Applied Science, Computing and Energy, 2026, 4(4), 184-197

Phytochemical Screening, Proximate Analysis, and Bioactive Principles of *Acacia Albida* Stem Bark Extract

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17 January 2025/Accepted: 12 March 2026 /Published: 30 March 2026

Abstract: *This study investigated the phytochemical composition, proximate analysis, and bioactive principles of Acacia albida stem bark extract to evaluate its nutritional and therapeutic potential. Crude fat extraction was performed using hexane and ethanol in a Soxhlet apparatus for 8 hours, while ash content was determined by combusting the sample at 550°C for 5 hours in a muffle furnace. Solvent extraction of the stem bark was carried out using hexane and ethanol, followed by solvent recovery with a rotary evaporator. Proximate analysis revealed moisture content of 10.29%, ash 6.96%, crude lipids 3.43%, crude fiber 6.13%, and crude protein 8.48%, indicating substantial nutritional value. Qualitative phytochemical screening confirmed the presence of tannins, saponins, flavonoids, phenols, steroids, and alkaloids, while oxalates and phytates were absent. Gas Chromatography-Mass Spectrometry (GC-MS) analysis identified key bioactive compounds, including dodecanoic acid (2.27% area), hexadecanoic acid (3.44% area), 2,6-dihexadecanoate ascorbic acid (5.48% area), and 5-benzoyl-1H-benzimidazol-2-yl (13.77% area). The findings highlight A. albida as a rich source of bioactive and nutritional compounds, providing a scientific basis for its ethnomedicinal uses and potential applications in nutrition, medicine, and sustainable utilization.*

Keywords: *Phytochemical Screening, Acacia albida, Stem Bark Extract, Proximate Analysis*

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1.0 Introduction

Plants play essential roles as sources of nutrition, therapeutic agents, and bioactive compounds that support human health and pharmaceutical development. Throughout human history, plants have been useful to humans (Balic and Cox, 2020). As herbal

supplements, botanicals, and nutraceuticals, 30 to 40% of the medications on the market are derived from the therapeutic and restorative qualities of different plants (Schulz *et al*., 2004; Nile & Khobragade, 2009). "Consequently, scientific investigation of plant phytochemicals and nutritional composition has become an important strategy for identifying novel bioactive compounds and validating traditional medicinal uses. Particularly in developing nations, wild edible plants, many of which have the potential to be profitable as human substitutes, can be crucial in balancing the growing population with the low productivity of agriculture (Vishwakarma and Dubey, 2011). Some plants have long been known for their significant benefits, but many others have not yet been thoroughly studied. Thus, it is essential to investigate their applications and carry out pharmacological research to determine their medicinal qualities (Mushtaq et al., 2006). "Medicinal plants contain diverse secondary metabolites such as alkaloids, flavonoids, tannins, and phenolic compounds that contribute to their pharmacological activities. (Doughari and Saa-Aondo, 2021). "Previous phytochemical investigations of medicinal plants have demonstrated that variations in plant parts and extraction methods significantly influence bioactive composition and nutritional value.

Acacia albida (syn. Faidherbia albida), commonly known as the gum Arabic tree or white acacia, is an important multipurpose leguminous species widely distributed across Africa. With a maximum height of 30 meters, the apple-ring acacia is a deciduous legume tree. Its taproot extends down to 40 meters. Its leaves are pinnate with 6-23 pairs of tiny oblong leaflets, and its branches have paired thorns. The fruits (pods) are twisted and glossy orange, indehiscent, 25 cm long, and 5 cm broad, with flowers clustered in yellow spikes (Yazarlu *et al.,* 2021). "The species is well adapted to arid and semi-arid environments and is valued for its ecological, nutritional, and medicinal applications. (Shikov *et al.,* 2021). Native to arid or semi-arid regions of Africa, *Faidherbia albida*, also called *A. albida*, is a common plant on the continent. It is frequently found in Southeast Asia, the Middle East, India, Pakistan, Cyprus, Cape Verde, and Peru. With extended dry seasons and temperatures between 6 °C and 42 °C, it thrives in sandy regions with 250–1800 mm of annual rainfall (Salmerón-Manzano *et al.,* 2020). Various parts of A. albida have been traditionally used in African ethnomedicine for the management of infections, inflammation, and nutritional deficiencies. Both salt and waterlogging are tolerated by it (Quadri *et al.,* 2021). Plant-derived substances have gained a lot of attention lately because of their many applications and advantages (Abubakar & Haque, 2020). One important factor in people's overall health is herbal medicine. A variety of natural plant materials are utilized as medicinal plants to heal illnesses. Medicinal plants are inexpensive and sustainable sources of pharmacologically active compounds. They are also known to generate specific chemicals that can be utilized to treat and cure illnesses (Seigler, 2003).

