Kongunadu Research Journal 12 (2): 31-41, 2025 ISSN 2349-2694, All Rights Reserved,
Publisher: Kongunadu Arts and Science College, Coimbatore. https://krjournal.com/index.php/krj/article/view/712

DOI:10.26524/krj.2025.15

RESEARCH ARTICLE

GC-MS ANALYSIS OF BIOACTIVE COMPOUNDS, ANTIOXIDANT AND ANTIBACTERIAL ACTIVITY OF *ABUTILON INDICUM (L)* LEAVES

S.V. Saranyaa[a] and J. Dhanalakshmi[b,*]

[a]Ph.D Research scholar, PG and Research Department of Biochemistry,
Bharathidasan College of Arts and Science, Erode:638116, India.
[b,*]Associate Professor, PG and Research Department of Biochemistry,
Bharathidasan College of Arts and Science, Erode:638116, India.
*Corresponding Author Ph: 9942653373
*Corresponding Author email id: dhanajd26@gmail.com

Abstract

The present study explored the therapeutic potential of *A.indicum* leaves. In today's world, plant secondary metabolites are increasingly favored as therapeutic agents to address various diseases and disorders. This study aimed to analyze the bioactive secondary metabolite profile of *A.indicum* leaves by assessing the total alkaloid, phenolic, and flavonoid content, antioxidant capability, and properties of four aqueous and ethanolic extracts. Qualitative phytochemical analysis using different polarity solvents and established methods revealed the presence of alkaloids, flavonoids, phenols, steroids, tannins, saponins, phytosterols, terpenoids, and glycosides in the leaves. The antioxidant potential was evaluated using DPPH and ABTS radical scavenging assays, while spectrophotometric methods were employed to measure the total alkaloid, flavonoid, and phenolic contents in the leaf extracts. The ethanolic extract showed a higher yield, greater antioxidant potential, and elevated total phenolic and flavonoid contents compared to the aqueous extracts. Analysis of bioactive compounds using Gas Chromatography-Mass Spectrometry (GC-MS). Gas Chromatography-Mass Spectrometry (GC-MS) examination of ethanolic leaf extracts identified 36 chemical entities of both high and low molecular weight in different quantities. These bioactive chemical compounds have been shown to have physiological significance and are crucial from a pharmaceutical perspective. This study indicates that the leaves of *A.indicum* are rich in bioactive secondary metabolites that positively impact human health, possess strong antioxidant properties, and exhibit antibacterial activity against certain bacterial strains, highlighting their considerable therapeutic potential.

KEYWORDS

Abutilon indicum, phytochemical, Antioxidant, Anti-bacterial activity.

Introduction:

In India, ancient traditions such as Ayurveda, Unani, and Siddha have relied on herbal medicines to address a wide range of health issues and physiological conditions. Traditional medicine comprises the medicinal elements derived from the plant kingdom. The wealth of knowledge has historically been regarded as valid[1]. The World Health Organization (WHO) defines traditional medicine as the collective understanding of indigenous practices, beliefs, and their applications of plants for treating various ailments. According to WHO, the healthcare needs of many individuals in developing nations are primarily supported by traditional medicine, predominantly sourced from natural plant products[2]. The species *A. indicum*, commonly referred to as "Country mallow" in English, and known as "Thuthi" locally, can be found throughout the warmer regions of India[3]. Abutilon indicum (L.) Sweet is referred to as Atibala in Sanskrit and has been extensively utilized in Ayurvedic medicine[4]. *A.indicum* belongs to the economically significant Malvaceae family[5]. Primary plant metabolites consist of simple compounds like nucleic acids, proteins, amino acids, polysaccharides, and carbohydrates, while secondary metabolites encompass a wide array of chemical compounds produced via distinct metabolic pathways, diverging from primary metabolism, including alkaloids, phenols, flavonoids, glycosides, lipids, terpenes, tannins, steroids, anthraquinones, and saponins, which serve as essential elements for various effective medications[6]. Plants naturally resist oxidative damage due to their secondary metabolites, which, when consumed, contribute to a dietary source of antioxidants. The green extraction process is recognized as a vital technique in the extraction and identification of phytochemicals, which exhibit beneficial properties without toxic effects[7]. Microorganisms are a primary cause of both acute and chronic illnesses, leading to an increased reliance on plant extracts, which are abundant sources of antimicrobial agents and are recognized

as innovative treatments against antibiotic-resistant pathogens[8]. Plant extracts have found applications as preservatives, antibiotics, and antimicrobial agents across various sectors such as food, aquaculture, pharmaceuticals, and clinical settings[9]. Given the advantageous effects of plant bioactive compounds on human health, this research was conducted to evaluate the presence of secondary metabolites, free radical scavenging capability, and antibacterial activity in the leaves of *A.indicum*[10]. According to the findings of this study, these leaves possess a high concentration of bioactive constituents, including alkaloids, flavonoids, phenols, saponins, terpenoids, glycosides, steroids, carbohydrates, and amino acids[11]. Therefore, this research aims to examine the phytochemicals, antioxidants, and antimicrobial properties in order to explore the potential biological applications of the leaves of *A.indicum.*

2. Materials and Methods

2.1 Plant material

The plant specimens were authenticated as *Abutilon indicum (L)* Sweet subsp. Indicum (Malvaceae) by the Botanical Survey of India, Coimbatore (BSI/SRC/5/23/2024-25/ Tech./509). The aerial parts of the plant sample were washed in normal water and again rinsed in distilled water and was shade dried at room temperature for 15 days.

