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UV–VISIBLE SPECTROSCOPY AND GC–MS PROFILING OF THE HYDROALCOHOLIC EXTRACT OF ABUTILON INDICUM (L.)

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ABSTRACT

Background: *Abutilon indicum* (L.) is a medicinal plant widely used in traditional systems of medicine for the treatment of inflammatory, infectious, and metabolic disorders. The therapeutic potential of the plant is mainly attributed to its diverse phytochemical constituents. The present study was undertaken to investigate the phytochemical profile of the hydroalcoholic extract of *Abutilon indicum* using UV–Visible spectroscopy and Gas Chromatography–Mass Spectrometry (GC–MS) techniques. **Methods:** The whole plant material was shade dried, powdered, and extracted using a hydroalcoholic solvent system. Preliminary characterization was performed by UV–Visible spectroscopy in the wavelength range of 200–800 nm to identify characteristic absorption bands associated with major phytochemical classes. Further phytochemical profiling was carried out using GC–MS analysis for the identification of bioactive constituents based on retention time and mass spectral data. **Results:** UV–Visible spectral analysis revealed prominent absorption maxima at 225–235 nm, 265–280 nm, and 320–340 nm, indicating the presence of phenolic acids, flavonoids, tannins, coumarins, and related polyphenolic compounds. The hydroalcoholic extract exhibited higher absorbance compared to non-polar solvent extracts, suggesting superior extraction efficiency for biologically active constituents. GC–MS analysis identified several phytochemicals belonging to different chemical classes, including oxygenated compounds, aromatic hydrocarbons, phytosterols, and triterpenoids. Among the detected compounds, γ-sitosterol (86.81%), lupeol (76.74%), taraxasterol (2.55%), and α-sitosterol (4.55%) were recognized as major bioactive constituents. These compounds are reported to possess anti-inflammatory, antioxidant, antimicrobial, hypocholesterolemic, chemoprotective, and anticancer activities. The predominance of phytosterols and triterpenoids indicates the significant pharmacological potential of the plant extract. **Conclusion:** The findings demonstrate that the hydroalcoholic extract of *Abutilon indicum* is a rich source of biologically active phytochemicals. UV–Visible spectroscopy and GC–MS proved to be effective analytical tools for phytochemical characterization and compound identification. The study provides scientific evidence supporting the traditional medicinal use of *Abutilon indicum* and highlights its potential as a promising source of natural therapeutic agents for future pharmaceutical and nutraceutical applications.

KEYWORDS: *Abutilon indicum*; Hydroalcoholic extract; UV–Visible spectroscopy; GC–MS analysis; Phytochemical profiling.

1. INTRODUCTION

Medicinal plants continue to serve as an important source of therapeutic agents for the prevention and treatment of various diseases. According to the World Health Organization, a substantial proportion of the global population relies on traditional herbal medicines for primary healthcare needs. The growing interest in plant-derived products has encouraged extensive research on medicinal plants to identify bioactive constituents responsible for their pharmacological activities. Phytochemical characterization of medicinal plants is essential for validating their traditional uses, ensuring quality control, and supporting the development of novel phytopharmaceutical products.

Abutilon indicum (L.) Sweet, commonly known as Indian mallow and belonging to the family Malvaceae, is a widely distributed medicinal herb found throughout tropical and subtropical regions. The plant has been extensively utilized in Ayurvedic, Siddha, and traditional systems of medicine for the management of inflammation, fever, ulcers, diabetes, respiratory disorders, and urinary ailments. Different parts of the plant, including leaves, roots, seeds, and the whole herb, have been reported to possess diverse pharmacological properties such as anti-inflammatory, antimicrobial, antioxidant, analgesic, hepatoprotective, antidiabetic, and wound-healing activities. These biological effects are primarily attributed to the presence of various secondary metabolites including flavonoids, phenolic compounds, alkaloids, glycosides, sterols, and triterpenoids (Chandrashekhar et al., 2004; Giri et al., 2009).