Medicinal plants are those that have been utilized for millennia or that science has proven to offer medicinal benefits (Adhikari *et al*., 2021). These plants have substances that can be used to treat or lessen several illnesses or symptoms. Since ancient times, people have utilized medicinal plants to create herbal teas, natural treatments, and other types of traditional medicine to treat illnesses and advance health (Ahmad *et al*., 2021). The therapeutic qualities of plants such as lavender, chamomile, acacia albida, and aloe vera are examples of medicinal plants (Akbar, 2020). The human body uses chemicals found in plants for specific physiological purposes (Abdel-Farid *et al*., 2014). In Africa, a wide variety of plants have been used to cure various illnesses.

Since ancient times, nature has provided us with therapeutic agents. It typically generates a large number of secondary metabolites, that provide key components for the development of new, eco-friendly insecticides, herbicides, microbicides, and pharmaceutical medications (Alagbe *et al*., 2020).

Plant secondary metabolites are recognized as major contributors to antimicrobial, antioxidant, anti-inflammatory, and pharmacological activities (Badu *et al*., 2020). Ongoing studies of their secondary metabolites have produced significant pharmacological advances and greatly aided the development of contemporary pharmacotherapeutics in Africa and globally (Behl *et al*., 2020). It is estimated that less than 10% of the aromatic compounds that plants may produce are secondary metabolites, of which at least 12,000 have been identified (Benarba & Pandiella, 2020). In order to protect themselves from being eaten by insects, herbivores, and microbes, plants use the aromatic compounds they produce, or metabolites. Nonetheless, terpenoids, quinines, and tannins may contribute to plant odor, while capsaicin may contribute to flavor (Khadka *et al.,* 2021). Due to their significant role in the health care of both individuals and communities, humans respect the therapeutic value that these protective compounds give plants. The stem bark has long been used for both medicinal and dietary purposes, yet its elemental and nutritional profiles remain poorly studied. "Despite the extensive traditional use of *A. albida*, comprehensive information regarding the phytochemical composition, proximate nutritional profile, and specific bioactive constituents of its stem bark remains limited. Existing studies have largely focused on other plant parts, leaving a significant gap in understanding the chemical and nutritional potential of the stem bark. Therefore, this study aimed to evaluate the phytochemical constituents, proximate composition, and bioactive principles of *Acacia albida* stem bark extract using standard analytical and GC–MS techniques. "The findings of this study are expected to provide scientific validation for the traditional uses of the plant, contribute to nutritional and pharmacological databases, and support the sustainable utilization of A. albida as a potential source of natural bioactive compounds."

2.0 Materials and Method

2.1 Collection of Plant

Stem bark of *Acacia albida* was collected in August 2023 from [specific location or coordinates, if available]. The species was authenticated by the Department of Plant Biology, Federal University Dutse. The herbal plant was identified as apple-ring *acacia*, or *A. albida,* by the Department of plant biology, Federal University Dutse. The collected stem bark was washed thoroughly with running water, oven-dried at 40°C for 24 hours, pulverized into coarse powder using an electronic mixer, and stored in airtight containers for further analysis

2.2 Chemicals and reagents

All chemicals and reagents used were of analytical grade (Merck, Sigma-Aldrich), and solutions were prepared using distilled water in clean glassware.

2.3 Sample analysis

The results of the triple proximate analysis were the average values. Moisture content was determined by drying 5 g of powdered sample to constant weight at 100–107°C using the method of AOAC (2019). Ash, crude fat, crude fiber, and crude protein were determined according to standard AOAC procedures (2019), while total carbohydrates were calculated by difference. (AOAC, 1990). Crude fat was extracted from 15 g of powdered stem bark using a Soxhlet apparatus with hexane as the solvent for 8 hours, following AOAC (2019). The ash content was measured by combusting the sample in a muffle furnace at 550 °C for five hours. Crude fiber was assessed through successive hot digestion of the defatted

samples using dilute acid and alkaline solutions (AOAC, 1990). The crude protein levels were determined through the Kjeldahl digestion procedure and nitrogen concentration was quantified using Devani's spectrophotometric method (Devani *et al.*, 1989). Total carbohydrate content was then obtained by deducting the percentages of protein, crude fat, crude fiber, moisture, and ash from 100 (AOAC, 1990).

