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Proximate, Mineral and Vitamin Composition of Locally Grown *Carica papaya* Leaf Extract

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ABSTRACT

Background and Objective: *Carica papaya*, a widely utilized medicinal plant in Nigeria, has been traditionally used to treat conditions such as fever, asthma and colic. This study investigated the vitamin, mineral and proximate composition of *Carica papaya* leaves cultivated in Uyo, Nigeria. **Materials and Methods:** Fresh *Carica papaya* leaves were collected, authenticated, dried and extracted with ethanol. Proximate and mineral analyses were conducted using the American Society for Testing and Materials (ASTM) and the American Public Health Association (APHA), respectively. Vitamins A, B1, B2 and C were quantified using specific extraction and UV spectrophotometric techniques. Results were presented as Mean±Standard error of the mean (SEM) based on triplicate determinations (n = 3). Statistical significance was set at $p \leq 0.05$. Data management and statistical analyses were conducted using Microsoft Excel. **Results:** Mineral analysis indicated the leaves contained potassium (6.423 mg/kg), sodium (0.914 mg/kg), calcium (15.225 mg/kg), magnesium (6.613 mg/kg), manganese (3.816 mg/kg), zinc (14.582 mg/kg), iron (89.103 mg/kg), copper (12.306 mg/kg) and phosphorus (0.334 mg/kg). Proximate composition results showed moisture (53.05%), ash (3.17%), fiber (3.80%), crude lipid (2.41%), crude protein (7.18%) and carbohydrate (30.27%). The vitamin content was as follows: Vitamin B1 (3.117 mg/100 g), vitamin B2 (3.290 mg/100 g), vitamin C (0.00773 mg/100 g) and vitamin A (0.00369 mg/100 g). **Conclusion:** This study demonstrated that *Carica papaya* leaves were rich in essential vitamins and minerals, making them a promising nutritional resource. These findings contributed valuable insights into the nutritional profile of locally grown *Carica papaya* leaves, highlighting their potential role in supporting health and preventing nutritional deficiencies.

KEYWORDS

Carica papaya, proximate analysis, mineral composition, nutritional profile, vitamins

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INTRODUCTION

Carica papaya, commonly known as papaya, is a tropical fruit with various medicinal and nutritional properties, highly valued for both its fruit and leaves. The leaves are rich in vitamins, minerals and bioactive compounds, making them nutritionally significant. Proximate analysis reveals the presence of essential nutrients, such as vitamins C, A and E, as well as minerals like calcium and potassium.

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Traditionally, papaya leaves have been used worldwide to treat ailments like dengue, malaria, diabetes, asthma and fever due to their immunomodulatory and antiviral properties. In Nigeria, papaya is cultivated for its food and medicinal uses and its leaves are specifically employed in traditional remedies for diabetes.

Besides its leaves, papaya contains biologically active compounds like chymopapain and papain, widely used in brewing, textile production and traditional medicine[1,2]. Studies have shown that papaya possesses antioxidant properties that help prevent cholesterol oxidation, offering protection against heart disease, stroke and diabetes[3-5]. Papaya fruit also exhibits diuretic, antiseptic and stomachic effects and fermented papaya products have demonstrated free radical scavenging activity, beneficial for immune support and tumor protection. Papaya's broad therapeutic applications underscore its cultural and medicinal value as a versatile natural remedy[3-5].

Carica papaya is a tropical fruit valued for its medicinal and nutritional properties across various cultures. The leaves contain a wealth of vitamins, minerals and bioactive compounds, making them nutritionally significant[6]. Proximate analysis has highlighted the leaves' macronutrient and micronutrient content, including vitamins C, A and E and minerals like calcium, phosphorus and potassium, contributing to dietary value and potential health benefits[7]. Traditionally, papaya leaves have been used worldwide to treat ailments such as dengue, malaria, diabetes, asthma and fever, due to their immunomodulatory and antiviral properties[8-11].

In Nigeria, *Carica papaya* is cultivated for its food ornamental and traditional medicinal uses, with its leaves specifically employed in remedies for diabetes[12]. The fruit and latex also contain bioactive compounds such as chymopapain and papain, widely used in brewing, wine-making and the textile industry. Numerous studies highlight papaya's antioxidant properties, which help prevent cholesterol oxidation and protect against heart disease, stroke and diabetes[4,13,14]. The fruit also demonstrates diuretic, antiseptic and stomachic effects, while fermented papaya products show free radical scavenging activity, supporting immune health and providing protection against tumors[15]. These diverse medicinal uses across cultures emphasize *Carica papaya*'s longstanding value as a versatile natural remedy and important dietary resource.