Source: Young *A. indicum* plants were collected from the vicinity of Pallipalayam, Namakkal district, Tamil Nadu, India in the flowering season.

Sample for Research: The above Cultivated *A. indicum* was used for the further research work.

2.2 Preparation of extract

The leaves of the *A.indicum* plant, which were dried in the shade, were chopped into pieces and then ground into a fine powder using a micro-crusher. The powder, weighing 10 g, was then placed in 100 ml of ethanol, aqueous solution, acetone, and chloroform for a maceration process lasting 48 hours. A magnetic stirrer was used to enhance the extraction process. Afterward, the solvent was removed, and the remaining residue was filtered through filter paper before drying with a Rotavapor. The ethanol, aqueous, acetone, and chloroform extracts of the plant were collected and stored at 4°C for future experiments. Subsequently, a phytochemical screening was conducted to identify the active phytoconstituents present in the leaves extracts of *A.indicum* in the aforementioned solvents.

2.3 Preliminary Phytochemical Analysis:

Qualitative tests were performed on different solvent extracts of *A.indicum* to identify various active compounds such as alkaloids, flavonoids, saponins, tannins, glycosides, phenols, carbohydrates, and proteins, among others[12].

2.4 Quantitative Determination of Phytochemicals

2.4.1 Determination of Total Alkaloids Contents:

To 1 ml of the test extract, 5 ml of phosphate buffer at pH 4.7 was added along with 5 ml of BCG solution, and the mixture was shaken with 4 ml of chloroform. The extracts were subsequently collected in a 10-ml volumetric flask and diluted with chloroform to reach the desired volume. The absorbance of the chloroform complex was measured at 470 nm, using a blank prepared in the same way but without the extract. Atropine was used as a standard for comparison against Atropine equivalents in the assay.

2.4.2 Determination of Total Flavonoid Contents:

To assess the total flavonoid content, 500 µL of each sample (at a concentration of 1 mg/mL) was combined with 100 µL of 10% (w/v) aluminum chloride and 100 µL of 1.0 M potassium acetate. Following this, 1.5 mL of ethanol and 2.8 mL of distilled water were added, and the mixture was blended. The resulting solution was kept in a dark environment for 1 hour, and its absorbance was subsequently measured at 415 nm using a SpectraMax M2e microplate reader. The total flavonoid content is expressed in terms of quercetin equivalents (mM QE/g).

2.4.3 Determination of Total Phenol Contents:

The total phenolic content in various solvent extracts was assessed using Folin-Ciocalteu's reagent (FCR). In this procedure, different concentrations of the extracts were combined with 0.4 ml of FCR (diluted 1:10 v/v). After allowing the mixture to stand for 5 minutes, 4 ml of sodium carbonate solution was added. The tubes were then filled to a final volume of 10 ml with distilled water and allowed to sit for 90 minutes at room temperature. The absorbance of the samples was measured at 750 nm against a blank using a spectrophotometer. A standard calibration curve was created using catechol solutions, and the total phenolic content of the extract was reported in milligrams of catechol per gram of dry weight based on the standard graph.

2.5 Antibacterial activity of ethanolic leaves extract of *A.indicum*

The antibacterial activity of the ethanolic leaves extract of *A.indicum* was evaluated using the disc diffusion method (Kirby-Bauer method). Select microorganisms, including Streptococcus, Staphylococcus aureus, Pseudomonas, and E. coli, were cultured on separate nutrient agar plates. A 20 ml portion of sterilized nutrient agar medium containing agar was poured into each Petri dish and allowed to solidify for 10-15 minutes. Following this, 100 µl of bacterial inoculum was evenly spread across the respective solidified Petri dishes using a cotton swab. Discs containing the extract were

placed on the surface of the agar plates and then incubated for 24 hours at 26-37°C in a bacterial incubator. After the incubation period, the antibacterial activity was assessed by measuring the diameter of the clear zone of inhibition in millimeters (mm).

2.6 Evaluation of Scavenging activity of ethanolic leaves extract of *A.indicum*

2.6.1 Determination of Antioxidant Activity Using the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) Radical Scavenging Method:

The radical scavenging capability of the sample against DPPH was assessed spectrophotometrically in a dark environment using the DPPH method, which is a stable free radical that accepts an electron or hydrogen radical to achieve stability. The reaction mixture, with a total volume of 3 ml, consisted of 1 ml of DPPH, 0.5 ml of the sample, and was completed to 3 ml with distilled water. The tubes were incubated at 37°C for 10 minutes. A blue color chromophore developed, and its absorbance was measured at 517 nm.

Inhibition (%) = [(A control – A test)/ A control] × 100

2.6.2 Determination of Antioxidant Activity Using the ABTS Free Radical Scavenging Method:

The ABTS radical scavenging ability of the ethanolic leaf extract of *A.indicum* was evaluated following the method outlined by Dorman and Hiltunen (2004). A total of 10 ml of 7 mM ABTS was combined with 10 ml of 2.45 mM potassium persulphate solution and allowed to stand for 16 hours. Subsequently, the absorbance of the reaction solution was measured at 734 nm. After this, varying concentrations of ethanolic leaf extract of *A.indicum* (ranging from 50 to 250 µg/ml) were added to 1.48 ml of the ABTS solution. The absorbance of the reaction mixture along with the sample was recorded at 734 nm after incubating for 30 minutes at 37 degrees Celsius. Vitamin C (Ascorbic acid) was used as the positive control. The percentage of inhibition was determined by plotting the ABTS scavenging curve against the extract dosages.

