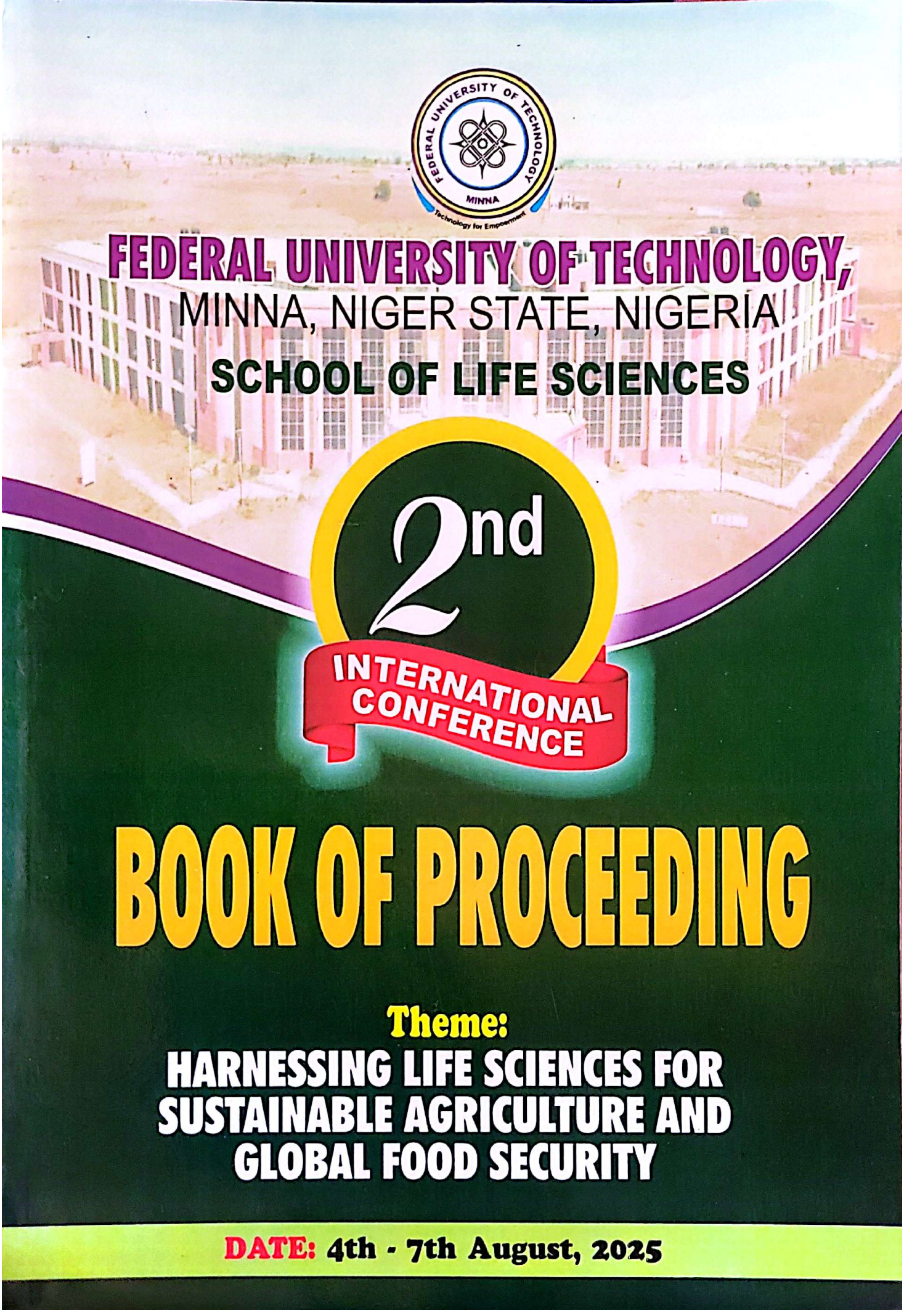

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TABLE OF CONTENTS

Trace Metal Contamination and Bioaccumulation in Water, Sediment, and *Sarotherodon melanotheron* fish from the Upper Bonny Estuary, Niger Delta, Nigeria.....1

Prevalence and Demographic Patterns of Malaria Transmission in Four Communities of Minna, Niger State, Nigeria.....12

