



(RESEARCH ARTICLE)



PHYTOCHEMICAL, PROXIMATE, AND PARTIAL CHARACTERIZATION OF ETHANOLIC CRUDE EXTRACT OF *ADANSONIA DIGITATA* SEED

E. J. Zamdai ^{1,*}, E. T. Williams ¹, I. B. Bwatanglang ¹ and Anami Paul ²¹Department of Pure and Applied Chemistry, Adamawa State University, MUBI, PMB 25 MUBI, Adamawa State, Nigeria²Department of Integrated Science, Adamawa State College of Education, Hong, Adamawa State, Nigeria

* Corresponding Author; Email: jamesemma5277@gmail.com

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ABSTRACT

This study evaluated the phytochemical composition, proximate content, and partial characterization of ethanolic crude extracts of baobab seeds collected from Uba, Askira/Uba, Borno State, Nigeria. Phytochemical screening revealed the presence of flavonoids (52.46 mg/g), total phenols (166.32 mg/g), terpenoids (143.73 mg/g), glycosides (14.43 mg/g), tannins (13.14 mg/g), alkaloids (6.32 mg/g), and steroids (3.36 mg/g), indicating notable antioxidant, antimicrobial, and anti-inflammatory potential. Proximate analysis showed the seeds to contain protein (16.18%), carbohydrates (68.85%), fat (4.43%), moisture (6.03%), ash (3.82%), and crude fiber (0.73%), demonstrating a nutritionally balanced profile suitable for dietary supplementation. Fourier Transform Infrared (FTIR) spectroscopy identified functional groups such as hydroxyl, carbonyl, aliphatic C–H, and C–O, suggesting the presence of ester-linked and oxygenated compounds. Gas Chromatography–Mass Spectrometry (GC–MS) analysis detected fatty acids, long-chain hydrocarbons, and minor terpenoids, with 9,12-octadecadienoic acid ethyl ester as the most abundant compound. The findings confirm that *A. digitata* seeds are a valuable source of macronutrients, vitamins, and bioactive metabolites, supporting their potential use as functional food ingredients and in pharmacological applications. Further studies are recommended to isolate specific bioactive compounds and evaluate their in vivo pharmacological properties.

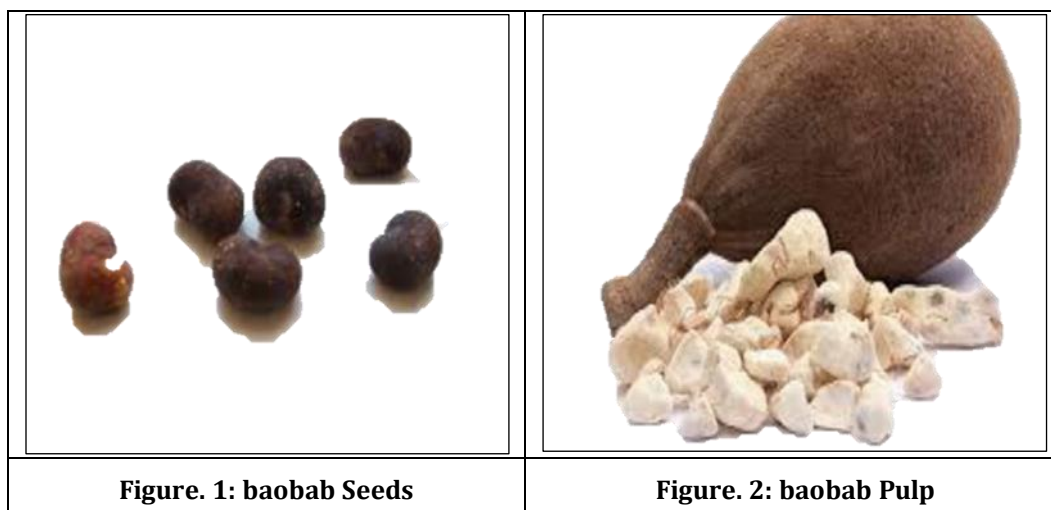
Keywords: Phytochemical; Proximate; Partial Characterization; Crude Extract; *Adansonia Digitata*; Seed

1 INTRODUCTION

Adansonia digitata L., commonly known as the baobab tree, is one of the most iconic and economically valuable trees native to sub-Saharan Africa. It belongs to the family Malvaceae and is widely distributed across semi-arid and savanna regions, where it plays a vital role in local nutrition, traditional medicine, and sustainable livelihoods (Abioye *et al.*, 2023). Every part of the baobab tree leaves, fruit pulp, bark, and seeds has been reported to possess significant nutritional and therapeutic value. Among these, the seeds have attracted growing scientific attention for their rich nutrient composition, bioactive compounds, and potential for use as functional food ingredients (Nwosu *et al.*, 2021).

