammatory potential. They are widely distributed in the plant kingdom and exhibit distinct pharmacological properties. Flavonoids can be classified into categories such as anthocyanins, catechins, flavanols, flavones, and flavanones (Ezugwu, 2008). Both flavonoid and phenolic compounds are well-known antioxidants and anti-inflammatory agents (Kumar & Goel, 2019). Several studies have shown that natural antioxidants, particularly flavonoids and phenolics, exert protective effects against diseases caused by oxidative stress, including liver diseases (Casas-Grajales & Muriel, 2015). Experimental evidence also demonstrates that flavonoids can prevent and treat hepatotoxin-induced liver injury in rodents (Tai *et al.*, 2015; Akwas *et al.*, 2025).

Quantitative analysis of pawpaw seed extracts revealed flavonoid content at $6.11 \pm 0.09\%$ and phenolic content at $7.32 \pm 0.01\%$. These results align with Asghar *et al.* (2016), who reported total flavonoid content of 8.62 ± 0.16 mg CE/g in ethanol extracts of pawpaw seeds. Thus, pawpaw seeds are a good source of flavonoids. Flavonoids have been associated with anti-allergic, anti-inflammatory, antiviral, antiproliferative, and anticancer activities (Baskaran *et al.*, 2012).

The alkaloid content ($19.91 \pm 0.00\%$) was the highest among the seed extract phytochemicals. Alkaloids such as nicotine and choline isolated from papaya have been shown to display anti-inflammatory properties (Baskaran *et al.*, 2012). Alkaloids are considered among the most therapeutically significant plant compounds. Both pure alkaloids and synthetic derivatives are used as medicinal agents due to their analgesic properties. Quinine, for example, is an alkaloid with anti-malarial activity (Baskaran *et al.*, 2012). Li *et al.* (2011) further noted that many drugs have been derived from alkaloid-containing plants, though excessive doses can be toxic. Krishna *et al.* (2008) reviewed the medicinal value of different parts of the pawpaw tree, reinforcing its pharmacological importance.

The proximate composition of pawpaw seeds (Table 2) revealed the presence of moisture, protein, ash, crude fiber, crude fat, and carbohydrate in varying concentrations. These nutrients suggest that pawpaw seeds may be beneficial for growth, body development, and anti-aging, with potential as a food supplement. Carbohydrate content was the highest (64.62%), closely matching the 50.07% reported by Watson (2013) in other plants. The high carbohydrate level indicates that pawpaw seeds can provide energy to support metabolic processes.

The moisture content of pawpaw seeds was 13.09%, indicating seed viability and germination potential. In the human body, moisture is crucial for regulating temperature, lubricating joints and tissues, and facilitating nutrient transport and waste removal (Williams, 2012). Crude fat content was 1.12%, much lower than the 27.50% reported in unripe pawpaw seeds by Kolawole *et al.* (2013). This low level indicates a limited energy and fatty acid

source, though still nutritionally relevant. Crude protein content was 9.43%, while ash content was 8.44%. These values are similar to Garret (2018), who reported 8.90% crude protein in unripe pawpaw seeds.

Table 3 revealed the presence of vitamins A, E, and C in pawpaw seed extract, with vitamin C showing the highest concentration (68.90 ± 0.02 mg/kg), followed by vitamin A (29.34 ± 0.046 mg/kg), and vitamin E (9.22 ± 0.018 mg/kg). These vitamins play vital roles in human health. Vitamin A supports vision in dim light and maintains epithelial integrity across the skin, mucous membranes, and organ linings. Vitamin E strengthens the immune system and promotes healthy skin and eyes, while vitamin C aids collagen formation, wound healing, and antioxidant defense (Krishna, 2008).

Table 4 indicated the presence of minerals such as iron, copper, zinc, manganese, and nickel in pawpaw seed extract, but no lead was detected. Iron (0.47 ppm) is essential for oxygen transport, DNA synthesis, and electron transport. Zinc (0.09 ppm) contributes to cholesterol regulation, blood pressure control, DNA synthesis, protein building, tissue repair, and immune system function. Copper (0.08 ppm), manganese (0.19 ppm), and nickel (0.02 ppm) were also present, further highlighting the nutritional value of pawpaw seeds (Krishna, 2008).

5. Conclusion

The results of this study revealed that pawpaw seed extract contains diverse phytochemicals, including alkaloids, flavonoids, phenols, saponins, and tannins, as well as vitamins (A, C, and E) and essential minerals. These bioactive constituents are known for their strong antioxidant properties and may play a significant role in scavenging free radicals, thereby contributing to potential health-promoting and disease-preventive effects.

Conflicts of Interest

The authors declare no conflicts of interest.

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