2.7 Identification of components in GC-MS analysis:

GC-MS, or gas chromatography-mass spectrometry, is a crucial tool for analysing unknown plant-origin components. The ethanolic extract of *A. indicum* leaves were analysed using GC-MS. A 6890 N Agilent gas chromatograph and a JMS 600 H JEOL mass spectrometer were used for GC-MS. In a temperature program ranging from 50 to 256 °C at a rate of 4 °C/min with a 2-minute hold, the compound mixture was separated on a fused silica capillary SPBI column with dimensions of 30 m x 0.32 mm and a film thickness of 0.25 µm. The injector's temperature was 260 °C, and the carrier gas helium was flowing at a rate of 1 mL per minute. The ion source temperature was 250 °C, the analyser temperature was 250 °C, the electron emission was 100 µA, and the ionization voltage was 70 eV in the EI mode JMS 600 H JEOL mass spectrometer. Split mode was used to manually inject the sample. The sample ratio in split mode was 1:45 [13].

2.8 Statistical analysis

Three biological replicate extracts were analyzed for each assay described above. Results were expressed as the mean ± standard deviation of mean (SD).

3. Results and Discussion

3.1 Phytochemical screening of leaves extract of *A.indicum*

Phytochemicals are a notable source of bioactive compounds. During the current drug discovery process, the bioactivity of various phytochemicals is of great importance. **Table 1** presents the phytochemical profile results, showing that the leaf extract of *A.indicum* contains a range of phytocomponents, such as tannins, phenols, carbohydrates, proteins, and saponins. These phytoconstituents have been studied for their potential in treating numerous conditions, including diabetes, cancer, inflammation, and others. A variety of therapeutic, antibacterial, and antifungal properties, as well as treatments for various ailments that affect overall skin health, are attributed to these phytochemical compounds.

Table -1: Phytochemical screening of various solvent leaves extract of *A.indicum*

Phytochemicals	Aqueous	Ethanol	Acetone	Chloroform
Sugar	+	+	+	+
Glycosides	-	-	+	+

Phenols	+	+	+	+
Amino acids	+	+	-	-
Alkaloids	+	+	+	-
Flavnoids	+	+	+	-
Steroids	-	+	+	+
Saponins	+	+	-	+
Tannins	+	-	-	+
Terpenoids	+	+	-	-
Xanthoproteins	+	+	+	+

Note: +: Present, -: Absent

These plants are proving to be an increasingly valuable reservoir of bioactive compounds of significant therapeutic potential, according to the study's findings, which also suggest that the detected phytochemical substances may represent the bioactive elements.

3.2 Estimation of secondary metabolite in aqueous and ethanolic leaves extract of *A.indicum*

The presence of Alkaloid, Flavonoid and phenolic content was investigated in aqueous and ethanolic leaves extract of *A.indicum* extracts. The results of this investigation were observed in Table 2.

Table 2: Alkaloid, Flavonoid and phenolic content in aqueous and ethanolic leaves ethanolic leaves extract of *A.indicum*

S.No	Name of Secondary metabolite	Alkaloid	Flavonoid	Phenol
1	Aquoeus Extract	5.31±0.45	7.37±0.39	9.41±0.29
2	Ethanolic Extract	6.41±1.40	8.70±1.03	10.24±0.35

As a result, it shows that the highest levels of Alkaloid, Flavonoid, and phenolics are present in the ethanolic extract of *A.indicum* leaves. Nevertheless, Alkaloids and Flavonoids may contribute to hormonal regulation and immune response. The presence of these phytoconstituents enhances the antibacterial, anti-inflammatory, and anticancer properties of this extract. Compounds such as tannins and other polyphenols, along with phenolics, are beneficial in combating various diseases. Phenolic compounds exhibit anti-inflammatory, anticancer, and cardioprotective benefits. The apparent anticancer properties may stem from the antioxidant effectiveness of the phenolic substances isolated from the plant [14].

The potent antioxidant characteristics of the extracts were evidenced by their elevated phenolic content. They possess the capacity to neutralize free radicals and prevent cellular damage. Furthermore, the phenolic compounds showcased the pharmacological potential of this extract by displaying antibacterial activity against a wide range of pathogens [15].

3.3 Antibacterial activity of aqueous and ethanolic leaves extract of *A.indicum*

Secondary metabolites, including phenols, tannins, and saponins, contributed to the observed antibacterial effects. The aqueous and ethanolic extracts of *A.indicum* exhibit antibacterial properties due to their ability to inhibit the growth of various microbes, suggesting potential applications in food packaging, wound care, and personal hygiene products. When evaluated for antibacterial properties, the aqueous and ethanolic extracts of *A.indicum* demonstrated a noteworthy antibacterial profile against E. coli, Klebsiella pneumoniae, Staphylococcus aureus, and Enterococcus faecalis. Tables 3 and 4 & Figures 1 and 2 provide a summary of the antibacterial activities of the ethanolic and aqueous extracts, measured as the zone of inhibition (mm) [16].

