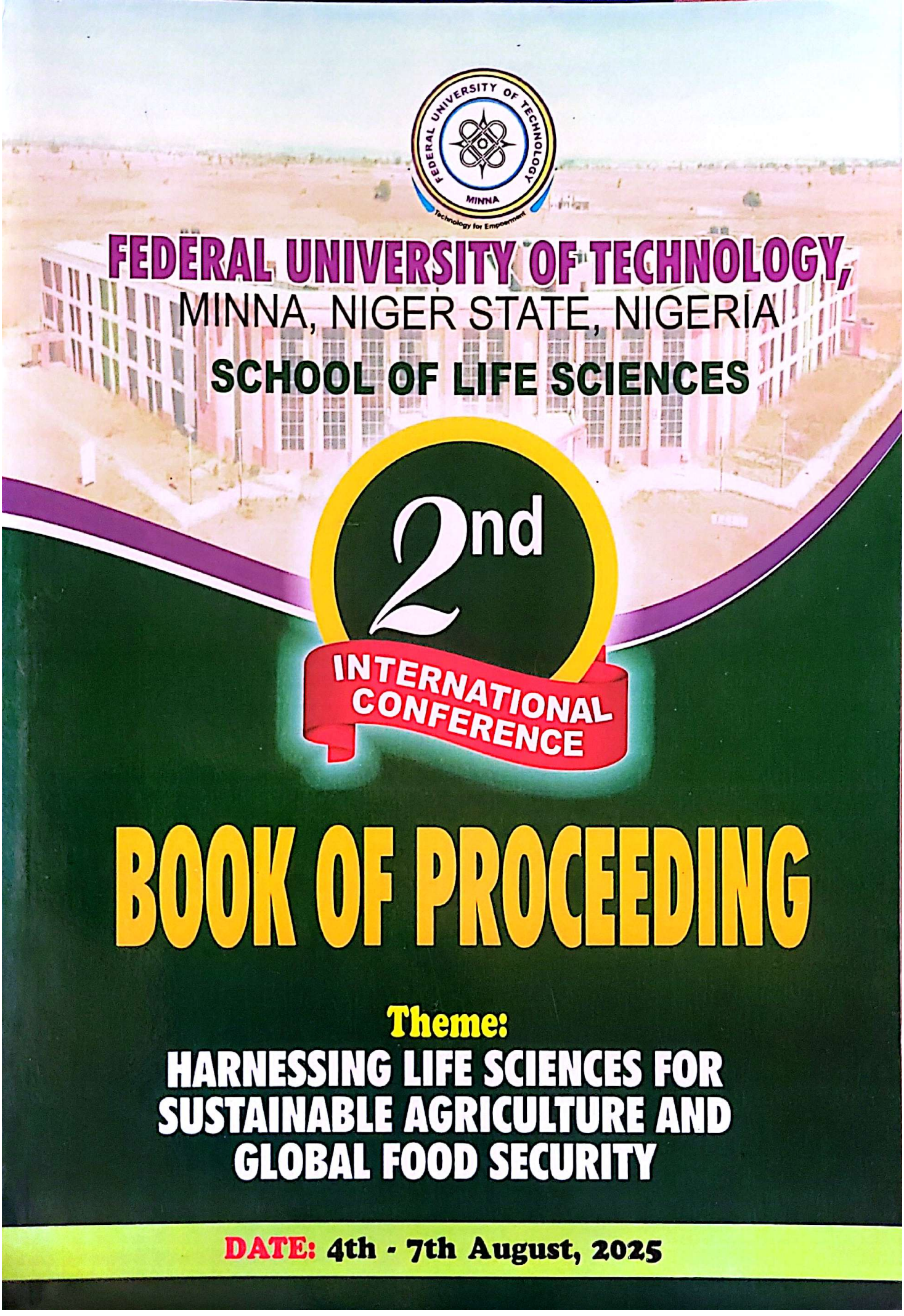


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Evaluation of the Phytochemical Composition and Antioxidant Activity of Prickly Ash (*Zanthoxylum armatum*) Seeds

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ABSTRACT

Phytochemicals are naturally occurring bioactive compounds in plants known for their health-promoting properties, including antioxidant and antimicrobial activities. *Zanthoxylum armatum* (prickly ash), a plant with traditional medicinal applications, was evaluated in this study for its phytochemical constituents and antioxidant potential. Dried prickly ash seeds were sourced from Kure Market, Minna, Nigeria, and extracted using ethanol. Antioxidant activity was assessed using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay, while phytochemical constituents were screened qualitatively following standard procedures. Phytochemical screening revealed a rich composition of bioactive compounds, with tannins highly present (+++), and phenols, flavonoids, and saponins moderately present (++). Low levels of oxalates, phytates, and alkaloids were observed, while cyanide, terpenoids, and anthocyanins were absent, indicating a favourable safety profile. The DPPH assay demonstrated that prickly ash possesses significant antioxidant activity, which increased with concentration. At 1.0 mg/mL, the extract showed a 79.52% inhibition, compared to 98.53% for ascorbic acid. The IC50 value for prickly ash was 0.56 mg/mL, slightly less potent than ascorbic acid (0.43 mg/mL). These findings confirm that prickly ash is a potential natural source of antioxidants due to its rich phytochemical content. The presence of beneficial compounds supports its traditional use and offers promise for future pharmaceutical and nutraceutical development. Further research is recommended to isolate active constituents, evaluate toxicological safety, and explore synergistic applications with other medicinal plants, particularly for food preservation and the treatment of oxidative stress-related disorders.