The study was conducted to analyze the proximate composition, mineral content and selected vitamin levels in locally grown *Carica papaya* leaves and to compare these with samples from other regions to observe trends and variations in their nutrient profile.

MATERIALS AND METHODS

Study area: The study was conducted in the Research Laboratory of the Department of Pharmaceutical and Medicinal Chemistry, Faculty of Pharmacy, University of Uyo, Uyo, Akwa Ibom State, Nigeria. The plant samples were collected from Idak Okpo, Uyo, Akwa Ibom State, Nigeria, all located at approximately Latitude 5.03°N and Longitude 7.93°E. Fresh *Carica papaya* leaves were collected in October, 2020 and all experimental procedures were carried out between October, 2020 and December, 2021.

Materials

Disposable materials: Aluminum foil, cotton wool, hand gloves, masking tape, hand towels, handkerchief, marker pen, syringes, filter paper, serviette paper.

Non-disposable materials: Water bath, Electronic balance JA3103 (Shimadzu-Japan), beakers, wash bottle, conical flasks, glass funnel, maceration tank, measuring cylinders (10 and 100 mL), test tubes, volumetric flasks, retort stand, spatula, scissors, sieve cloth, test tube (Pyrex) and test-tube rack, syringe (2 mL), centrifuge and glass stirrer.

Reagents: Chloroform (analar 99.5%), distilled water, ethanol (analar 99.5%), H_2SO_4, HCl, Wagner's reagent, conc. HCl, potassium ferrocyanide, 10% NH_4OH, $FeSO_4$, $FeCl_3$, KOH, ethanol KOH, zylene, phospho tungstate, acetic anhydride, mercury (II) acetate, perchloric acid.

Methods

Collection and identification of plant: The fresh leaves of *Carica papaya* were collected from Idak Okpo in Uyo in October 2020. It was identified and authenticated with the identification number, UUPH 18(a), by Mrs. Emmanuel G. Udoma, a Taxonomist at the University of Uyo Pharmacy Herbarium. The leaves were dried and pulverized for extraction.

Extraction of plant material: The 60 g of the dried leaves was macerated in a maceration tank with 70% of ethanol for 72 hrs at room temperature. The tank was intermittently shaken to ensure a good mix. After 72 hrs, the mixture was filtered using a sieve cloth. The marc was re-macerated under the same conditions to obtain a higher yield. The obtained macerate was concentrated to dryness in a water bath at 50°C. Upon complete drying, the crude extract was weighed and then stored in a refrigerator for subsequent use[16,17].

Proximate and mineral element analysis: Proximate analysis of moisture content was done on the fresh leaf, while ash, fibre, crude lipid, crude protein, carbohydrate analysis and the estimation of the mineral content for sodium, potassium, calcium, magnesium, manganese, zinc, iron, copper and phosphorus were performed on the extract at the Akwa Ibom State Ministry of Science and Technology Research and Development Laboratory using the method by ASTM[18] and APHA[19].

Determination of vitamin A

Extraction of vitamin A from *Carica papaya* leaves[20]: A 30 g portion of fresh *Carica papaya* leaves was weighed, thoroughly washed to remove sand and debris and drained using a sieve. The leaves were then squeezed to obtain an aqueous extract, which was collected in a beaker. A 5 mL of this extract was transferred to a test tube (test tube I) with a secure stopper, followed by the addition of 5 mL of 1 M ethanol-KOH solution. The mixture was shaken vigorously for 1 min. Next, 5 mL of xylene was added and the test tube was sealed and shaken again for 1 min. The tube was centrifuged at 1500 rpm for 10 min, resulting in a separation of the upper layer, containing the Vitamin A extract.

The upper layer was carefully transferred to a second test tube (test tube II, made of soft (sodium) glass). The absorbance (A1) of the extract in test tube II was measured at 335 nm using xylene as a blank. The sample was then irradiated under UV light for 30 min and the absorbance (A2) was recorded. Absorbance readings were taken in triplicate and the average was calculated.

The concentration (Cx) of vitamin A (µM/30 g) in the sample was determined using the formula:

$$Cx = \text{Mean of A1-Mean of A2} \times 22.23$$

where, 22.23 is the multiplier based on the absorption coefficient for a 1% vitamin A solution (retinol form) in xylene at 335 nm using a 1 cm pathlength cuvette.