Comparative Growth Performance of *Clarias gariepinus* Fingerlings Fed varying Indigenous Protein Diets under Laboratory condition in Minna, Nigeria.....18

Evaluation of the Phytochemical Composition and Antioxidant Activity of Prickly Ash (*Zanthoxylum armatum*) Seeds.....26

Free Radical Scavenging Activity and Phytochemical Profile of Dried Fruits of Cayenne Pepper (*Capsicum annuum*).....32

Mutagenic Effects of Colchicine on Agro-Morphological and Yield Traits on Selected Landraces of Bambara Groundnut (*Vigna subterranea* L. Verdc).....37

A Review of Current and Future Role of Artificial Intelligence (AI) in Diseases Diagnosis.....46

Prophylactic *In vivo* Neutralization Efficacy of Chitosan-Encapsulated Seed Extract of *Tamarindus indica* Against *Naja nigricollis* Venom-Induced Lethality and Coagulopathy.....57

Nanotechnology in water treatment: current advances and prospects.....68

Potency evaluation of the plant extract of *Azadirachta indica* on the adult and larval stages of *Anopheles* Mosquitoes in Keffi, Nasarawa State.....81

Determination of physicochemical and microbiological quality of palm oils from four Nigerian States.....90

Nephroprotective Effect of Phenol-Rich Extract of *Tridax Procumbens* Plant on Cisplatin-Induced Renal Damage in Rats.....103

Honeybee (*Apis mellifera*) Foraging Activities in Relation to their Nutritional and Morphometric Variability of the Bee Species Populations in Niger State, Nigeria.....122

In vitro hypoglycemic and antioxidant activity of flavonoids, saponins and alkaloids in *Ipomoea batatas* leaves.....134

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Free Radical Scavenging Activity and Phytochemical Profile of Dried Fruits of Cayenne Pepper (*Capsicum annuum*)

[1]Ibrahim, L., [2]Akande, J. O. and *[1]Akande, K. E.

[1]Department of Animal Production, School of Food Science and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria
[2]Department of Microbiology, School of Life Sciences, Federal University of Technology, Minna, Niger State, Nigeria.

ABSTRACT

Cayenne pepper (*Capsicum annuum*), a member of the Solanaceae family, is known for its nutritional and therapeutic benefits, particularly due to its high content of bioactive compounds. This study aimed to evaluate the antioxidant potential and phytochemical composition of cayenne pepper using standardized laboratory procedures. Dried cayenne pepper fruits were procured from Kure Market, Minna, Niger State, Nigeria, and processed into powder. Ethanolic extraction was performed at 70°C for 40 minutes. The antioxidant activity of the extract was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay, and the phytochemical profile was determined through qualitative screening. The cayenne pepper extract demonstrated a concentration-dependent increase in antioxidant activity, ranging from 24.16% inhibition at 0.2 mg/mL to 73.41% at 1.0 mg/mL. Ascorbic acid, used as the standard, showed higher inhibition values, peaking at 98.53%. Phytochemical screening revealed a rich composition of flavonoids and saponins (highly present), followed by moderate levels of tannins and alkaloids. Phenols, terpenoids, oxalates, and phytates were present in low amounts, while cyanide and anthocyanins were absent. The results confirm cayenne pepper's potential as a natural antioxidant source due to its phytochemical richness and significant radical scavenging ability. These findings reveal that cayenne pepper is a valuable source of natural antioxidants, substantiating its use in traditional medicine and suggesting its potential as a functional food ingredient for mitigating oxidative stress. It is therefore recommended that cayenne pepper can be used as an animal feed additive or nutraceutical.

Keywords: Cayenne pepper, free radicals, phytochemicals, antioxidant activity

***Correspondence author's email:** kemi777akande@gmail.com

INTRODUCTION

Cayenne pepper, known scientifically as *Capsicum annuum*, is part of the Solanaceae family, which includes other commonly consumed plants such as tomatoes, eggplants, and potatoes. This classification highlights its botanical relevance within a group of agriculturally significant crops, all of which share certain phytochemical properties. Studies confirm that cayenne peppers are nutritionally rich, offering considerable amounts of provitamin A, various carotenoids, and vitamin C, all critical for human health (Wahyuni *et al.*, 2011; Loizzo *et al.*, 2016). These biochemical constituents contribute to the fruit's impressive antioxidant profile.