The Major phytochemical constituents include alkaloids, flavonoids, tannins, saponins, terpenoids, and glycosides (Agunbiade *et al.*, 2023). These compounds have been associated with antioxidant, antimicrobial, anti-inflammatory, and antidiabetic effects (Ibrahim *et al.*, 2022). *A. digitata* seeds contain substantial levels of these metabolites, which

contribute to its therapeutic potential and justify its use in traditional medicine (Badu *et al.*, 2020). The presence of alkaloids and flavonoids, for instance, enhances the antioxidant properties of *A. digitata* extracts, enabling them to scavenge free radicals that cause oxidative stress. Tannins and saponins contribute to antimicrobial and anti-inflammatory activities, while steroids and glycosides have been linked to cardiovascular and immune system modulation (Saulawa *et al.*, 2024). The phytochemical screening of the seed extract provides a foundation for understanding its pharmacological value. Proximate analysis assesses the nutritional composition of plant-based materials in terms of moisture, crude protein, lipid, ash, fiber, and carbohydrate content. These parameters are vital indicators of food quality and nutritional balance (Babalola *et al.*, 2021). The seeds of *A. digitata* have been reported to contain high levels of proteins (up to 35%), oils rich in unsaturated fatty acids, and moderate carbohydrate content (Agunbiade *et al.*, 2023). Moisture content affects the stability and shelf life of seed-based products, while lipid and protein concentrations determine their energy and nutritional value. High crude protein and lipid levels make *A. digitata* seed a potential source of plant-based nutrition, particularly in regions facing food insecurity. Moreover, processing methods such as roasting and fermentation can improve digestibility and nutrient retention (Ibrahim *et al.*, 2022). The seed of *A. digitata* is known to be an excellent source of macronutrients and micronutrients, including proteins, essential amino acids, fatty acids, and minerals such as calcium, potassium, and magnesium (Ogbodo *et al.*, 2021). The oil extracted from baobab seeds has also been reported to possess high oxidative stability and a favorable fatty acid profile, comparable to other edible oils, making it suitable for both nutritional and cosmetic applications. The importance of baobab seeds in combating micronutrient deficiencies, especially in regions where conventional nutrient sources are scarce (Adekunle *et al.*, 2022). their vitamin composition, including vitamin C, E, and some B-complex vitamins, enhances their contribution to immune function and metabolic health. Such nutritional richness positions *A. digitata* seed as a valuable underutilized food resource that could contribute to food security and health promotion in developing countries (Ogunyemi *et al.*, 2022). Nutritional and medicinal potential, *Adansonia digitata* remains underexploited due to limited awareness, inadequate processing technologies, and insufficient scientific documentation of its bioactive compounds. Therefore, comprehensive studies examining its proximate, elemental, vitamin, and phytochemical composition are essential to unlocking its full potential for industrial and dietary applications. Current research aims to establish a scientific basis for the inclusion of baobab seed extracts in food formulations, nutraceuticals, and therapeutic products (Abioye *et al.*, 2023; Nwosu *et al.*, 2021). The seeds of *Adansonia digitata*, though often underutilized compared to its fruit pulp, represent a rich source of essential nutrients and phytochemicals. Studies have reported that the seeds contain considerable quantities of protein (20–35%), lipids (10–20%), fiber, and minerals such as calcium, potassium, magnesium, iron, and phosphorus (Babalola *et al.*, 2021).



These nutrients make baobab seeds a potential alternative protein source and a valuable ingredient in food fortification and animal feed formulation (Saulawa *et al.*, 2024). *A. digitata* seed contains certain anti-nutritional factors such as phytates, oxalates, and tannins, which can interfere with the absorption of essential minerals and proteins (Badu *et al.*, 2020). However, studies have shown that these anti-nutrients can be significantly reduced through appropriate processing methods such as roasting, boiling, fermentation, or soaking (Babalola *et al.*, 2021). Hence, understanding the levels of these anti-nutrients is important to determine the safety and suitability of baobab seeds for human and animal consumption. The vitamin composition of *A. digitata* seeds adds to their nutritional value. Vitamins such as A, C, and E have been detected in seed extracts, contributing to their antioxidant capacity and ability to combat oxidative stress (Ibrahim *et al.*, 2022). These vitamins are essential for maintaining cellular integrity, immune function, and overall health. Evaluating the vitamin profile of the seed is therefore crucial in determining its contribution to dietary and therapeutic applications.