Keywords: *Zanthoxylum armatum*; antimicrobial properties; phytochemicals; free radicals; oxidative stress

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INTRODUCTION

Phytochemicals are abundant in plants, and research studies have revealed that they can protect the body from a variety of illnesses, including oxidative stress and microbial infection (Dhiman *et al.*, 2024). Prickly ash (*Zanthoxylum armatum*) is a deciduous aromatic shrub belonging to the Rutaceae family. It is highly valued for its extensive pharmacological and phytochemical properties and has been traditionally used in various cultures for medicinal purposes (Shah *et al.*, 2025).

The potent antioxidant activity of *Zanthoxylum armatum* has been widely documented, attributed primarily to its high content of polyphenols and

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flavonoids, which exhibit efficient free radical scavenging, metal chelating, and reducing properties (Dahiya *et al.*, 2025; Shah *et al.*, 2025). Extracts of the leaves, seeds, and bark show significant antioxidant effects, which may underlie their traditional use for inflammation, infections, and chronic diseases. Additionally, the essential oils extracted from fruits and seeds demonstrate strong bioactivity, including antimicrobial, insecticidal, and nematocidal effects, further expanding the therapeutic scope of this plant (Dahiya *et al.*, 2025).

Notably, the phytochemical richness and antioxidant capacity of *Zanthoxylum armatum* underline its potential as a natural source of bioactive compounds for pharmaceutical and nutraceutical development. Continued systematic research focusing on its chemical constituents and the mechanisms of its antioxidant action will contribute to validating its traditional uses and exploring novel therapeutic applications.

MATERIALS AND METHODS

Source and preparation of test sample (prickly ash seeds)

Dried prickly ash seeds were procured from the Kure ultra-modern market, Minna, Niger State, Nigeria. It was blended into powder and stored in a polythene bag.

Preparation of sample extract

The extract preparation of the dried prickly ash seeds was carried out by weighing one gramme (1g) of the ground sample into a conical flask. Afterwards, 100ml of ethanol was measured and then added to the weighed sample in the flask. Extraction was performed for 40 minutes with the use of a digital 4-hole water bath (Model: E-Track England) at 70 degrees. The resultant extract was allowed to cool at room temperature and then filtered using a Whatman filter paper (No. 1).

Free radical scavenging assay

In this study, the free radical used to evaluate the antioxidant activity of dried prickly ash seeds was 2, 2-diphenyl-1-picrylhydrazyl (DPPH), in line with the procedure described by Mukherjee *et al.* (2011) with minor modifications. 2, 2-diphenyl-1-picrylhydrazyl of 100 µM concentration was dissolved in methanol to a final concentration of 0.03mM. Serial dilutions were made to determine the IC50. Different concentrations (0.2, 0.4, 0.6, 0.8 and 1.0 mg/ml) of the extracts of the dried prickly ash seeds and ascorbic acid (the standard antioxidant) were used. An ultraviolet spectrophotometer was used to determine the absorbance at 517 nm. The percentage inhibition of the samples at the varying concentrations was calculated using the formula below:

$$\%Inhibition = \frac{A_s - A_w}{A_s} \times 100$$

Where A_s = absorbance of the standard

A_w= absorbance of the test sample (prickly ash)

Qualitative screening analysis of phytochemicals in prickly ash

The phytochemical qualitative screening analysis of prickly ash seeds was carried out according to the procedure outlined by Harborne (1973) and Sofowara (1993).

RESULTS

Phytochemical screening of prickly ash

The results obtained for the phytochemical screening of prickly ash seed are presented in Table 1. Phenols, flavonoids, tannins, and saponins were

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found to be moderately to highly present, with tannins highly present (+++), phenols, flavonoids, and saponins moderately present (++). Oxalate, phytate, and alkaloids were present in low amounts (+), while cyanide, terpenoids, and anthocyanins were not detected (-).

Table 1: Qualitative phytochemical screening of prickly ash seeds

Phytochemical constituents	Inference
Phenols	+ +
Flavonoids	+ +
Tannins	+ + +
Oxalate	+
Phytate	+
Saponin	+ +
Alkaloids	+
Cyanide	-
Terpenoids	-
Anthocyanins	-

- Absent + Lowly present + + Moderately present + + + Highly present

The antioxidant activity of prickly ash

The antioxidant activity of prickly ash was evaluated through its free radical scavenging properties, which demonstrated a concentration-dependent pattern, as outlined in Table 2. At the lowest concentration tested (0.2 mg/mL), prickly ash exhibited an inhibition rate of 29.62%, which steadily increased as the concentration rose, reaching a peak of 79.52% at 1.0 mg/mL. A similar trend was evident for ascorbic acid (vitamin C), the standard reference, which showed higher inhibition values at each concentration, ranging from 48.07% at 0.2 mg/mL to 98.53% at 1.0 mg/mL. This progressive increase suggests a direct relationship between extract concentration and antioxidant activity for both samples.