Capsicum annuum is a widely cultivated and consumed spice. It is rich in diverse phytochemicals such as capsaicinoids, phenolics, flavonoids, and fatty acids, which contribute to its significant health-promoting properties (Jang *et al.*, 2024).

The implications of antioxidant compounds in cayenne pepper extend beyond cellular protection. The primary bioactive component, capsaicin, promotes smooth blood flow and helps manage cardiovascular health, by facilitating the dilation of blood vessels and preventing clot formation (Slamet *et al.*, 2022; Antonjous, 2018). Moreover, research indicates that capsaicin

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interacts with free radicals, potentially enhancing the body's antioxidant defenses (Slamet *et al.*, 2022).

MATERIALS AND METHODS

Source and Preparation of Cayenne Pepper

Dried fruits of cayenne pepper were purchased from Kure Ultra-Modern Market, Minna, Niger State, Nigeria. It was blended into powder before laboratory analyses.

Preparation of Sample Extract

Dried cayenne pepper was pulverized into a fine, homogenous powder. A precisely one gramme (1.0 g) of this powder was weighed and transferred to a 250 mL flask. Ethanolic extraction was performed by adding one hundred millilitres (100 mL) of 95% ethanol. The mixture was maintained at a constant temperature of 70°C for 40 minutes in an E-Track England digital 4-hole water bath to facilitate the dissolution of bioactive compounds. Following the heating period, the extract was allowed to cool to ambient room temperature. The resulting liquid was then clarified by gravity filtration through Whatman No. 1 filter paper, yielding a transparent ethanolic extract, which was stored for subsequent assays.

Free Radical Scavenging Assay

The antioxidant capacity of the cayenne pepper extract was assessed by its ability to neutralize the stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical, following a modified protocol from Mukherjee *et al.* (2011). The principle of this assay is based on the ability of an antioxidant to donate an electron to the DPPH radical, thereby reducing it. A 100 µM stock solution of DPPH was prepared in methanol and diluted to a final working concentration of 0.03 mM. To determine the half-maximal inhibitory concentration (IC_{50}), serial dilutions of the cayenne pepper extract were prepared to yield final concentrations of 0.2, 0.4, 0.6, 0.8, and 1.0 mg/mL. Ascorbic acid, a well-known potent antioxidant, was prepared at the same concentrations to serve as a positive control for comparison. The reaction was initiated by mixing the extract/standard with the DPPH solution. After incubation, the absorbance of each solution was measured at 517 nm using a UV-Vis spectrophotometer. The percentage of radical inhibition, representing the scavenging activity, was calculated using the following formula:

$$\%\text{Inhibition} = \frac{Ac - Ap}{Ac} \times 100$$

Where:

Ac = Absorbance of the control

Ap = Absorbance of cayenne pepper

Qualitative Phytochemical Screening

To identify the classes of secondary metabolites, present, a qualitative phytochemical analysis of the cayenne pepper extract was performed. The screening was carried out as described by Harborne (1973) and Sofowora (1993).

RESULTS

Free Radical Scavenging Activity of the Cayenne Pepper

The antioxidant potential of the cayenne pepper extract was demonstrated through its effective scavenging of the DPPH radical. As illustrated in Figure 1, the extract exhibited a clear and consistent dose-dependent relationship, where an increase in concentration led to a proportional increase in radical scavenging activity. The inhibition started at 24.16% at the lowest concentration of 0.2 mg/mL and progressively climbed to a maximum of 73.41% at 1.0 mg/mL. The control, ascorbic acid, showed a similar dose-dependent trend but with markedly higher efficacy, with inhibition percentages ranging from 48.07% to a near-complete scavenging of 98.53%.