The therapeutic potential of medicinal plants is largely dependent on their phytochemical composition. Therefore, comprehensive chemical profiling is necessary to understand the relationship between phytoconstituents and biological activities. Among the available extraction systems, hydroalcoholic solvents are widely preferred because they facilitate the extraction of both polar and moderately non-polar compounds. Such solvent systems enhance the recovery of phenolic compounds, flavonoids, and other bioactive metabolites that contribute significantly to the medicinal value of herbal preparations. Consequently, hydroalcoholic extraction has become a standard approach for phytochemical investigations and pharmacognostic studies.

Spectroscopic and chromatographic techniques play a vital role in the characterization of plant extracts. UV–Visible spectroscopy is a rapid, simple, and cost-effective analytical technique used for the preliminary identification of compounds containing chromophoric groups. The absorption patterns observed in the ultraviolet and visible regions provide valuable information regarding electronic transitions associated with phenolic acids, flavonoids, tannins, and other conjugated phytochemicals. This technique serves as an important screening tool for assessing the presence and distribution of major classes of secondary metabolites within plant extracts (Skoog et al., 2007; Pavia et al., 2015).

Gas chromatography–mass spectrometry (GC–MS) is one of the most powerful analytical platforms for phytochemical profiling. The technique combines the separation efficiency of gas chromatography with the structural identification capability of mass spectrometry, enabling accurate detection of volatile and semi-volatile compounds. GC–MS analysis provides detailed information regarding retention behavior, molecular weight, fragmentation patterns, and relative abundance of phytoconstituents. The generated chemical fingerprints are valuable for standardization, quality assessment, and discovery of biologically active molecules. Furthermore, GC–MS has become an indispensable tool for identifying phytosterols, terpenoids, fatty acids, and other pharmacologically important metabolites present in medicinal plants (Fernie et al., 2004).

In view of the extensive traditional use and therapeutic significance of Abutilon indicum, the present study was undertaken to perform spectroscopic and chromatographic characterization of its hydroalcoholic extract. UV–Visible spectroscopy was employed to investigate the presence of characteristic chromophoric phytochemicals, while GC–MS analysis was conducted to identify major bioactive constituents. The study aims to establish a comprehensive phytochemical profile that may support future pharmacological investigations and contribute to the development of standardized herbal formulations derived from Abutilon indicum.

2. EXPERIMENTAL METHODOLOGY

Procedure for UV–Visible Spectroscopic Analysis

1. The powdered plant material of *Abutilon indicum* was extracted separately using different solvents such as hydro-alcoholic solution, hexane, petroleum ether, and chloroform through suitable extraction technique (maceration/Soxhlet).
2. The obtained extracts were filtered and concentrated to remove excess solvent.
3. A small quantity of each dried extract was accurately weighed and dissolved in the respective solvent to prepare standard sample solutions.
4. The solutions were scanned using a UV–Visible spectrophotometer in the wavelength range of **200–800 nm** against the corresponding solvent blank.
5. Absorbance values were recorded, and spectra were plotted to identify the characteristic absorption maxima (λmax).
6. The spectral patterns were compared to evaluate the presence of phytoconstituents with chromophoric groups.

Preparation of Hydro-Alcoholic Whole Plant Extract

The whole plant of *Abutilon indicum* was collected, washed thoroughly to remove adhering dust, and shade dried to preserve thermolabile constituents. The dried material was coarsely powdered using a mechanical grinder. Approximately **10 g of powdered whole plant material** was extracted with a **hydro-alcoholic solvent (ethanol–water mixture)** using a Soxhlet apparatus for about **48 hours**, maintaining the temperature below the solvent's boiling point.

The obtained extract was filtered and concentrated to remove excess solvent, producing a clear sample suitable for GC–MS analysis.

3. RESULTS AND DISCUSSION

Interpretation of UV Spectra

Hydro-Alcoholic Extract

- The spectrum showed prominent absorption peaks in the **UV region (around 220–280 nm)** and moderate peaks near **300–350 nm**.
- These peaks indicate the presence of **phenolic compounds, flavonoids, and tannins**, which typically absorb due to π→π* transitions.
- Higher absorbance suggests that polar solvents extracted more phytochemicals.