2 MATERIAL AND METHODS

All reagents were of analytical grade unless otherwise stated. The physicochemical analyses were carried out in triplicates unless otherwise stated. Baobab seed was collected from Uba of Askira/uba Local Government of Borno State Nigeria,

The seed was washed and dried under the sun for three days. The dried seeds were pound with mortar and pestle into powder and stored in polyethylene bag for further use. Extraction of seeds was carried out using Soxhlet extraction apparatus Adopted by Warra *et al.*, 2011. Phytochemical screening was carried out as adopted by Williams *et al.*, 2018: Li *et al.*, 2024 proximate analysis was carried out using standard AOAC method (1990). The partial characterization of the extract was carried out using spectroscopic techniques which are: FT-IR and GC-MS

3 RESULTS AND DISCUSSION

Table 1: Quantitative Phytochemical Analysis of Seed Samples

Phytochemical	Mg/g
Flavonoid	52.456±0.026
Total Phenol	166.323±0.020
Steroids	3.356±0.309
Alkaloid	6.316±0.015
Terpenoids	143.733±0.015
Tannins	13.136±0.015
Glycosides	14.433±0.020

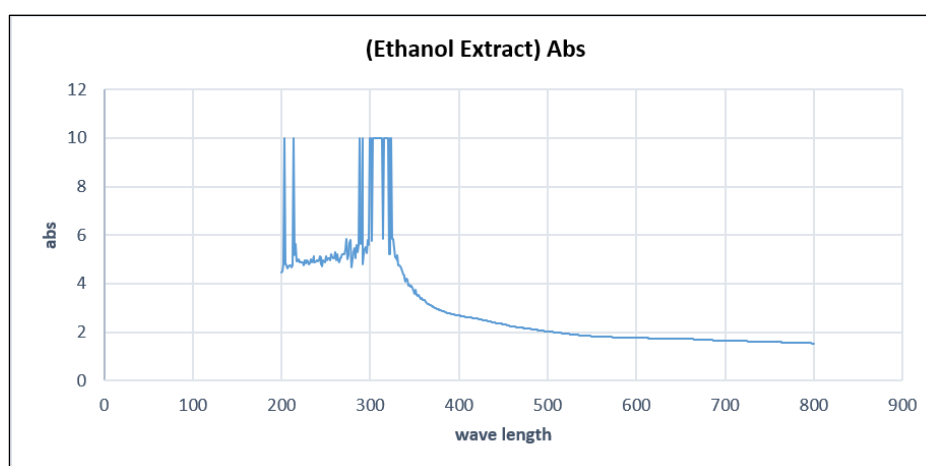
Values are Mean ± SD Error values represent the standard deviation of the triplicate measurement

The phytochemical analyses of the seed extracts revealed the presence of various classes of bioactive compounds. The flavonoid content was 52.456 ± 0.026 mg/g, which aligns with reports from Li *et al.* (2024) and Nwachukwu and Aliyu (2024) that flavonoids, being polyphenolic and highly polar, are more soluble in polar solvents. Flavonoids play a vital role in antioxidant, anti-inflammatory, and antimicrobial activities due to their hydrogen-donating capacity and metal-chelating properties. The total phenolic content was 166.323 ± 0.020 mg/g, The phenols in the extract corroborates findings by Mishra and Singh (2023), Phenolic compounds, as secondary metabolites, are known for their strong antioxidant and free radical scavenging activities (Kumar and Patel, 2023; Rafiq and Qureshi, 2024). Steroid level was relatively low 3.356 ± 0.309 mg/g Steroids, such as β -sitosterol and stigmasterol identified in *A. digitata* (Nwachukwu and Aliyu, 2024), are moderately nonpolar compounds, which explains their extraction in both polar and nonpolar solvents. Their biological significance lies in their anti-inflammatory, anticancer, and cardioprotective properties (Adebayo *et al.*, 2024). The relatively low steroid content aligns with prior studies indicating that baobab seeds contain minor quantities of these metabolites compared to their leaves and pulp. The alkaloid content was 6.316 ± 0.015 mg/g, the concentration agrees with Harborne (1998) and Ogunbiyi *et al.* (2024), who reported that most alkaloids are polar nitrogen-containing compounds soluble in alcoholic solvents. Alkaloids have well-documented pharmacological activities including analgesic, antimalarial, and antimicrobial properties (Li *et al.*, 2024; Nguyen *et al.*, 2020). Terpenoid concentration was 14.373 ± 0.015 mg/g although terpenoids are typically nonpolar, the elevated content suggests the dominance of oxygenated terpenoids such as triterpenoid saponins or glycosides (Eze *et al.*, 2022). These compounds are known for their antioxidant, antimicrobial, and hepatoprotective activities (Satapathy *et al.*, 2024). Tannin content was 13.136 ± 0.015 mg/g, Tannins are known for their astringent, antimicrobial, and antioxidant activities (Adebayo *et al.*, 2021; Cosme *et al.*, 2025). The moderate presence of tannins in extract further reinforces the multipurpose medicinal potential of baobab seeds. The glycoside content was 14.433 ± 0.020 mg/g, these compounds are pharmacologically important, exhibiting cardioprotective, antioxidant, and antidiabetic properties (Kumar *et al.*, 2023). The substantial amount obtained in ethanol extract signifies its potential health-promoting value.