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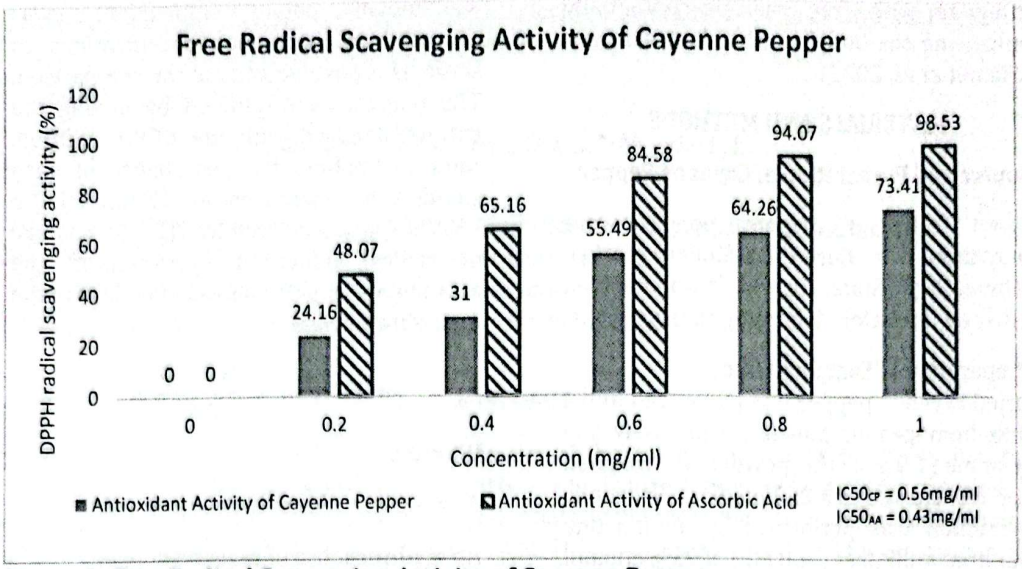

Figure 1: Free Radical Scavenging Activity of Cayenne Pepper

Qualitative Phytochemical Profile of Cayenne Pepper

The phytochemical screening of cayenne pepper revealed a diverse array of bioactive constituents. The results, summarized in Table 1, show that the extract is particularly rich in flavonoids and saponins, which were detected in high (+++) concentrations. Moderate (++) levels of tannins and alkaloids were also observed. In contrast, phenols, terpenoids, oxalates, and phytates were present in low (+) but detectable amounts. Notably, tests for cyanide and anthocyanins yielded negative (-) results, indicating their absence.

Table 1: Qualitative Phytochemical Screening of Cayenne Pepper

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

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

DISCUSSION

The observed antioxidant activity is likely a synergistic effect of the various phytochemicals present, particularly the high concentration of flavonoids and other phenolic compounds, which are known to be excellent electron donors (Materska and Perucka, 2005). Cayenne pepper can serve as a valuable natural source for combatting free radical-mediated damage. A critical metric for evaluating antioxidant potency is the IC_{50} value, which represents the concentration of an antioxidant required to inhibit 50% of the initial free radicals. For the cayenne pepper extract, the IC_{50} was calculated to be 0.60 mg/mL. This value signifies a moderate but definitive antioxidant capacity. While less potent than

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ascorbic acid, which typically has a much lower IC_{50} of 0.43mg/ml, this result is highly encouraging for a crude plant extract.

The high concentration of flavonoids is particularly significant, as this class of polyphenolic compounds is renowned for its potent antioxidant and anti-inflammatory properties, which are central to mitigating oxidative stress (Panche *et al.*, 2016). Similarly, the abundance of saponins is noteworthy; these glycosides have been linked to a range of bioactivities, including antimicrobial and cholesterol-lowering effects (Al-Fatimi *et al.*, 2007). The moderate presence of tannins and alkaloids further enhances the therapeutic profile of the extract, as these compounds are well-established for their antimicrobial, anti-inflammatory, and astringent properties (Trease and Evans, 2002; Del-Rio *et al.*, 2013). The overall phytochemical richness strongly supports the traditional use of cayenne pepper in ethnomedicine and points to its potential for providing multiple, synergistic health benefits.

Conclusion

This study has successfully demonstrated that cayenne pepper fruit (*Capsicum annuum*) is a rich reservoir of bioactive phytochemicals, most notably flavonoids and saponins. Furthermore, it possesses significant, dose-dependent free radical scavenging properties, confirming its status as a potent natural antioxidant. The findings provide a firm scientific rationale for the historical use of cayenne pepper in traditional medicine

Recommendation

i. Cayenne pepper has the potential for development as an animal feed additive, functional food ingredient or a source for novel nutraceuticals aimed at preventing and managing diseases rooted in oxidative stress.
ii. Future research should focus on the isolation and characterization of the specific compounds responsible for these effects and the elucidation of their mechanisms of action in more complex biological systems.

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