Table 2: Antioxidant Activity

	Antioxidant Activity	
Concentration (mg/mL)	Prickly Ash	Ascorbic Acid
0	0	0
0.2	29.62	48.07
0.4	38.05	65.16
0.6	60.09	84.58
0.8	72.56	94.07
1	79.52	98.53
IC50	0.56mg/ml	0.43mg/ml

DISCUSSION

The phytochemical screening results for prickly ash revealed the moderate to high presence of phenols, flavonoids, tannins, and saponins, which align with findings reported in similar medicinal plants known for their therapeutic potential (Sofowora, 1993). Tannins, highly present in this study, are well documented for their astringent properties and their role in protecting

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plants against microbial invasion, as well as their antioxidant capabilities (Chung *et al.*, 1998). Phenols and flavonoids, which are moderately present in prickly ash, contribute significantly to scavenging free radicals, thereby exhibiting potent antioxidant and anti-inflammatory activities. This supports the traditional uses of prickly ash in managing oxidative stress-related conditions (Rice-Evans *et al.*, 1997; Pietta, 2000).

Saponins, also moderately present, have been shown to possess a wide range of bioactivities including antimicrobial, anti-inflammatory, and immune-modulatory effects (Makkar *et al.*, 2007). The low presence of alkaloids, oxalate, and phytate may suggest a limited but potentially important role in the plant's pharmacological profile, as alkaloids are known for their diverse bioactivities, including analgesic and antimalarial effects, while oxalates and phytates are often involved in reducing mineral bioavailability but can also have protective roles (Hostettmann and Marston, 1995)

The absence of cyanide, terpenoids, and anthocyanins indicates these phytochemicals do not contribute to the bioactivity of prickly ash according to this qualitative analysis. Cyanide absence is favourable from a toxicological standpoint, while terpenoids are common in many medicinal plants with anti-inflammatory and antimicrobial properties; their absence suggests that prickly ash's therapeutic effects are more likely governed by phenolic compounds and saponins (Bakkali *et al.*, 2008). Overall, this phytochemical profile supports the traditional medicinal uses of prickly ash due to the bioactive compounds identified, particularly tannins, phenols, flavonoids, and saponins, which are widely recognized for their health-promoting properties.

The observed antioxidant activities confirm previous literature that documents the potential health-promoting effects of plant-derived compounds in neutralizing free radicals (Prior *et al.*, 2005; Rice-Evans *et al.*, 1997). Thus, while prickly ash did not match the efficacy of vitamin C, its substantial inhibitory action across all tested concentrations underscores its value as a functional antioxidant agent, in agreement with findings reported for phytochemical-rich spices (Shahidi and Ambigaipalan, 2015). Furthermore, the IC50 value, a parameter indicating the concentration required to achieve 50% inhibition, was calculated as 0.56 mg/mL for prickly ash and 0.43 mg/mL for vitamin C. The lower IC50 of vitamin C corroborates with its well-documented strong radical scavenging activity, while the IC50 for prickly ash signals a comparatively moderate yet significant antioxidant capacity.

Conclusion

The phytochemical screening of prickly ash revealed a rich profile of bioactive compounds, notably tannins (high), and phenols, flavonoids, and saponins (moderate). These compounds are associated with various therapeutic effects, including antioxidant, anti-inflammatory, and antimicrobial properties, supporting the traditional use of prickly ash in herbal medicine. The low levels of alkaloids, oxalates, and phytates suggest limited but notable pharmacological contributions, while the absence of cyanide is toxicologically favourable. Additionally, the antioxidant activity demonstrated a concentration-dependent increase, with prickly ash showing substantial free radical scavenging activity (IC50 = 0.56 mg/mL), though less potent than vitamin

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C (IC50 = 0.43 mg/mL). These findings highlight the potential of prickly ash as a natural source of antioxidants.

Recommendations

Considering the promising phytochemical profile and antioxidant potential of prickly ash, the following recommendations are made:

i. Further pharmacological studies should be conducted to isolate and characterise individual compounds responsible for the observed activities.

ii. Toxicological evaluations are recommended to ensure safety, especially for long-term or high-dose use.

iii. Prickly ash could be used as a natural preservative to prevent microbial food spoilage; in addition, it can be developed into nutraceuticals or herbal formulations as supplements aimed at combating oxidative stress-related disorders.

iv. Future studies should also explore its synergistic effects with other medicinal plants to enhance therapeutic efficacy in combating microbial infection.

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