2.4 Hexane/ethanol extraction of plant material

A method for extracting solvents from the resultant powder that involved utilizing a Soxhlet apparatus with hexane first and ethanol second was followed as described in the report by AOAC, (1980). For eight hours, hexane was utilized as the extracting solvent while 200 g of the ground fruit was sealed within muslin cloth and positioned within the Soxhlet extraction apparatus. At the conclusion of this time, the hexane and ethanol used were removed by using a rotary evaporator, and any leftover oil was oven-dried for an hour at 750 °C. Following hexane extraction, ethanol was used to extract the same sample for 8 hours. Solvents were removed using a rotary evaporator, and the resulting extracts were dried at 40–50°C and stored in airtight containers for subsequent analysis. Following this time frame, Solvent recovery was carried out with the aid of a rotary evaporator, and the remaining extract was dried for an hour at 850 °C. After cooling in a desiccator, the two extracts were stored for analytical testing.

2.5 Phytochemical screening

Hexane and ethanol extracts were subjected to qualitative phytochemical screening to detect flavonoids, tannins, saponins, alkaloids, glycosides, oxalates, and phytates using standard procedures (Harborne, 1973; Trease & Evans, 1989; Sofowora, 1993).

2.6 Statistical analysis

Samples were examined, and assays were performed in duplicate for the fractions. A one-way analysis of variance (ANOVA) was performed to assess the statistical differences among the groups.

2.7 Preparation of Aqueous Extract Stem Bark

After being removed from the plants, the stem bark was thoroughly washed with deionized water and left to dry in the room and open air to eliminate any remaining moisture. A ceramic mortar and pestle were used to crush the stem bark to powder, and the sample was labelled and stored in an airtight plastic container (Ben-Shabat *et al.*, 2020). Approximately 5.0 g of the aqueous leaf extracts was weighed and added with 300 mL of distilled deionized water at 100 °C. It was then left to stand for 10 minutes. Using Whatman filter paper, the extract was filtered, and the filtrate was stored in a refrigerator between 4 – 10 °C until further analysis.

2.8 Methods

2.8.1 Qualitative Phytochemicals Determination

Using the technique outlined by Beshah *et al.* (2020) with some modifications, a phytochemical analysis was performed on the extract in order to detect flavonoids, alkaloids, oxalate, phytate, glycosides, tannins, and saponins.

Alkaloids: 3 cm^3 of extract was acidified with 1% HCl, heated at 50°C for 20 min, cooled, filtered, and treated with Wagner's reagent. Formation of a reddish-brown precipitate indicated the presence of alkaloids."

Tannins: 1 cm^3 of the extracts was mixed with 1 cm^3 of freshly prepared 10% KOH. The formation of an off-white precipitate indicates the presence of tannins.

Glycosides: 1.0 cm^3 of extract was mixed with 10 cm^3 of 50% H_2SO_4, thereafter, the content was heated to boiling in a water bath for 15 minutes, followed by the addition of 10 cm^3 of Fehling's solution then heated to boil. A precipitate with a brick-red coloration is formed when glycosides are present.

Saponins: Test for frothing: 2 cm^3 of the extract was shaken vigorously for two minutes in a test tube. When foaming occurs, saponins are present.

Flavonoids: 3 cm^3 of the extract was mixed with 1 cm^3 of 10% NaOH. A yellow color formation signifies the presence of flavonoids.

Phytate: 1 cm^3 of 2% HCl was added to 25 mL of extract followed by the addition of 0.3% solution of ammonium thiocyanate, then iron (III) chloride was incorporated into the mixture until a brownish-yellow color was observed.