Table 2: Proximate composition of Seed Samples (%)

Test	Results (%)
Crude Protein	16.180±0.026
Fat	4.430±0.026
Crude Fibre	0.730±0.026
Ash	3.823±0.020
Moisture	6.030±0.026
Carbohydrates	68.853±0.083

The crude protein content was $16.18 \pm 0.03\%$ which is in agreement with Ibrahim *et al.*, (2022); Adeola *et al.*, (2023). who reported protein contents ranging from 15% to 18%, indicating that the sample is a moderate source of plant protein. This suggests that the sample could contribute meaningfully to dietary protein intake, especially in regions where animal protein sources are limited. The high protein content implies that the seed or sample can support body tissue repair, enzyme formation, and growth (FAO, 2020). The crude fat value of $4.43 \pm 0.03\%$ is slightly below the acceptable range (5–30%) recommended by WHO (2021). This suggests that the sample has low lipid content, indicating it is not a significant source of oil or energy from fat. However, low fat levels can be beneficial in reducing risks associated with high-fat diets such as obesity and cardiovascular diseases. Similar findings were reported by Musa *et al.* (2021), who observed low fat contents in baobab seeds, making them suitable for low-fat food formulations. The crude fibre content of $0.73 \pm 0.03\%$ is below the recommended range of 2–20%, indicating that the sample has low indigestible fibre content. Dietary fibre is important for maintaining healthy digestion, preventing constipation, and lowering cholesterol levels (WHO, 2021). The low fibre value suggests that the sample would require supplementation with high-fibre foods if consumed as part of a diet. However, a low fibre content may improve digestibility and palatability in certain food applications (Owolabi *et al.*, 2022). The ash value of $3.82 \pm 0.02\%$ falls within the permissible limit ($\leq 8\%$) specified by FAO (2020). This indicates that the sample contains a moderate amount of mineral matter, including essential elements such as calcium, potassium, and magnesium. A reasonable ash level reflects the presence of nutritionally important minerals that play roles in bone formation, electrolyte balance, and enzyme activation (Adeyemi *et al.*, 2023). The result aligns with previous reports on the mineral-rich nature of baobab seed flour (Aminu *et al.*, 2021). The moisture content of $6.03 \pm 0.03\%$ lies comfortably within the WHO recommended limit (5–15%). Low moisture content is desirable as it enhances the shelf life and microbial stability of the product. High moisture levels generally encourage microbial growth and enzymatic degradation, leading to spoilage. Therefore, the low moisture value indicates that the sample can be stored for a longer period without significant deterioration (FAO, 2020). The carbohydrate value of $68.85 \pm 0.08\%$ is high and within the permissible range of 40–70%, indicating that the sample is a rich source of energy. Carbohydrates are vital for energy metabolism and the proper functioning of the brain and muscles. This high value suggests that the sample may serve as a potential energy-dense ingredient in human and animal diets. The result is consistent with reports by Haruna *et al.*, (2022), who observed carbohydrate contents between 65–70% in similar seeds.

**Figure 3: Ethanol UV-vis Spectra**

The UV-Visible absorption spectrum of the ethanol extract (Figure 3) revealed intense absorption within the ultraviolet region, extending from approximately 200 to 330 nm, followed by a gradual decline in absorbance toward the visible

region (330–800 nm). The pronounced absorption in the 200–280 nm region is attributed primarily to $\pi \rightarrow \pi^*$ electronic transitions associated with aromatic rings and conjugated double bonds present in phenolic compounds, flavonoids, tannins, and related secondary metabolites. Plant-derived phenolics generally exhibit strong ultraviolet absorption due to their aromatic benzene structures and hydroxyl substitutions, making UV–Visible spectroscopy a rapid technique for their qualitative assessment. Ethanol has consistently been reported as one of the most efficient extraction solvents for these compounds because its intermediate polarity enhances penetration into plant tissues while effectively solubilizing hydroxyl-containing phytochemicals (Dai and Mumper, 2010; Azwanida, 2015). Flavonoids typically display two principal absorption bands in UV spectroscopy: Band II (240–280 nm) arising from the benzoyl system of the A-ring and Band I (300–380 nm) associated with the cinnamoyl system of the B-ring. The presence of absorption within this latter region suggests that the extract contains flavones, flavonols, or structurally related polyphenolic compounds possessing conjugated aromatic systems (Harborne, 1998; Kumar and Pandey, 2013). This observation agrees with numerous phytochemical investigations demonstrating that ethanol preferentially extracts flavonoids because of their moderate polarity and hydrogen-bonding capacity. The major absorption region, the absorbance decreased rapidly beyond approximately 330 nm, reaching values close to 1.5 absorbance units at 800 nm. The absence of distinct absorption bands within the visible region indicates that the extract contains relatively low concentrations of pigments such as chlorophylls, carotenoids, or anthocyanins, which normally absorb strongly above 400 nm. Instead, the gradually declining baseline most likely reflects weak electronic transitions of highly conjugated compounds together with minor light scattering caused by suspended extract particles (Skoog *et al.*, 2018). Such spectral behaviour is characteristic of ethanol extracts enriched predominantly with phenolic compounds rather than coloured pigments. The intense absorption within the ultraviolet region confirms the effectiveness of ethanol as an extraction solvent for polyphenolic compounds and supports the phytochemical composition observed in complementary analytical techniques. These findings further suggest that the extract possesses significant potential as a natural source of antioxidant and biologically active compounds.