Table -3: Antibacterial activity of ethanolic leaves extract of A. indicum. Average value = Mean ± standard

Name of the microorganism	ZONE OF INHIBITION (mm)				
	Sample extract (µl)			Control	
	50	100	200	Penicillin	Streptomycin
E.coli	1.2	1.8	2.8	3.2	4.4
Klebsiella pneumonia	1.8	2.3	3.2	4.2	4.5
Staphylococcus aureus	2	3.6	4.7	5.2	5.4
Enterococcus faecalis	1.7	2.2	3.5	3.3	3.3

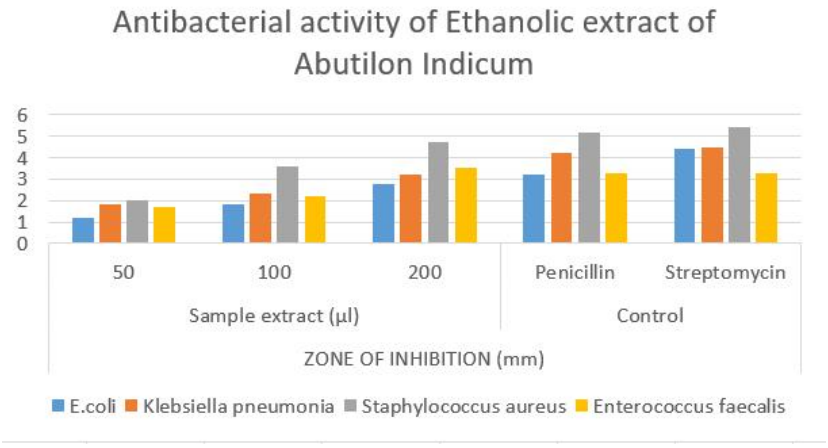

Fig: 1 Antibacterial activity of ethanolic leaves extract of *A. indicum*.

Table -4: Antibacterial activity of aqueous extract of A. indicum. Average value = Mean ± standard

Name of the microorganism	ZONE OF INHIBITION (mm)				
	Sample extract (µl)			Control	
	50	100	200	Penicillin	Streptomycin
E.coli	1.6	1.8	2.1	2.4	2.5
Klebsiella pneumonia	2	2.2	2.5	2.6	2.5
Staphylococcus aureus	2.2	2.4	2.5	2.8	2.9
Enterococcus faecalis	1.5	2.2	2.3	2.5	2.6

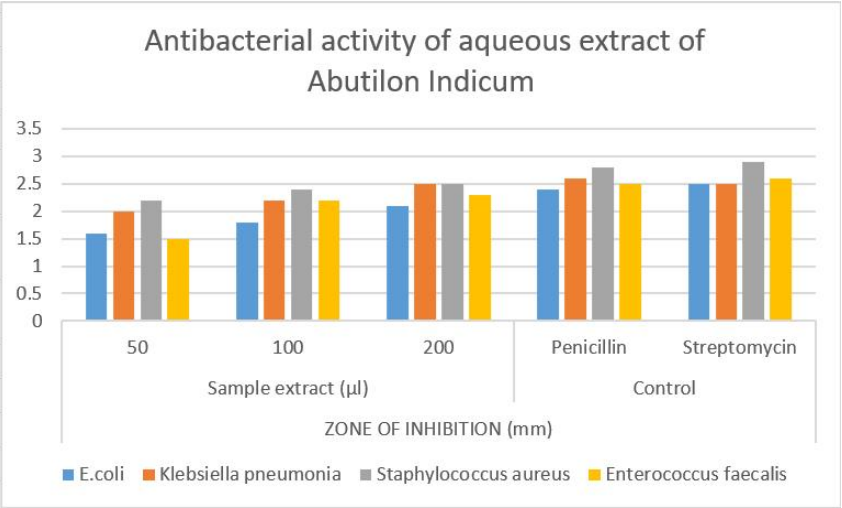

Fig: 2 Antibacterial activities of aqueous leaves extract of *A. indicum*.

Based on **Tables 3 and 4,** the *A.indicum* leaf extracts showed notable microbicidal efficacy against all tested pathogenic strains, with a range of inhibition zone widths between 1.5 to 10.0 mm. The microbicidal activity was lowest against E. coli and Enterococcus faecalis, while it was highest against Klebsiella pneumoniae and Staphylococcus aureus. From Tables 3 and 4, it is anticipated that these findings will prompt further research into *A.indicum* and its potential development into antibacterial medications.

3.4 Evaluation of scavenging activity:

3.4.1 Determination of Antioxidant Activity Using the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) Radical Scavenging Method

DPPH is a stable free radical found in both aqueous and ethanol solutions. It becomes a stable diamagnetic molecule by accepting either a hydrogen or an electron radical. To enhance the antioxidant activity, DPPH is a common substrate used in experiments.

The antioxidant capacity of *A.indicum's* ethanolic leaf extract was evaluated using a DPPH radical scavenging assay, with results presented in **Table 5 and Figure 1**. The administration of varying doses of the aqueous and ethanolic leaf extracts revealed a significant ability to effectively neutralize DPPH free radicals. At concentrations ranging from 50-250 µg, the ethanolic leaf extract of *A.indicum* showed a marked reduction in DPPH radicals.