Oxalate: The extract was mixed with 1 cm^2 of 1.5 N H_2SO_4, and the mixture was gently swirled continuously for an hour using a magnetic stirrer. The mixture was filtered using Whatman filter paper. A 0.25 cm^3 portion of the filtrate was titrated with 0.1 N $KMnO_4$ solution at 80–90°C until a slight pink tint was seen.

2.8.2 Quantitative Phytochemicals Determination

Quantitative analysis of phytochemical constituents in *A. albida* stem bark extracts was performed following the methods of Sadiq et al. (2025) with slight modifications.

Proximate Composition Analysis

Moisture content: The evaporation of moisture is the basis for this technique. The metal dishes were cleaned here, dried in an oven, and then cooled in desiccators. Every dish's weight was measured. Five grams of the ground sample were transferred into a sterile aluminum dish, and the initial weight of the dish along with the undried sample was recorded in duplicate. The samples were then dried in an oven, first at 30 °C for 2 hours and subsequently at 100 °C for 3 hours. After drying, the dish was removed and allowed to cool in a desiccator before being weighed using a precision balance. The sample was returned to the oven for an additional hour, after which it was cooled and weighed again. This drying and weighing cycle was repeated until a constant weight was achieved. Moisture content was determined as the difference between the initial weight and the final constant weight. The percentage moisture content was calculated through the application of equation 1

$$Moisture\ content = \frac{W_2 - W_S}{W_2 - W_1 \times 1} \times \frac{100}{1} \quad (1)$$

where, w_I, w_2 and w_S are the initial weight of the empty crucible, weight of the crucible plus sample before drying and final weight of the crucible plus sample after drying, respectively. The percentage of total solids (dry matter) was calculated as:

% Total solids (dry matter) = 100 − % moisture (AOAC, 2019).

Ash content: After all moisture has been eliminated, the ash represents both the organic material and the sample's inorganic component (minerals). The procedure is destructive and involves breaking down all organic materials, which may result in the loss of mineral elements. Twenty grams of each sample were accurately weighed and transferred into a clean, dry, and pre-cooled platinum crucible. The crucible was then placed in a furnace maintained at 550 °C and heated for three hours to ensure complete ashing. After the heating period, the crucible was carefully removed and allowed to cool in a desiccator before being reweighed. The ash content was determined as the percentage of the remaining residue relative to the initial sample weight.

Ash content (%) = (weight of ash ÷ weight of original sample) × 100

$$Ash\ content = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1} \quad (2)$$

where W_1, w_2, and w_3 are the weights of the empty crucible, weight of the crucible with the sample before drying or ashing and weight of the crucible with the ash, respectively (AOAC, 2019).

Lipid content: Soxhlet extraction process, as outlined by Shir Law (1967), was used. Fifteen grams of the sample were accurately weighed and transferred into a fat-free extraction thimble, which was loosely plugged with cotton wool to prevent sample loss. The thimble was then placed in a

Soxhlet extractor, while a previously weighed, fat-free Soxhlet flask was filled with approximately 200 mL of petroleum ether and connected to the apparatus. The extraction was carried out by heating the solvent with a heating mantle, allowing continuous reflux. After a minimum extraction period of six hours, the system was allowed to cool under running water, enabling the solvent to siphon back completely into the flask. The solvent was subsequently removed using a rotary vacuum evaporator, leaving the extracted lipids behind. The flask containing the lipid residue was then dried in an oven at 60 °C until a constant weight was obtained, cooled in a desiccator, and finally reweighed. Three duplicates of each determination were made. The amount of fat extracted was calculated by

Ether extracts (100g) dry matter =

$$\frac{\text{weight of extracted lipids}}{\text{weight of dry sample}} \times \frac{100}{1}) \qquad (3)$$

(AOAC, 2019)

Protein determination: The Kjedahl method, as modified by Williams (1964), was used to calculate total protein. Determining the quantity of reduced nitrogen present is the foundation for the Kjedahl method's examination of a compound's protein composition. A Kjedahl flask was filled with approximately 20.0 g of the samples which had been weighed onto filter paper. Ten tablets of $NaSO_4$ and one gram of $CuSO_4$ were added, respectively. 20 mL of concentrated H_2SO_4 were added and the mixture was digested in a fume cupboard until the color disappeared. Packs of ice block were used to cool the content to room temperature. After cooling overnight, the digest was diluted with 200 mL of distilled water and transferred into a 500 mL flask. A receiving flask containing 50.0 mL of 4% boric acid solution and 67.0 mL of 40% sodium hydroxide was prepared, with a screened methyl red indicator added. The liberated ammonia was then distilled into the receiving solution until complete collection was achieved. Finally, the distillate was titrated with 0.01 M hydrochloric acid until the endpoint was reached, indicated by a color change to colorless. The percentage protein is calculated as follows:

V_s - V_b × 0. 01401 × N acid (6.25) × 100
Original weight of sample used…………(4)

Where V_s = Volume (mL) of acid required to titrate sample, V_b = Volume (mL) of acid required to titrate blank, N acid = normality of acid (AOAC, 2019).

Crude fiber: Crude fiber is the term used to describe the majority of roughages found in food. Each 20 g of sample was first defatted with diethyl ether for eight hours, after which it was reflux- boiled for 30 minutes in 200 mL of 1.25% sulfuric acid. A fluted funnel was used to filter it through cheesecloth and cleaned with hot water. The residue was further refluxed for 30 minutes in a round-bottom flask containing 200 mL of 1.25% sodium hydroxide (NaOH) solution. The resulting mixture was then filtered using a pre-weighed Gooch crucible. The crucible with its contents was dried in an oven at 100 °C, cooled in a desiccator, and weighed. It was subsequently incinerated in a muffle furnace at 600 °C for 3 hours, after which it was cooled again in a desiccator and reweighed.

$$\text{Weight of fiber} = (C_2\text{-}C_3)\ y$$

$$\%\ \text{fiber} = \left(\frac{C2 - C3}{\text{weight of original sample}}\right) \times 100 \qquad (5)$$

Carbohydrate determination

Available carbohydrates (%) were determined by subtracting the sum of protein, moisture, ash, fibre, and fat percentages from 100.

Energy or Caloric Value (KJ/100g) = (Protein × 16.7) + (Lipids × 37.7) + (Carbohydrate × 16.7) (AOAC, 2019).

2.9 Gas Chromatography Mass Spectroscopy (GC-MS) Analysis

Dried powdered stem bark was extracted with n-hexane. The extracts were analyzed using a Shimadzu GCMS-QP2010 PLUS with an Elite-5 capillary column (30 m ×

0.25 mm, 0.25 µm film). Helium was used as the carrier gas (0.5 mL/min). The oven temperature was programmed from 80°C (4 min) to 200°C, then to 280°C at 20°C/min, holding for 5 min. Mass spectra were acquired at 70 eV, and compounds were identified by comparison with the GC-MS library."

3.0 Results/Discussion

3.1 Result

Gas chromatography–mass spectrometry (GC–MS) analysis of Faidherbia albida stem bark revealed the presence of several bioactive compounds that contribute to its pharmacological potential. Dodecanoic acid, a saturated medium-chain fatty acid commonly found in plant oils and medicinal plants, was detected. This compound is well-known for its antimicrobial, anti-inflammatory, and antioxidant properties, which support the therapeutic use of F. albida, particularly in the treatment of infections and inflammatory conditions (Christalin et al., 2024).

Hexadecenoic acid, a long-chain saturated fatty acid, was also identified in the extract. This compound exhibits antioxidant, antimicrobial, anti-inflammatory, and cytotoxic activities, making it pharmacologically significant. GC–MS studies of medicinal plants, including F. albida, frequently report hexadecenoic acid as a major bioactive component responsible for biological activity (Wilson et al., 2024; Qureshi et al., 2025).

The analysis further revealed the presence of 2,6-dihexadecanoate ascorbic acid, a lipophilic derivative of vitamin C formed through esterification with fatty acids. This derivative enhances both the stability and membrane permeability of ascorbic acid, thereby improving antioxidant potential and overall biological activity. Such compounds are associated with free-radical scavenging and protective effects against oxidative stress, which supports the medicinal relevance of F. albida extracts (Hammoudi et al., 2023).

(Z)-Octadec-9-enoic acid, commonly known as oleic acid, was also detected. As a monounsaturated fatty acid with recognized health benefits, oleic acid demonstrates anti-inflammatory, antimicrobial, cardioprotective, and antioxidant activities. Its presence in the extract may contribute to wound healing, immune modulation, and metabolic regulation, aligning with the ethnomedicinal applications of F. albida (Christalin et al., 2024).

