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Phytochemical Screening of Leaf and Root Extracts of *Carica papaya* (Pawpaw) from Asaba, Delta State, Nigeria

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Abstract
A rekindled interest in the Pharmaceutical importance of plants has led to the discovery and adoption of plant extracts, which were commonly used in medicine as an alternative source of remedies. This study evaluated the phytochemical constituents in *Carica papaya* leaf and root extract using standard methods. The aqueous extract of the leaves analyzed revealed the presence of tannins (0.002±0.001), flavonoids (0.020±0.002), phenolics (0.011±0.002), and alkaloids (0.024±0.003), while that of the roots gave tannins (0.100±0.010), flavonoids (0.019±0.001), phenolics (0.016±0.002), and alkaloids (0.027±0.001). Cardiac glycosides, phlobatannins, and triterpenes were not detected in the leaves and root extract of the plant. The high alkaloid content means the leaves and the roots are medicinally efficacious. The result obtained in this study showed the scientific basis for the effectiveness of this plant in the treatment of various ailments and diseases, as well as its uses in industries and medical sciences.

Keywords: Phytochemicals, *Carica papaya* leaves, roots, and plant extract, Cardiac glycosides

Introduction

Plants are very rich in a wide variety of chemical compounds. They serve as rich resources of natural drugs for research and development. The impact of the medicinal effects of plant materials in folk medicine for the treatment of various ailments and diseases is gradually gaining ground (Elansary et al., 2018). This is due to the chemical compounds produced by plants, primarily due to the synthesis of various secondary metabolites (Nduche et al., 2019). Phytochemicals are chemical compounds found naturally in plants. Phytochemicals, which contain bioactive constituents like alkaloids, tannins, flavonoids, and phenolic compounds, possess the ability to treat infectious diseases with minimal side effects (Adachukwu et al., 2013). They are responsible for the colors: orange, red, purple, and yellow, as well as other organoleptic properties of plants. Bioactive constituents found in phytochemicals include alkaloids, tannins, flavonoids, and phenolic compounds. As a result of their therapeutic properties, they have the potential to treat infectious diseases while having fewer side effects than synthetic pharmacological agents (Chávez-Pesqueira & Núñez-Farfán, 2017). Plant medicinal actions are unique to specific species, such as *Carica papaya*, which contains many phenolic groups that scavenge free radicals. Aqueous extract of papaya leaves has antioxidant properties (Aravind et al., 2013). Although phytochemicals have health benefits, excessive plant consumption can lead to adverse effects (Ayoola & Adeyeye, 2010). Identifying and quantifying the bioactive chemicals present in plant extracts is essential, as phytochemicals are known for their varied biological actions, including antioxidant, anti-inflammatory, antibacterial, and anticancer characteristics (Yahaya et al., 2017). *Carica papaya*, sometimes known as paw-paw, is a tropical plant species belonging to the Caricaceae family. Paw-paw originated from Central and South America and has been widely farmed and naturalized (Akash et al, 2023), with a strong presence in Africa and Asia. Paw-paw is a popular fruit tree in Nigeria, especially in the southern regions (UN Food and Agriculture Organization Statistical Database (FAOSTAT, 2022).

Botanically, papaya plants have a variety of reproductive features, including dioecious, monoecious, and hermaphroditic, as well as different flower structures. It is high in antioxidant nutrients such as carotenes, vitamin C, vitamin B, folate, and pantothenic acid, as well as minerals like potassium and magnesium (Agbonghae & Nwokoro, 2019). The plant has been used in traditional medicine for centuries, notably in Africa and Asia, to cure a variety of diseases, including malaria, diarrhea, and skin infections (Aravind et al., 2013). The fruits, leaves, roots, seeds, and stems of *C. papaya* are highly appreciated for their medical characteristics (Biswas et