The highest dosage (250 mg) of the ethanolic leaf extract indicated a significant decrease in DPPH radical levels, as evidenced by absorbance measurements at 517 nm, confirming the extract's free radical scavenging capability. These findings affirm the antioxidant activity of the ethanolic leaf extract of *A.indicum* as a free radical scavenger, although its scavenging effect was less than that of standard vitamin C.

Table 5: DPPH antioxidant assay of ethanolic leaves extract of *A.indicum* (Average value = Mean ± standard)

Percentage of radical scavenging activity		
concentration of sample (µg /ml)	**control: Vitamin c**	**Ethanolic leaves extract of *A.indicum***
250	64.91±0.84	59.58±1.20
200	55.71±0.54	51.38±1.10
150	45.10±0.49	42.77±0.89
100	37.06±1.69	34.73±0.82
50	25.25±0.90	23.92±0.69

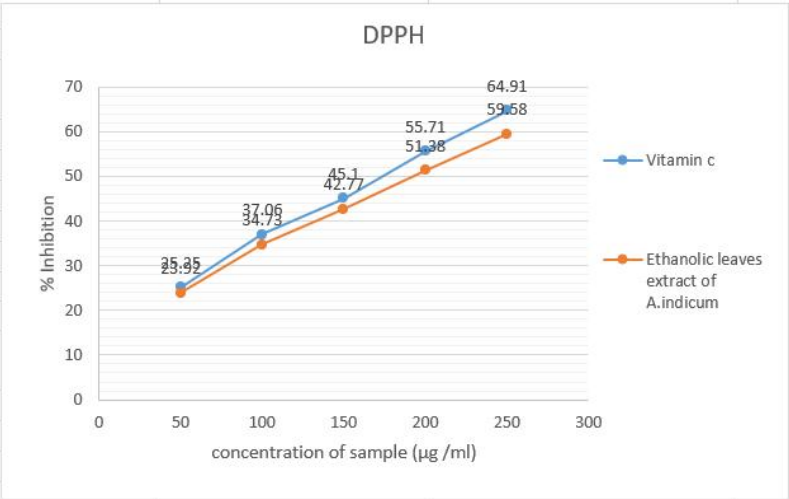

Figure 3: DPPH activity of ethanolic leaves extract of *A.indicum*

Tables 5 and Figure 3, showed that the ethanolic extract was able to neutralize the DPPH free radicals by 59.58%, 51.38%, 42.77%, 34.73%, and 23.92% at concentrations 250,200,150,100,50 µg/ml, and the control Ascorbic acid was able to do so by hydrogen donating activity by 64.91%, 55.71%, 45.10%, 37.06% and 25.25% at dosages of 250,200,150,100,50 µg/ml. Ethanolic extracts and control Ascorbic acid have their highest scavenging efficacy at doses of 250 µg/ml respectively, as shown in Figures 3 . In contrast to ascorbic acid, which served as the study's positive antioxidant control, it was demonstrated that DPPH scavenging increased in a concentration dependent way.

3.4.2 Determination of Antioxidant Activity Using the ABTS Free Radical Scavenging Method

The effectiveness of the ethanolic extract from the leaves of A. indicum in scavenging ABTS radicals was assessed, with the findings shown in table 6 and figure 4. The various concentrations of the ethanolic leaf extract of A. indicum demonstrated a significant ability to scavenge ABTS radicals efficiently. The ethanolic leaf extract of A. indicum at different doses ranging from 50 to 250 µg showed a notable decrease in the absorbance of the ABTS radical at 734 nm in a dose-dependent manner [17].

Table 6: ABTS antioxidant assay of ethanolic extract *of A.indicum*
(Average value = Mean ± standard)

Percentage of radical scavenging activity		
concentration of sample (µg /ml)	**control: Vitamin c**	**Ethanolic leaves extract of *A.indicum***
250	63.64±0.96	57.61 ±0.83
200	52.94±0.88	47.3±1.28
150	41.45±1.06	40.15±1.51
100	35.01±0.73	33.81±0.60
50	31.98±1.65	30.24±2.06