In addition, imidazole derivatives, which are nitrogen-containing heterocyclic compounds, were identified. These compounds are widely known for pharmacological activities including antifungal, antibacterial, anti-inflammatory, and anticancer effects. Their ability to interact with biological targets such as enzymes and receptors renders them important therapeutic agents, and they may contribute to the antimicrobial properties observed in F. albida (Fu et al., 2024).

Finally, benzimidazole derivatives were detected in the stem bark extract. These heterocyclic compounds possess broad pharmacological activities, including antioxidant, antimicrobial, antiparasitic, and anticancer effects. They are also investigated for enzyme inhibition and DNA-binding potential, further supporting the therapeutic relevance of F. albida. The presence of these compounds may help explain some of the biological activities attributed to the plant in traditional medicine (BenchChem, 2024).

A qualitative phytochemical screening of Acacia albida stem bark aqueous extract was conducted to determine the presence of key secondary metabolites, including alkaloids, flavonoids, tannins, saponins, glycosides, oxalates, and phytates. The results of this analysis are summarized in Table 1. Phytochemicals detected in the extract are indicated as positive (+), whereas compounds not detected are represented as negative (−). The analysis revealed the presence of alkaloids, flavonoids, tannins, saponins, and glycosides, while oxalates and

phytates were absent, suggesting the extract may possess therapeutic potential without contributing to anti-nutritional effects.

To further assess the extract's bioactive potential, a quantitative phytochemical analysis was performed to determine the percentage composition of alkaloids, flavonoids, tannins, saponins, and glycosides. As shown in **Table 2**, alkaloids were found in the highest concentration (1.81%), followed by glycosides (1.70%), flavonoids (1.40%), tannins (1.34%), and saponins (1.20%). These findings indicate that A. albida stem bark is rich in bioactive secondary metabolites, which may underlie its medicinal properties.

Table 1. Qualitative Phytochemical Composition of A. albida Stem Bark Aqueous Extract

Phytochemical	Presence/Absence
Alkaloids	+
Flavonoids	+
Tannins	+
Saponins	+
Glycosides	+
Oxalates	−
Phytates	−

Table 2. Quantitative Phytochemical Composition of A. albida Stem Bark Aqueous Extract

Phytochemical	% Composition
Alkaloids	1.81
Flavonoids	1.40
Tannins	1.34
Saponins	1.20
Glycosides	1.70

The proximate composition of the stem bark extract was evaluated to determine its nutritional attributes, including moisture, ash, crude lipids, crude fiber, and crude protein. Results are summarized in Table 3. The extract contained 10.19% moisture, 6.96% ash, 3.43% crude lipids, 6.13% crude fiber, and 8.48% crude protein. The calculated calorific value was 1319.86 kJ/100 g, indicating that the extract may also serve as a nutritional supplement in addition to its therapeutic benefits.

The GC–MS screening of the aqueous extract of A. albida revealed the presence of multiple bioactive compounds with potential pharmacological applications. Retention time (RT) and peak area percentage were used to characterize the compounds, while chemical identification was confirmed using the PubChem compound database. As summarized in **Table 4**, the extract contains saturated and unsaturated fatty acids, ascorbic acid derivatives, and heterocyclic nitrogen compounds.

Table 3. Proximate Composition of A. albida Stem Bark Aqueous Extract

Component	% Content
Moisture	10.19
Ash	6.96
Crude Lipids	3.43
Crude Fiber	6.13
Crude Protein	8.48
Calorific Value	1319.86 kJ/100 g

Table 4. Bioactive Phytochemical Compounds Detected in A. albida Stem Bark Aqueous Extract

Chemical Compound	PubChem ID	Retention Time (min)	Area (%)	Molecular Formula
Dodecanoic acid	3893	19.602	2.27	$C_{12}H_{24}O_2$
Hexadecanoic acid	985	34.768	3.44	$C_{17}H_{34}O_2$
2,6-Dihexadecanoate ascorbic acid	5472220	37.650	5.48	$C_{38}H_{68}O_8$
(Z)-Octadec-9-enoic acid	445639	42.690	10.81	$C_{18}H_{34}O_2$

4,5-Dichloro-1-methyl-1H-imidazole	591536	45.490	11.62	$C_4H_4Cl_2N_2$
[5-Benzoyl-1H-benzimidazol-2-yl]	624301	48.897	13.77	$C_{15}H_{13}N_5O$

The GC–MS spectrum of the extract, shown in **Fig. 1**, provides a visual representation of the peaks corresponding to the identified compounds. The chromatographic data, combined with molecular structures and retention times, offer insights into the chemical composition of A. albida and may serve as a basis for future pharmacological studies (PubChem, 2026).