al., 2013; Sarkar et al., 2020), as they include unique physiologically active chemicals that are effective as medicines and valuable in industrial processes. *C. papaya* has sparked substantial interest as it includes a wide variety of bioactive chemicals, including alkaloids, enzymes, flavonoids, glycosides, vitamins, and minerals. *C. papaya's* medicinal benefits can be attributed to its high content of therapeutic substances, including vitamins A and C, potassium, carotenoids, and saponins (Ayoola & Adeyeye, 2010). The medicinal properties are further validated by studies demonstrating its anti-inflammatory, antioxidant, anti-cancer, and wound-healing capabilities (Subrata et al., 2023). The key phytochemicals present include papain, a proteolytic enzyme known for its anti-inflammatory and wound-healing effects, found in fruits, stems, and leaves, as well as Chymopapain, which facilitates digestion (Singh et al., 2020). Papain also supports digestion due to its proteolytic enzyme content. Additionally, papain has been used orally to address milder digestive issues such as bloating and chronic indigestion. It is also applied in the treatment of arthritis and intestinal parasites (Titanji et al., 2008; Abhishek et al., 2011). The phytochemicals in papain may enhance immune function and potentially stimulate the release of natural substances that target tumor cells. The leaves of the papaya plant are rich in carpaine, a chemical compound that eliminates microorganisms that interfere with digestive function (Aravind, 2013). The leaves are brewed into a tea rich in antioxidants and vitamins used for fever reduction (Plamada & Vodnar, 2022). The extract from papaya leaves has shown the ability to inhibit the growth of cancer cells. It seems to enhance the production of important signaling molecules known as Th1-type cytokines, which play a role in regulating the immune system (Aravind, 2013). Although the seeds of the papaya are very strong and spicy, making them nearly impossible to eat, they appear to possess greater medicinal properties than the fruit itself, as they exhibit antibacterial effects and are effective against infections caused by E. coli, salmonella, and staphylococcus (Rahmani & Aldebasi, 2016). The seeds are also useful in eliminating intestinal parasites. In certain Asian countries, juice extracted from papaya roots is utilized to alleviate urinary issues (Elansary et al., 2018).

An aqueous extract of papaya root administered orally at a dosage of mg/kg to rats has been observed to significantly increase urine production and exhibit urinary electrolyte excretion profiles comparable to those of Hydrochlorothiazide (Krishna, 2008). Historically, the root has been utilized for treating conditions like rheumatism and arthritis, as well as digestive issues such as constipation and diarrhea (Wadood et al., 2013), and it has also been employed in addressing skin ailments like eczema and acne (Ayoola & Adeyeye, 2010). It is also noteworthy that the root of C. papaya can serve as a natural dye and is used in cosmetics due to its antioxidant and anti-inflammatory properties (Isaac & Adekoya, 2020). Papaya is a highly nutritious fruit that contains provitamin A, carotenoids, vitamin C, vitamin B, lycopene, minerals, and dietary fiber (Alara et al., 2022). Almost all parts of C. papaya hold economic significance, and its applications extend to nutritional, industrial, and medicinal uses. The fruit is commonly consumed and made into juice and wine, while the unripe papayas are prepared as vegetables (Nduche et al., 2019). The seeds possess medicinal properties, aiding in the treatment of sickle cell disease and disorders related to poisoning (Elansary et al., 2018). Given the extensive potential of *Carica papaya*, a thorough investigation was conducted to perform a phytochemical analysis of the leaves and roots of *Carica papaya* sourced from the Federal College of Education in Asaba, Delta State, Nigeria.

Materials and Methods

Collection and Preparation of Samples

Carica papaya leaves and roots were collected from the Pawpaw plant in Federal College of Education (Technical), Asaba (Permanent Site), in Oshimili South Local Government Area of Delta State, Nigeria. The samples were washed with distilled water to remove dirt and other solid contaminants, air-dried, and ground into a fine powder using a mechanical blender. The pulverized sample was stored in a tightly closed glass sample bottle for extraction.