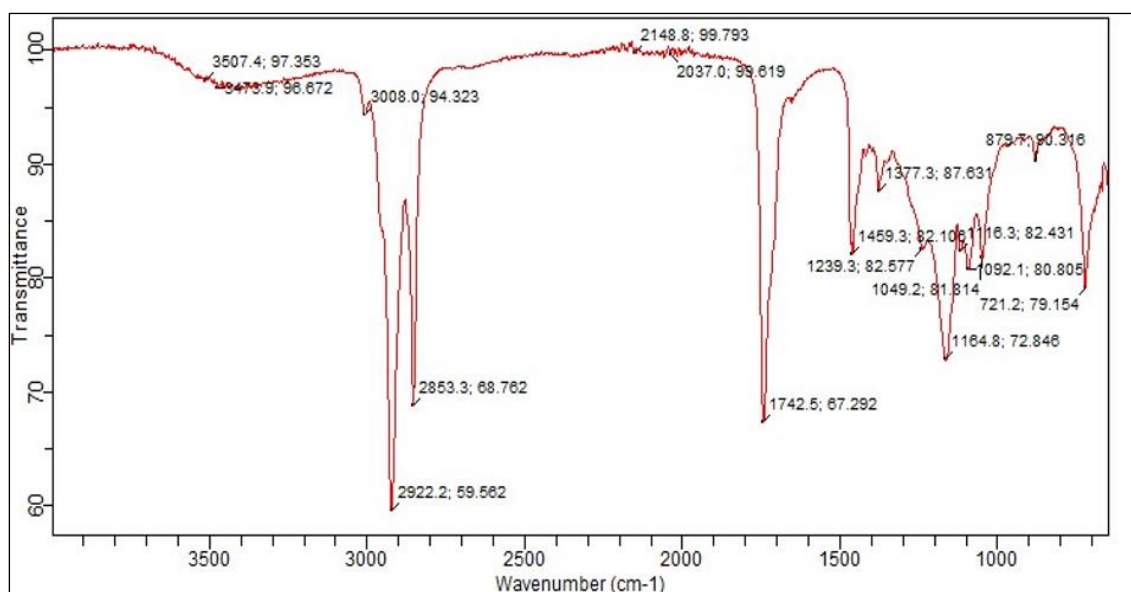


Figure 4: Ethanol FTIR Spectra

Figure 4 The Fourier Transform Infrared (FTIR) spectrum, The broad absorption band between 3507–3450 cm^{-1} is attributed to O–H stretching vibrations, which are typical of hydroxyl groups or adsorbed moisture. Broad O–H features in this region are commonly reported in FTIR analyses of organic and environmental samples (Bhadoria *et al.*, 2024; NMR Central, 2025). The presence of O–H stretching suggests hydrogen-bonded hydroxyl functionality, consistent with hydrophilic moieties or surface-adsorbed water. Strong absorption bands at 3008 cm^{-1} , 2922 cm^{-1} , and 2853 cm^{-1} correspond to C–H stretching vibrations of aliphatic $-\text{CH}_3$ and $-\text{CH}_2$ groups, indicating a predominantly hydrocarbon backbone (Bhadoria *et al.*, 2024). These aliphatic C–H stretches are characteristic of long-chain organic compounds and are often observed in polymeric and lipid-derived materials. A prominent and sharp band at 1742.5 cm^{-1} is characteristic of carbonyl ($\text{C}=\text{O}$) stretching vibrations. This intense absorption is consistent with ester functionalities, which typically absorb near 1735–1750 cm^{-1} in FTIR spectra (Bhadoria *et al.*, 2024; NMR Central, 2025). The absence of a very broad O–H stretch above 2500 cm^{-1} , which is typical for carboxylic acids, further supports the assignment of the carbonyl band to esters rather than acids. Weak features observed around 2148.8 cm^{-1} and 2037.0 cm^{-1} likely represent overtone or combination bands rather than primary functional groups, as minor absorptions in this region can arise from complex vibrational interactions (Bhadoria *et al.*, 2024). In the fingerprint region, peaks at 1459.3 cm^{-1} and 1377.3 cm^{-1} are attributed to C–H bending (deformation) vibrations, which further support the presence of saturated hydrocarbon chains (Bhadoria *et al.*, 2024). The region between 1239.3 cm^{-1} and 1049.2 cm^{-1} exhibits