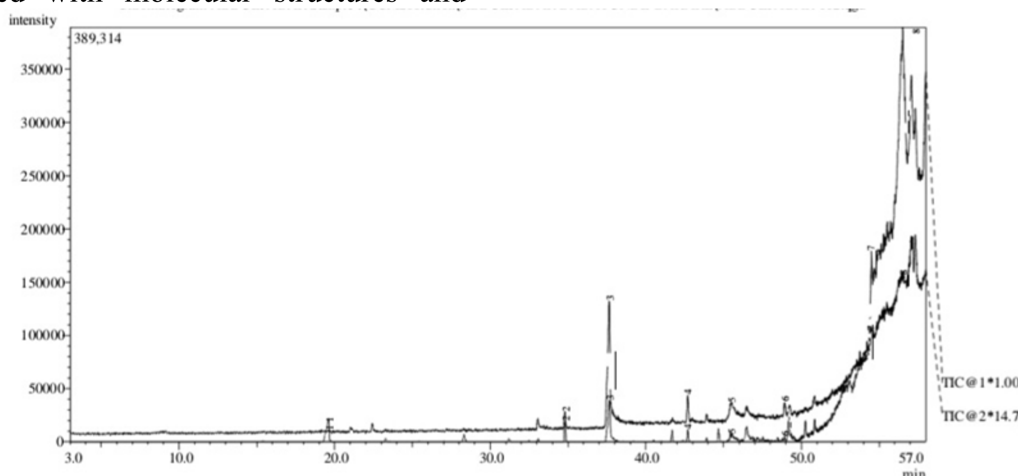

Fig. 1: GCMS Spectrum of the aqueous extract of *A. albida*

3.2 Discussion

The results of the qualitative and quantitative analyses of *A. albida* stem bark aqueous extracts were presented in Tables 1 and 2 respectively. The qualitative analysis revealed the presence of alkaloids, flavonoids, tannins, saponins, and glycosides, whereas oxalates and phytates were not detected. . The quantitative analysis indicated that alkaloids had the highest percentage composition of 1.81%, followed by glycosides (1.70%), flavonoids (1.40%), tannins (1.34%), and saponins (1.20%). These findings confirm that the stem bark of *A. albida* is rich in secondary metabolites.

According to Tufail et al. (2025), many medicinal plants exert their therapeutic effects primarily through the antioxidant activities of phytochemicals, including saponins, tannins, alkaloids, phenols, and flavonoids, which enable them to scavenge free radicals.

Given that flavonoids possess significant antioxidant and therapeutic potential, this indicates that the *A. albida* analyzed may confer notable health benefits. Alkaloids are nitrogenous compounds with diverse pharmacological activities. The relatively high alkaloid content confirms the bioactive nature of *A. albida* (Wilson et al., 2024).

Flavonoids are well-known antioxidants and may contribute to the plant's health-promoting properties (Correia et al., 2024). . The In addition to their anti-inflammatory qualities, tannins give plants their astringent flavor. The presence of tannins suggests potential anti-inflammatory and antimicrobial effects (Tukur et al., 2022; Wilson et al., 2024).

Saponins are glycoside compounds with foaming properties and possess diverse pharmacological activities. Their presence indicates potential applications as natural surfactants and therapeutic agents (Oluwakanyinsola et al., 2010). . Glycosides are known for cardiovascular, anti-inflammatory, and other bioactive effects. Their presence enhances the

pharmacological significance of the plant (Abubakar et al., 2016).

Excessive levels of oxalates can facilitate kidney stone formation; therefore, the absence of oxalates is beneficial for kidney health. Phytates may hinder mineral absorption, and their absence suggests that mineral bioavailability is unlikely to be compromised in *Acacia albida* (Mohammed et al., 2018).