Extraction

Twenty grams (20g) of the powdered samples were soaked in 800 mL of ethanol and kept for twenty-four hours with shaking at regular intervals, after which the content was filtered using Whatman filter paper (No. 1). The filtrate was evaporated at 30 °C. Four grams (4g) of both crude extracts were partitioned in a mixture of 20 ml of chloroform and 20 ml of water (1:1). The mixture was shaken properly, placed in a separating funnel to enable separation before collection in separate beakers. The crude extract was stored for photochemical screening.

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Test for Alkaloids
2-3 drops of Drangendoff's reagent were added to 0.1 mL of the crude extract and fractions in a test tube. An orange-red precipitate with turbidity denoted the presence of alkaloids (Ciulci, 1994). Analysis was performed in triplicate

Test for Flavonoids
4 mL of the crude extract and fractions were added to a piece of magnesium ribbon, followed by a drop-wise addition of concentrated Hydrochloric acid. A color change from orange to red indicated the presence of flavones; red to crimson indicated the presence of flavonoids (Sofowora, 1993). Analysis was performed in triplicate.

Test for Cardiac Glycosides
2 mL of the crude extract was treated with 1 mL of glacial acetic acid containing a few drops of $FeCl_3$. Concentrated H_2SO_4 was added to the above mixture, producing a green-blue colour depicting a positive result of the presence of cardiac glycosides (Adetuyi & Popoola, 2010; Trease & Evans, 1989; Sofowora, 1993). Analysis was performed in triplicate

Test for Phenolics and Triterpenes
This was analyzed using the standard method as described by Sofowora (1993), and Trease and Evans (1989). Analysis was performed in triplicate

Test for Tannins
Two milliliters (2ml) of the extract fraction was diluted with distilled water in separate test tubes, and 2-3 drops of 5% ferric chloride ($FeCl_3$) solution were added. A green-black or blue coloration indicates tannin (Ciulci, 1994). Analysis was performed in triplicate

Test for Phylobatannins
About three (3ml) of the aqueous extract was added to 2ml of 1% HCl, and the extract was boiled. The deposition of a red precipitate was taken as evidence of the presence of Phylobatannins (Mehta et al., 2013). Analysis was performed in triplicate

Results
The results of the phytochemical screening of *Carica papaya.*

Table 1: Phytochemical screening of the aqueous extract.

Phytochemicals	**Aqueous extract of *Carica papaya***	
	Leaves	**Roots**
Phenolics	++	++
Cardiac glycosides	--	--
Flavonoids	++	++
Phlobatannins	--	--
Alkaloids	++	++
Tannins	++	++
Triterpenes	--	--

Key: -- Absent

++ Present

Table 2. Quantitative Phytochemical screening of the aqueous extract.

Phytochemicals Components	**Aqueous extract of *Carica papaya***	
	Leaves	**Roots**
Tannins	0.002±0.001	0.100±0.010
Flavonoids	0.020± 0.002	0.019±0.001
Phenolics	0.011± 0.002	0.016±0.002
Alkaloids	0.024± 0.003	0.027±0.001

Values are the mean of triplicate determinations in % ± S.D.

From Table 1, the qualitative analysis of phytochemicals in the extracts indicated the presence of phenolics, flavonoids, alkaloids, and tannins, while cardiac glycosides, phlorotannins, and triterpenes were not detected. The detection of flavonoids and alkaloids supports the findings of Ukpo et al. (2017) and Singh et al. (2020), who also identified flavonoids in the leaves of *Carica papaya*. Additionally, alkaloids were reported in the studies

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conducted by Martel et al. (2020) and Aravind et al. (2021) regarding *Carica papaya*. The quantitative phytochemical analysis presented in Table 2, demonstrated that the leaves of *Carica papaya* contained 0.020% flavonoids, 0.002% tannins, 0.024% alkaloids, and 0.011% phenolics. Similarly, the roots showed 0.019% flavonoids, 0.10% tannins, 0.027% alkaloids, and 0.016% phenolic.