Determination of vitamin B1 and B2[21]: The *Carica papaya* leaves were thoroughly washed to remove any dirt or contaminants. The leaves were then dried at a temperature below 40°C to prevent degradation of vitamins. The dried leaves were ground into a fine powder using a mortar and pestle. To 1 g of the powdered leaf sample, 10 mL of 80% slightly acidic methanol was added. The mixture was then homogenized and heated at 50°C for 1 hr, after which it was centrifuged at 3,000 rpm for 10 min and the supernatant was filtered through Whatman filter paper to remove particulates.

A series of standard solutions of vitamins B1 and B2 at known concentrations of 0.1, 0.5, 1.0 and 5.0 mg/L) were prepared in the same solvent used for extraction. The absorbance of each standard solution was measured at approximately 246 nm for vitamin B1 and approximately 266 nm for vitamin B2. A calibration curve was plotted for each vitamin by plotting absorbance values against concentrations. The absorbance of the filtered leaf extract was measured at 246 nm for vitamin B1 and 266 nm for vitamin B2. If the sample's absorbance was too high, it was diluted appropriately with the solvent used for extraction and the dilution was adjusted for in the final calculation. Finally, calculations were performed in the fifth step. The calibration curve was used to determine the concentration of vitamins B1 and B2 in the extract based on the absorbance values. The formula used to calculate the concentration of each vitamin in the dried leaf sample was:

$$\text{Concentration of Vitamin (mg/g)} = C \times VM$$

where, C was the concentration of the vitamin in the extract (in mg/L), as obtained from the calibration curve, V was the volume of the extraction solvent used (in L) and M was the mass of the dried leaf sample used for extraction (in grams).

Analysis of vitamin C[22]: The 1 mL of the analyzed liquid was dispensed into a centrifugal test tube, followed by the addition of 1 mL of the phosphotungstate reagent. The mixture was thoroughly mixed and left at room temperature for 30 min. Subsequently, the test tube underwent centrifugation at 7000 g for 10 min and the entire separated supernatant was collected using a pipette. A standard sample was prepared similarly, excluding the centrifugation step. The absorbance of the test sample was measured at 700 nm against a mixture of phosphotungstate reagent and a 50 mM solution of oxalic acid in a 1:1 (v/v) ratio, serving as the reference sample.

Data analysis: Values were expressed as Mean±Standard error of the mean (SEM) of many parallel measurements (n = 3). Differences at $p \leq 0.05$ were considered statistically significant. Database management and statistical analysis were performed using Microsoft Excel.

RESULTS AND DISCUSSION

Table 1 shows the results of the analysis of minerals for pawpaw leaves. The mineral analysis showed that potassium (6.423 mg/kg), sodium (0.914 mg/kg), calcium (15.225 mg/kg) and magnesium (6.613 mg/kg) were below WHO limits. Manganese (3.816 mg/kg) and phosphorus (0.334 mg/kg) had no specified limits. Zinc (14.582 mg/kg), iron (89.103 mg/kg) and copper (12.036 mg/kg) exceeded WHO limits, indicating potential toxicity concerns.

Table 1 also indicates that potassium was significantly lower than the WHO limit and other typical literature values, which range from 80 mg/kg to over 1000 mg/kg depending on the sample preparation method, as reported by Onwuka[23]. Calcium was much lower than the WHO limit and other reported values (like 1086 mg/kg) for extracts[24]. Magnesium content was far below typical values of 13-50 mg/kg. Zinc, Iron and Copper values were significantly higher than commonly cited ranges (for example, zinc is often around 3-10 mg/kg). Phosphorus is much lower than the reported values of 1971 mg/kg. Even with wide deviations of the essential nutrients in our studied sample, mineral elements contributions from this source can effectively contribute to the proper functioning of tissues and act as second messengers in some biochemical cascade mechanisms as well as regulatory functions such as neuromuscular transmission, blood clotting, oxygen transport and enzymatic activity[25-27]. Calcium is the most abundant mineral in the body and it is necessary for the formation of bones and teeth. Phosphorus, along with calcium, is necessary for bone calcification. Phosphorus alone is used as a cofactor in many enzyme systems which are essential for the metabolism of carbohydrates, lipids and proteins. The phosphate ion also plays a role in acid/base balance. Magnesium is important for neuromuscular transmission and as a

Table 1: Analysis of mineral elements

S/N	Parameter	WHO limit (mg/kg)	Result (mg/kg)
1	Potassium	150.00	6.423±1.043
2	Sodium	2,000 mg/day	0.914±0.004
3	Calcium	75.00	15.225±0.122
4	Magnesium	50-150	6.613±0.025
5	Manganese	-	3.816±0.222
6	Zinc	3.00	14.582±3.454
7	Iron	0.30	89.103±6.715
8	Copper	1.00	12.036±0.355
9	Phosphorus	-	0.334±0.101