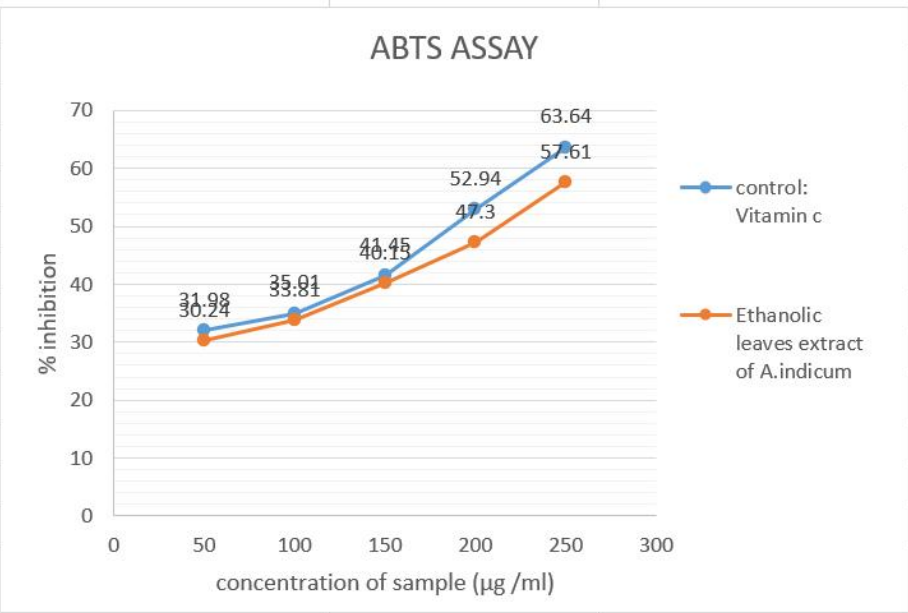

Figure 4: ABTS antioxidant assay of ethanolic extract *of A.indicum*

Tables 6 and Figure 4 showed that the ethanolic extract was able to neutralize the free radical activity by 57.61%, 47.3%, 40.15%, 33.81%, and 30.24% at concentrations of 250,200,150,100,50 µg/ml and compared with control Ascorbic acid. The ethanolic extracts have their highest scavenging efficacy at doses of 250 mg/ml, as shown in Figures 4. In order to neutralize the dangerous radical and shield cells from oxidative stress, The higher dosage (250 µg) of the ethanolic leaves extract showed a notable ability to scavenge ABTS radicals, hence indicating the in vitro free radical scavenging capability of it [14].

3.5 Identify biocomponents from leaves of *A. indicum* by GC-MS analysis:

Gas Chromatography-Mass Spectrometry (GC-MS) plays a key role in the analysis of unknown components of plant origin. The chemical composition of ethanolic extracts of leaves of *A. indicum* were subjected to GC-MS. A total of 13 compounds has been identified via GC-MS analysis considering retention time, molecular formula, molecular weight, and peak area. Table 7 displays the active compounds along with their molecular formula, molecular weight (MW), concentration (peak area %), and their biological applications. The main compounds found in the leaves included 2-Cyclopenten-1-one, N,N-Dimethylglycine, Butanedioic acid, monomethyl ester, Oxirane, hexyl-, 1,2-Benzenediol, O-(2-methoxyethoxycarbonyl)-O'-(cyclopropylcarbonyl)-, 4-Vinylphenol, 2-Methoxy-4-vinylphenol, Cyclohexasiloxane, dodecamethyl-, 4H-1,2,4-Triazol-4-amine, 2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-, 4-Methoxybenzoic acid, 3-fluorophenyl ester, 1,2-Benzisothiazol-3(2H)-one, 2-methyl-, 1,1-dioxide, .gamma.-Elemene. The active substances found in the Ethanolic leaves extract of A. indicum through GC-MS analysis are displayed in Table 7 and Figure 5.

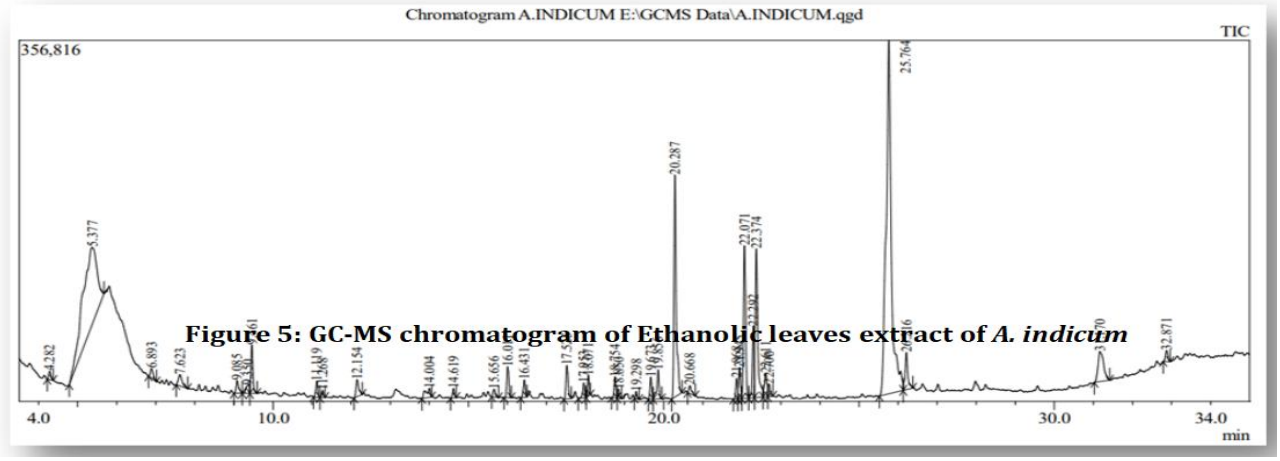

Figure 5: GC-MS chromatogram of Ethanolic leaves extract of *A. indicum*

Table 7: Identification of phytocomponents in ethanolic extract *of A.indicum* by GC-MS analysis:

Peak	Retention Time	Area %	Name of the compound	Molecular formula	Molecular Weight (g/mol)	Nature of the compound	Pharmacological activity
1	4.282	0.31	2-Cyclopenten-1-one, 2-hydroxy-	$C_5H_6O_2$	98.1	Enol and ketone	antiviral and cytoprotective effects [18]
2	5.377	20.3	N,N-Dimethylglycine	$C_4H_9NO_2$	103.12	Glycine derivative	anti-inflammatory, antioxidant, and immunomodulatory effect [19]
4	7.623	0.74	Butanedioic acid, monomethyl ester	$C_5H_8O_4$	132.11	free carboxylic acid group and a methyl ester group	No reported activity
5	9.085	0.6	Oxirane, hexyl-	$C_8H_{16}O$	128.21	epoxides	No reported activity
6	9.35	0.56	1,2-Benzenediol, O-(2-methoxyethoxycarbonyl)-O'-(cyclopropylcarbonyl)-	$C_{15}H_{16}O_6$	292.28	synthetic organic compound	No reported activity
7	9.461	1.71	4-Vinylphenol	C_8H_8O	120.15	phenolic styrene	Antioxidant, anti-angiogenic and Anti-cancer activity [20]
8	11.119	0.53	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	150.17	aromaticphenolic compound	anti-inflammatory, anti-cancer, antimicrobial [21]
9	11.268	0.23	Cyclohexasiloxane, dodecamethyl-	$C_{12}H_{36}O_6Si_6$	444.92	organosilicon compound	No reported activity
10	12.154	0.82	4H-1,2,4-Triazol-4-amine	$C_2H_4N_4$	84.08	heterocyclic organic compound	No reported activity
12	14.619	0.31	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-	$C_{11}H_{16}O_2$		lactone or cyclic ester	antifungal, antibacterial, and anticancer activities [22]
13	15.656	0.3	4-Methoxybenzoic acid, 3-fluorophenyl ester	$C_8H_7FO_3$	264.2	ester	No reported activity
14	16.011	1.04	1,2-Benzisothiazol-3(2H)-one, 2-methyl-, 1,1-dioxide	$C_8H_7NO_3S$	197.211	Organic heterobicyclic compound	Antibacterial, antifungal, antiviral, analgesic [23]
15	16.431	0.58	.gamma.-Elemene	$C_{15}H$	204.35	monocyclic sesquiterpene	Anti-inflammatory, antileishmanial activity, immunomodulation [24]

4. Conclusion

A. indicum is traditionally utilized in medicine for addressing conditions such as respiratory issues, urinary problems, inflammation, and digestive disorders. The phytochemical constituents such as alkaloids, flavonoids, phenols, tannins, saponins, glycosides, terpenoids, sugars, amino acids, and steroids present in *A. indicum* leaf extract are thought to possess antibacterial properties. *A. indicum* is known for its antibacterial capabilities and is traditionally employed to manage bacterial infections and treat wounds.

Due to the presence of phytochemicals like tannins and polyphenols, *A. indicum* might help protect the skin from free radical-induced damage and could potentially support anti-aging, showcasing its antioxidant activity. Numerous medicinal, antibacterial, and therapeutic attributes are linked to these phytochemical compounds. Products derived from pure and diverse phytochemical sources, such as the leaves of *A. indicum*, should be considered as alternatives to expensive medications that often have considerable side effects. Therefore, the leaves of *A. indicum* could be regarded as a promising candidate for drug development due to their significant medicinal potential. Phytoconstituents like alkaloids, flavonoids, saponins, and glycosides have been noted for their variety of biological effects, including anticancer, anti-inflammatory, and antimicrobial properties. Phenolic compounds, commonly found in both edible and non-edible plants, are acknowledged for their diverse biological effects, such as their antioxidant activity and promotion of health benefits. The findings from this study could enhance the understanding of the various medicinal properties of *A. indicum* leaves. This research implies that the ethanolic extract serves as a potent therapeutic agent. With these insights, it appears that the leaves of *A. indicum* represent a prudent choice regarding human health. Further investigations are required to isolate and identify these bioactive compounds.