In addition to their biological qualities, which include antioxidant activities, antimicrobial effects, detoxification enzyme modulation, immune system stimulation, platelet aggregation reduction, metabolism hormone modulation, and antineoplastic properties, phytochemicals are inexpensive, low toxicity, and readily available (Tufail *et al*., 2025). Because of the numerous metabolic processes in the human body, phytochemicals are necessary for human consumption. The uncooked plants that are ruminants, such as goats are known to contain so-called phytochemicals, and it is rare to find sick animals as a result of consuming them (Akintimehin *et al*., 2022).

The approximate analysis of plant extracts revealed Various percentages of ash, 6.96% moisture content 10.19%, crude protein 8.48%, crude fiber 6.13%, and crude lipids 3.43%. It is evident that the plant's nutrient levels make it edible (Akintimehin *et al*., 2022), in Nigeria and West Africa, in particular, the plant is used to make a variety of culinary condiments, such as vegetables (Khataniar *et al*., 2025). The plants are used as food and as remedies for a variety of illnesses in some parts of South Africa (Oluwakanyinsola *et al*., 2010). The nutritional value of the extract is influenced by the presence of protein. *A. albida* stem bark aqueous extracts' complex nature is highlighted by the combination of qualitative and quantitative analyses as well as proximate analysis. The presence of several phytochemicals indicates that it may have potential medical uses, and the proximate analysis provides information on its nutritional composition (Correia *et al*., 2022).

Using GC-MS, a number of chemicals were identified in the bioactive principles by noting their peaks and retention duration. The PubChem compound database was used to identify these chemicals, which gave important information on *A. albida's* chemical makeup. Notably, a rich phytochemical profile with possible biological activities is suggested by the presence of a variety of chemicals, such as fatty acids and heterocyclic structures (Wilson *et al.,* 2024; Abubakar *et al.,* 2016). To facilitate their separation, the retention times show how long each chemical remains in the chromatographic column. The bioactivity of these substances can be further examined by researchers using this information, which may help them determine their pharmacological importance. Furthermore, the molecular structures underlying *A. albida's* therapeutic qualities can be understood using the chemical formulas.

4.0 Conclusion

This study investigated the phytochemical composition and nutritional value of *Acacia albida* stem bark extracts to evaluate their potential health benefits. The extracts were found to contain bioactive compounds, including alkaloids, flavonoids, tannins, saponins, and glycosides, suggesting possible medicinal applications. The absence of oxalates and phytates is beneficial from a health perspective, as these compounds can interfere with mineral absorption or contribute to kidney stone formation. Quantitative analysis provided specific concentrations of these phytochemicals, highlighting the extract's richness in secondary metabolites.

Proximate analysis revealed notable levels of moisture, ash, crude lipids, crude fiber, and crude protein, indicating that the plant has nutritional value and could serve as a potential source of dietary energy, as reflected by its calorific value. Gas

Chromatography-Mass Spectrometry (GC-MS) identified a variety of bioactive compounds, including fatty acids and heterocyclic structures, each with distinct chemical formulas, retention times, and chromatographic peaks. These findings underscore the chemical complexity and pharmacological potential of *A. albida*.

Overall, *A. albida* appears to be a promising natural resource with both nutritional and therapeutic potential. Further studies are recommended to isolate and characterize the specific compounds responsible for its bioactivity and to explore their applications in medicine and nutrition. This work provides a foundation for future research aimed at harnessing the plant's health-promoting properties.

Acknowledgment

The authors express gratitude to the National Research Institute for Chemical Technology and Department of Chemistry, Federal University Dutse for providing a conducive environment and necessary facilities for carrying out the study.

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Declaration

Consent for publication

Not Applicable

Availability of data and materials

The publisher has the right to make the data public

Conflict of Interest

The authors declared no conflict of interest

Ethical Considerations

Not applicable

Competing interest

The authors report no conflict or competing interest

Funding

The author declared no source of funding

Authors'Contribution

Naseer Inuwa Durumin Iya conceptualized the study, supervised laboratory experiments, and prepared the initial manuscript draft. Musa Muhammad Bello, Ahmad Saminu, Abduljabbar Babatunde Bakare, Hafiz Ahmad, and Aminu Bala conducted phytochemical screening, proximate analyses, GC–MS characterization, data interpretation, and

literature review. All authors contributed to data validation, critical manuscript revision, and approved the final version for publication.