Table 2: Proximate analysis for *Carica papaya* leaves

S/N	Proximate analysis	Percentage (%)
1	Moisture content	53.05±3.500
2	Ash (%)	3.17±0.500
3	Fibre (%)	3.80±0.012
4	Crude lipid	2.41±0.111
5	Crude protein	7.18±0.045
6	Carbohydrate	30.27±0.211

Values are stated as Mean±SEM (n = 3)

Table 3: Results for analysis of vitamins

S/N	Vitamins	Concentration (μg/100 g)
1	B1	3117±4.450
2	B2	3290±23.200
3	C	7.733±1.000
4	A	3.687±0.024

Values are stated as Mean±SEM (n = 3)

cofactor in many enzyme systems. Sodium and potassium help maintain the body's fluid balance and thereby play a key role in regulating cardiac output. Iron, as an essential component of both hemoglobin and myoglobin, is crucial for effective oxygen transport throughout the body. Zinc acts as a cofactor for many enzyme systems, which regulate nucleic acid metabolism, cell repair, as well as tissue repair and growth. Copper helps the body to form collagen and to absorb iron and it also plays a role in energy production. Manganese plays a vital role in the formation of connective tissues, bones, blood clotting factors and sex hormones. It is also essential for proper brain and nerve function. The significance of these elements cannot be overstated, as they serve as crucial cofactors required for the optimal activity of many enzymes[26-29].

In proximate analysis (Table 2), the results showed that our plant is a good source of carbohydrate and confirmed a report by Agbonghae and Nwokoro[30], which confirmed that carbohydrate is the predominant nutritional component of papaya leaves. Although the protein content of the extract was relatively low (7.18%), it can still serve as a complementary source of protein when combined with other protein-rich foods to meet the recommended dietary allowance for children above 6 months, particularly those at risk of protein-energy malnutrition. The moisture content was lower than typical reported values, which generally range around 57 to 85%[31]. Ash Content was slightly higher than some reports (2.18%) but lower than others, citing 8-12%. Fiber was not significantly different from some lower-end literature values (3.10%) but significantly less than others reporting up to 25%[24,31]. The presence of crude fiber supports healthy bowel movements and enhances nutrient absorption. Although the lipid content of the sample was relatively low and insufficient to meet the daily recommended fat intake-thereby providing only limited amounts of essential fatty acids associated with wound healing and immune function-it can still contribute nutritional value when consumed alongside other foods with higher fat content[28].

Vitamin composition (Table 3) vitamin B1 and B2 values align with some high-end literature values, whereas Vitamin C was extremely low compared to 68.59 mg/100 g reported. The vitamin A value in our sample was much lower than the beta-carotene equivalents of 303.55 mg/100 g in the extracts. Vitamins play essential roles in regulating numerous physiological processes. The B-vitamin group is particularly important for the metabolism of carbohydrates, fats and proteins. Thiamine (B1) is crucial for generating energy from carbohydrates, while riboflavin (B2) supports energy production through its involvement in the electron transport chain, the citric acid cycle and the breakdown of fatty acids. Vitamin C contributes to collagen formation, enhances absorption, supports immune function, promotes wound healing and helps maintain cartilage, bones and teeth. Vitamin E is widely recognized for its strong antioxidant properties[32].

CONCLUSION

This study provided a comprehensive analysis of locally grown *Carica papaya* leaves, revealing a rich nutritional profile with significant concentrations of essential minerals, proximate components and vitamins. High levels of potassium, calcium and iron indicate the leaves' potential as a valuable source of micronutrients, while their balanced composition of moisture, fiber, protein and carbohydrates highlights their versatility as a dietary component. The presence of vitamins B1, B2, C and A further enhances their nutritional value, supporting overall health. These findings offer insights into the leaves' potential as a functional food or dietary supplement and lay the groundwork for future studies on their bioavailability, medicinal properties and practical applications in addressing nutritional deficiencies. The information will also guide cultivators in understanding the nutritional content of *Carica papaya* leaves, enabling strategies to further enrich their dietary value.

SIGNIFICANCE STATEMENT

This study discovered the rich vitamin, mineral and proximate composition of *Carica papaya* leaves that can be beneficial for improving nutrition, supporting health and preventing nutrient deficiencies. The high levels of essential elements such as iron, zinc, calcium and vitamins B1 and B2 indicate their potential as a natural dietary supplement. This study will help researchers uncover the critical areas of nutritional and therapeutic potential of locally grown *Carica papaya* leaves that many researchers were not able to explore. Thus, a new theory on the role of medicinal plants in addressing micronutrient deficiencies may be arrived at.

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