multiple absorptions consistent with C–O stretching vibrations, which are diagnostic of ester and ether linkages contained within the sample structure (Bhadoria *et al.*, 2024). Additional bands at 1164.8 cm^{-1} , 1092.1 cm^{-1} , and 1016.3 cm^{-1} reinforce the presence of oxygen-containing functional groups bonded to carbon, supporting the structural assignments suggested by the carbonyl and C–H bands. Lastly, absorptions at 879.7 cm^{-1} and 721.2 cm^{-1} are assigned to out-of-plane C–H bending vibrations, indicative of substituted aliphatic or possibly aromatic ring features, which are often observed in complex organic matrices (Bhadoria *et al.*, 2024). These spectral features indicate that ethanol extract is dominated by ester functional groups, aliphatic hydrocarbon chains, and oxygenated linkages that are consistent with ester-based organic materials such as plasticizers, lipid-like compounds, or biodegradable polymers. The FTIR spectral analysis confirms the presence of hydroxyl, aliphatic C–H, carbonyl, and C–O functional groups, enabling reproducible characterization of the sample's organic composition. (Bhadoria *et al.*, 2024; NMR Central, 2025).

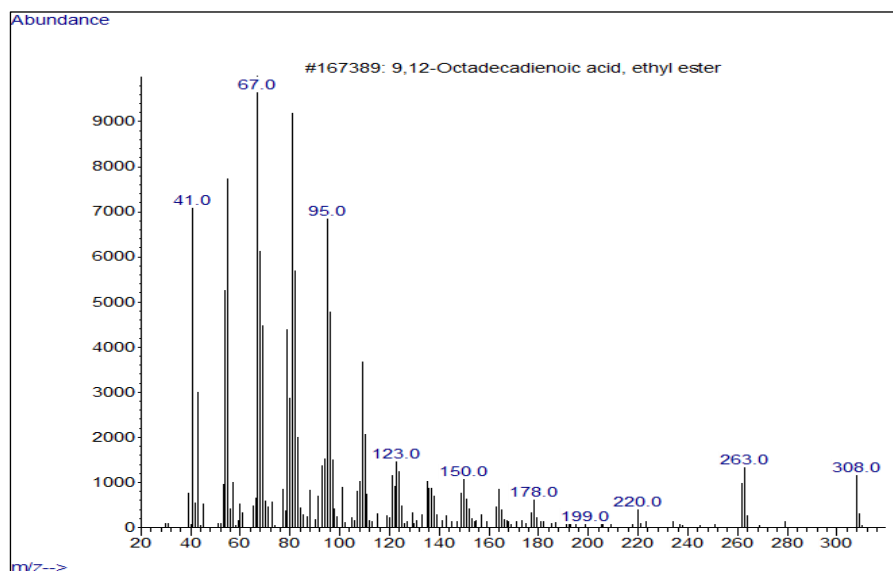


Figure 5a: GC-MS Ethanol Extract

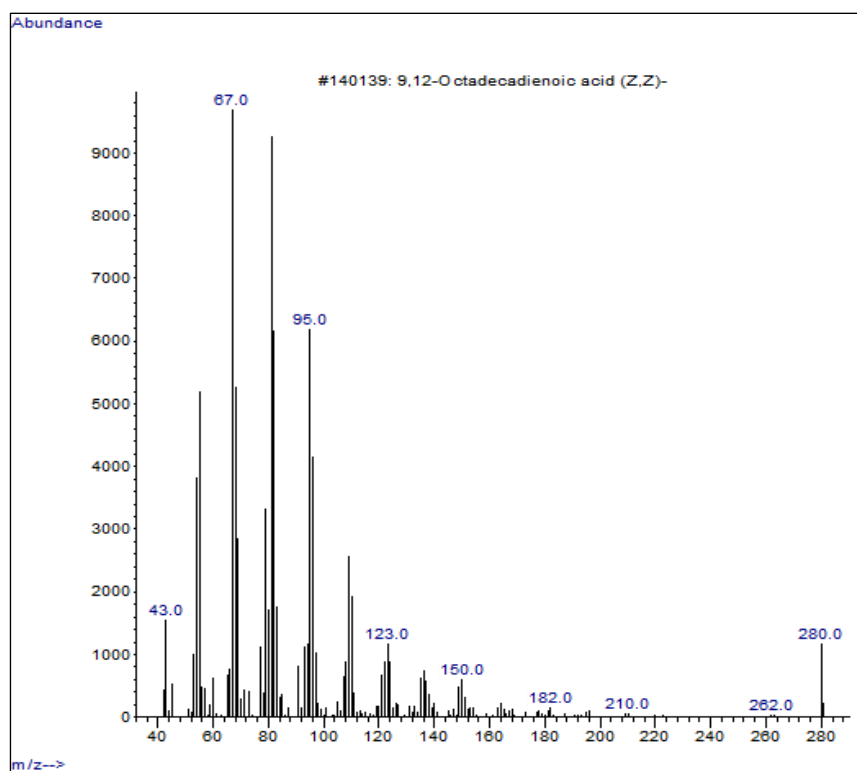


Figure 5b: GC-MS Ethanol Extract

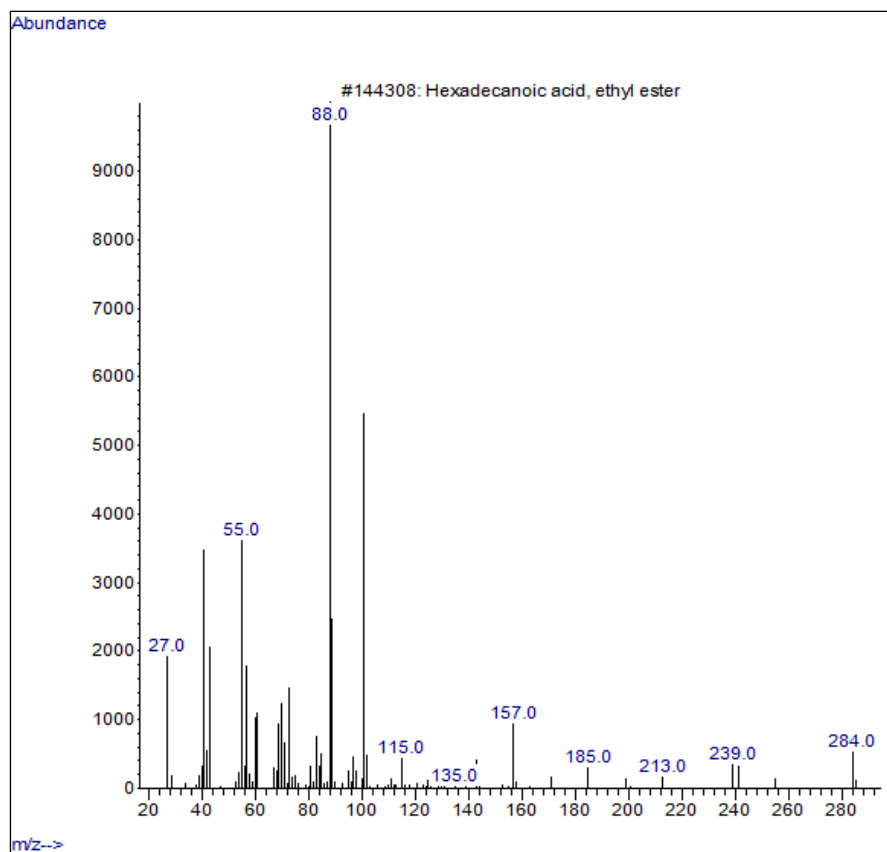


Figure 5c: GC-MS Ethanol Extract

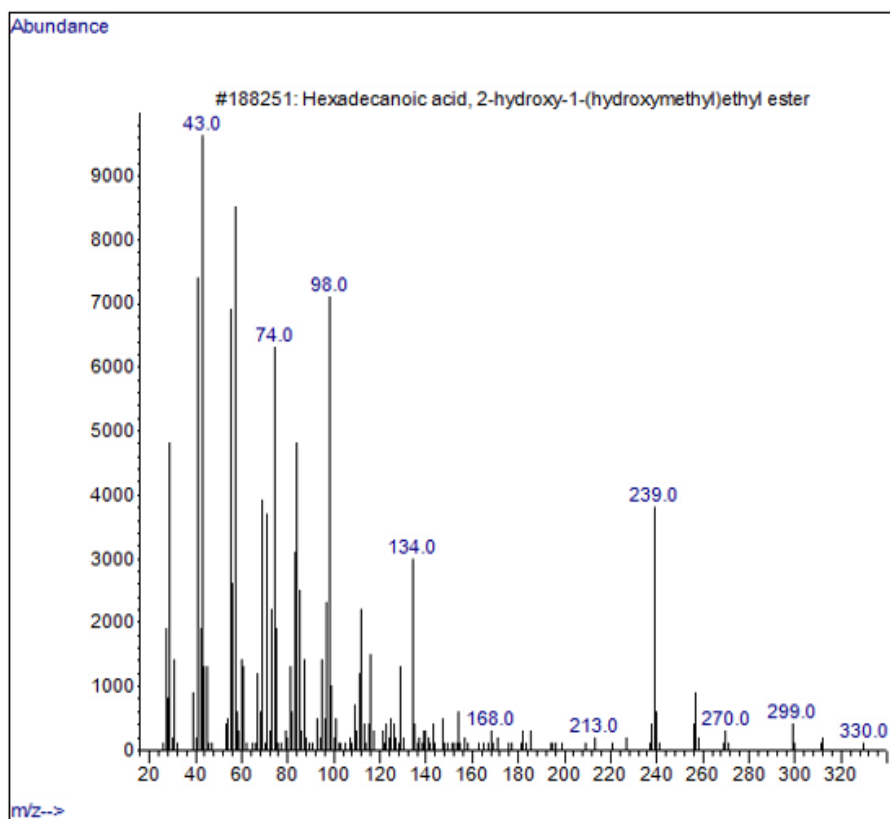


Figure 5d: GC-MS Ethanol Extract

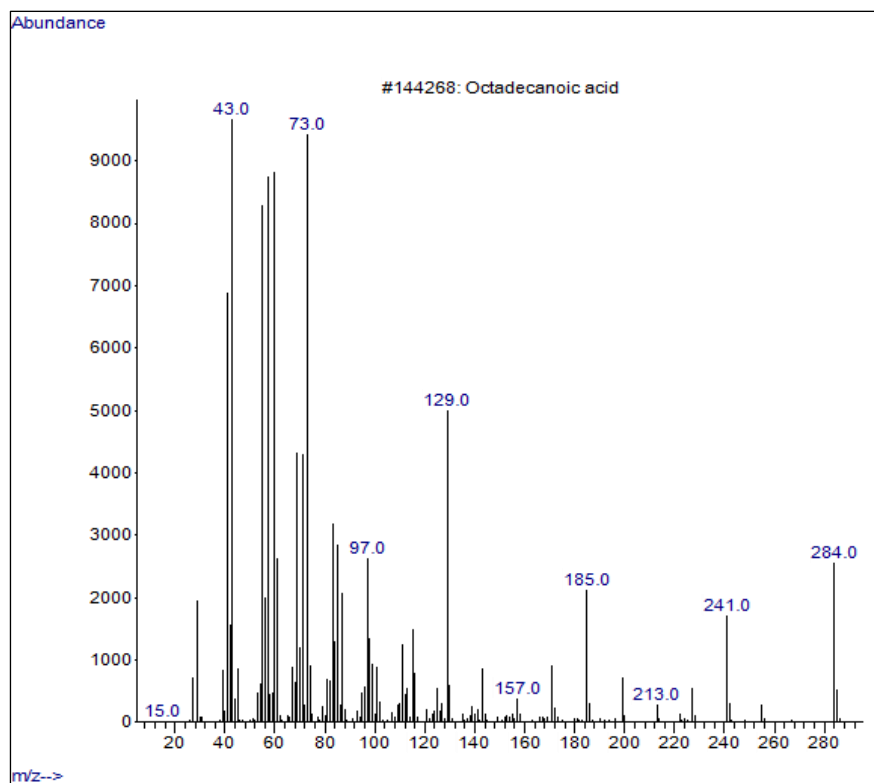


Figure 5e: GC-MS Ethanol Extract

The extract was characterized by the presence of long-chain hydrocarbons (e.g., tetradecane, pentadecane, hexadecane) and fatty acids, particularly n-hexadecanoic acid (palmitic acid) and 9,12-octadecadienoic acid (linoleic acid) derivatives. Among the compounds detected, 9,12-octadecadienoic acid, ethyl ester showed the highest relative abundance (17.67%), consistent with the known prevalence of polyunsaturated fatty acid (PUFA) esters in ethanol extracts of medicinal plants (Sharma and Singh, 2021). Palmitic acid and its derivatives (ranging 1.27–7.67%) were also notable, reflecting their common occurrence in lipid-rich plant matrices and their reported roles in antimicrobial and anti-inflammatory activities (Sun *et al.*, 2019). Minor terpenoid compounds, such as trans- α -bergamotene and cis- β -farnesene, were present in trace amounts, aligning with previous reports on volatile sesquiterpenes in ethanolic plant extracts (Bail *et al.*, 2020).

4 CONCLUSION

This study demonstrate that the seed contains significant levels of bioactive and nutritional constituents that justify its potential use in pharmaceutical, nutraceutical, and functional food industries. The presence of phenolic compounds, terpenoids, and squalene highlights its antioxidant, and anti-inflammatory properties. The study validates the seed as a promising natural source of health-promoting compounds and lays the groundwork for further pharmacognostic and biochemical investigations.

Recommendation

It is recommended that further bioassay-guided fractionation and pharmacological studies be conducted to isolate and characterize the active compounds responsible for the observed antioxidant properties. Future research should also include in vivo toxicity and safety evaluations to determine the seed's suitability for medicinal and nutraceutical applications.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declared that there is no conflict of interest

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