Acknowledgement: Nil

Funding: No funding was received for the conduct of this research

References

1. Perumal samy, R., Ignacimuthu, S., 1998. Screening of 34 Indian Medicinal Plants for antibacterial properties. Journal of ethanopharmacology 62, 173-182.
2. Agidew, M.G. Phytochemical analysis of some selected traditional medicinal plants in Ethiopia. *Bull Natl Res Cent* 46, 87 (2022).
3. Sunil M, Vedavijaya T, Sree P K, Babu Sayana S. Phytochemical Analysis and Antioxidant Evaluation of the Ethanolic Extract of the Leaves of Abutilon indicum. Cureus. 2023 Oct 26;15(10) 47703.
4. Wu, Xingping, and Sugapriya Dhanasekaran. "Protective effect of leaf extract of Abutilon indicum on DNA damage and peripheral blood lymphocytes in combating the oxidative stress." *Saudi Pharmaceutical Journal* 28.8 (2020): 943-950.
5. Anokwuru CP, Esiaba I, Ajibaye O, Adesuyi AO. Polyphenolic content and antioxidant activity of Hibiscus sabdariffa calyx. Res J Med Plant. 2011; 5: 557–566.
6. Elshiekh, Y. H. & AbdElMoniem, M. A. Phytochemical, antibacterial screening and antioxidantactivity of *Pulicaria crispa* extracts. *Pharma. Innov.* **3**(12), 12–15 (2015).
7. M.A. Tremocoldi, P.L. Rosalen, M. Franchin, A.P. Massarioli, C. Denny, É.R. Daiuto, J.A.R. Paschoal, P.S. Melo, S.M.D. Alencar., Exploration of avocado by-products as natural sources of bioactive compounds. PLoS One, 13 (2018), Article e0192577
8. A. Al-Rifai, A. Aqel, T. Al-Warhi, S.M. Wabaidur, Z.A. Al-Othman, A.Y. Badjah-Hadj-Ahmed. Antibacterial, antioxidant activity of ethanolic plant extracts of some Convolvulus species and their DART-ToF-MS profiling. Evid. Based Complement. Altern. Med., 2017 (2017), pp. 1-9
9. B. Khameneh, M. Iranshahy, V. Soheili, B.S.F. Bazz az. Review on plant antimicrobials: a mechanistic viewpoint, Antimicrob. Resist. Infect. Control, 8 (2019), pp. 1-28
10. S.A. Ezekwe, P.C. Chikezie, GC–MS analysis of aqueous extract of unripe fruit of Carica papaya. J. Nutr. Food Sci., 7 (2017), pp. 1-5
11. Shah A. A, Rehman A. U, Kapoor S, Kaur H, Rohilla B, Bajpai A. B, Gupta A. GC-MS Analysis of Phytoactive Compounds, Antioxidant and Antibacterial Activity of Citrullus lanatus Seeds. Biomed Pharmacol J 2023;16(1).
12. Harborne JB: Phytochemical methods. Chapman and Hall Ltd, London, 1973: 49-188.
13. Merlin NJ, Parthasarathy V, Manavala R and Kumaravel S: Chemical investigation of aerial parts of Gmelina asiatica Linn by GC-MS. Pharm Res 2009; 1(3): 152-56.
14. Kadriye Nur Kasapoğlu, Abdurrahim Kocyigit, Vildan Betül Yenigun, Ezgi Balkan, Evren Demircan, Funda Karbancıoğlu-Güler and Beraat Özçelik; "*In Vitro* Antioxidant and Anticancer Activities of Some Local Plants from Bolu Province of Turkey
15. M baebe BO, Edeoga HO, Afolayan AJ. Phytochemical analysis and antioxidants activities of aqueous stem bark extract of Schotia latifolia Jacq. *Asian Pac J Trop Biomed.* 2012; 2(2):118–124.
16. Ramakumar, R. (2001). Costs and margins in coconut marketing: some evidence from Kerala. *Indian Journal of Agricultural Economics,* 56(4), 668-682.

17. A. Soni, S. Sosa, Phytochemical Analysis and Free Radical Scavenging Potential of Herbal and Medicinal Plant Extracts. *Journal of Pharmacognosy and photochemistry,* 2 (4), (2013) 22-29.
18. Rossi, A., Elia, G., & Santoro, M. G. (1996). 2-Cyclopenten-1-one, a new inducer of heat shock protein 70 with antiviral activity. *Journal of Biological Chemistry*, *271*(50), 32192-32196.
19. Lendvai, A., Béke, G., Hollósi, E., Becker, M., Völker, J. M., Schulze zur Wiesche, E., Bácsi, A., Bíró, T., & Mihály, J. (2023). N,N-Dimethylglycine Sodium Salt Exerts Marked Anti-Inflammatory Effects in Various Dermatitis Models and Activates Human Epidermal Keratinocytes by Increasing Proliferation, Migration, and Growth Factor Release. *International Journal of Molecular Sciences,* 24(14), 11264. https://doi.org/10.3390/ijms241411264
20. Yue, GL., Lee, JM., Kwok, HF. *et al.* Novel PI3K/AKT targeting anti-angiogenic activities of 4-vinylphenol, a new therapeutic potential of a well-known styrene metabolite. *Sci Rep* 5, 11149 (2015). https://doi.org/10.1038/srep11149
21. Asami, E., Kitami, M., Ida, T., Kobayashi, T., & Saeki, M. (2023). Anti-inflammatory activity of 2-methoxy-4-vinylphenol involves inhibition of lipopolysaccharide-induced inducible nitric oxidase synthase by heme oxygenase-1. *Immunopharmacology and Immunotoxicology*, *45*(5), 589–596. https://doi.org/10.1080/08923973.2023.2197141
22. Bhuvaneswari, L., Rajesh, P., Dhanalakshmi, E., Muzammil, P., Kandan, P., Alodhayb, A. N., ... & Raja, M. (2025). Synthesis, GC-MS, spectroscopic, chemical absorption nature in various solvent, chemical reactivity, topology analyses and molecular docking evaluation of 2 (4H)-Benzofuranone, 5, 6, 7, 7a-tetrahydro-4, 4, 7a-trimethyl-,(R): A first principle study. *Journal of the Indian Chemical Society*, *102*(1), 101518.
23. Abbas, G., Asim, S., Bhatti, H. N., Mansha, A., Zahid, M., Ahmad, M., & Haider, R. (2019). Spectroscopic studies of interactions of 2-(2-Oxo-2-Phenylethyl)-1, 2-benzisothiazol-3 (2H)-one-1, 1-dioxide with human DNA. *Journal of Molecular Structure*, *1196*, 403-408.
24. de Lima Nunes, T. A., Costa, L. H., De Sousa, J. M. S., De Souza, V. M. R., Rodrigues, R. R. L., Val, M. D. C. A., ... & da Franca Rodrigues, K. A. (2021). Eugenia piauhiensis Vellaff. essential oil and γ-elemene its major constituent exhibit antileishmanial activity, promoting cell membrane damage and in vitro immunomodulation. *Chemico-Biological Interactions*, *339*, 109429.