Discussion

The analysis of the physicochemical composition of the plant indicated that both papaya leaves and roots contain significant levels of bioactive compounds essential for maintaining good health. However, the findings revealed that the leaves had a higher concentration of alkaloids compared to the roots, while the roots contained more tannins than the leaves. Alkaloids are utilized in medicine for their properties as analgesics and anesthetics, such as morphine and codeine (Ayoola & Adeyeye, 2010). Furthermore, they are used in in treating malaria, hypertension, and serve as local anesthetics in ophthalmic procedures. Alkaloids also act as stimulants for the central nervous system. They possess anti-parasitic qualities and can function as aphrodisiacs, assisting in the treatment of erectile dysfunction and various other conditions, particularly erectile dysfunction and infertility (Rivera-Pastrana et al., 2010). Flavonoids have antibacterial, antiviral, and antifungal activities (Cushnie & Lamb, 2011). This could explain their application in addressing various health issues, including measles, eczema, typhoid, malaria, yellow fever, tuberculosis, diarrhea, and dysentery. The flavonoid concentrations of 0.020% in papaya leaves and 0.019% in the roots contribute to its biological roles, which include offering protection against allergies, inflammation, ulcers, and hepatotoxins (Ayoolo & Adeyeye, 2010). The presence of tannins in C. papaya aligns with the findings of Dwivedi et al. (2020). Tannins have been noted to exhibit antibacterial characteristics that hinder enzymes and lead to a decrease in oxidative phosphorylation and iron deprivation, among other effects (Irabor et al., 2023). The anti-inflammatory properties of tannins aid in alleviating symptoms associated with gastritis, esophagitis, enteritis, and bothersome bowel disorders; they not only promote the healing of burns and cessation of bleeding but also prevent infection while facilitating internal wound healing (Dwivedi et al., 2020). The tannin concentrations in the leaves and roots are 0.002% and 0.10%, respectively, in *Carica papaya*, which underscores its capacity to create a protective barrier over exposed tissues, helping to prevent infection in wounds. Tannins are utilized indirectly as molluscicides to disrupt the transmission cycle of schistosomiasis. Additionally, they have been noted to exhibit anti-viral, anti-bacterial, and antiparasitic properties (Dwivedi et al., 2020). This evidence supports the medicinal benefits of *Carica papaya*. The concentrations of phenolics in *C. papaya* leaves and roots are 0.011% and 0.016%, respectively, which may provide a scientific basis for their application in alleviating body pain, as indicated by Isaac & Adekoya (2020), regarding the use of phenolics as analgesic and anti-inflammatory phytochemicals. Consequently, it is anticipated that both the leaves and particularly the roots of *C. papaya* are excellent and abundant sources of phytochemicals that contribute beneficially to the upkeep of a healthy body.

Conclusion

In this research, *Carica papaya* was identified as a nutraceutical plant with a variety of pharmacological applications. The roots of *Carica papaya* have been found to contain substantially higher tannins, making them a promising candidate for applications that value tannins, such as medical treatments or natural dyes. In contrast, the leaves and roots of *Carica papaya* have similar flavonoid content, indicating that both may be useful for addressing oxidative stress-related disorders. The roots also exhibit slightly higher phenolic content, suggesting greater antioxidant potential. However, the alkaloid content is comparable in both the leaves and roots, implying that both may be suitable for medical applications that require alkaloids. The occurrence of phytochemicals like alkaloids, tannins, phenolics, and flavonoids in the roots and leaves of the plant offers scientific backing for its therapeutic uses. The various phytochemicals present in C. papaya are acknowledged for their industrial and medical purposes, alongside their physiological effects. Consequently, this research indicates that the leaves and roots of *Carica papaya* are significant sources of phytochemicals.

Recommendations

1. Further purification and characterization: The bioactive compounds present in the aqueous extract of *Carica papaya* leaves and roots should be further purified and characterized to determine their specific identities and potential applications.

2. In vivo and in vitro studies: Further studies should be conducted to evaluate the biological activities of the aqueous extract of *Carica papaya* leaves and roots, including antioxidant, anti-inflammatory, and antimicrobial activities.

3. Exploration of medicinal applications: The aqueous extract of *Carica papaya* leaves and roots should be explored for potential medicinal applications, including the treatment of oxidative stress-related

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