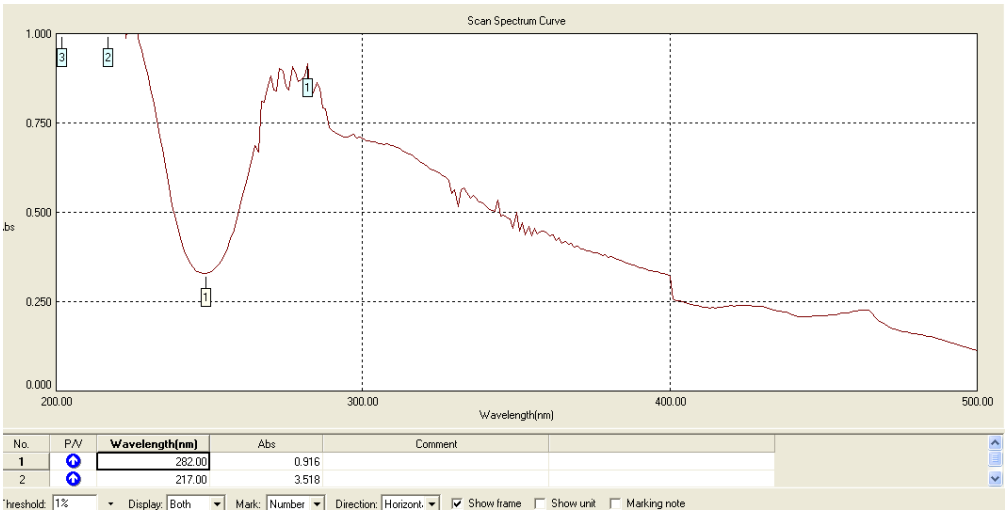

Fig. 1: UV spectrum of Hydro-Alcoholic Extract.

Hexane Extract

- The hexane extract displayed absorption mainly below **250 nm**, with relatively low intensity.
- This indicates the extraction of **non-polar constituents** such as lipids, terpenoids, and certain sterols.
- Limited peaks suggest fewer chromophoric compounds compared to polar extracts.

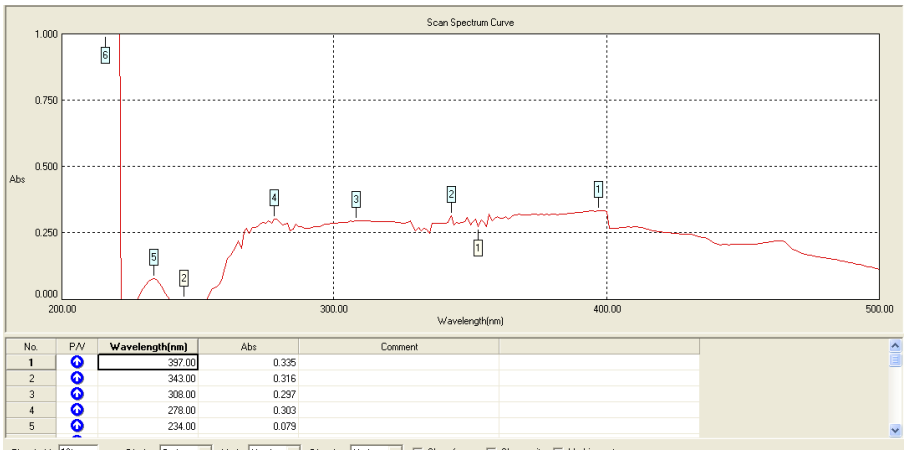

Fig.-2: UV spectrum of hexane Extract.

Petroleum Ether Extract

- The spectrum showed weak to moderate absorption bands in the lower UV region.
- This pattern confirms the presence of **fatty acids and hydrocarbons**, which generally lack strong conjugation.
- The extract contains fewer aromatic phytoconstituents.

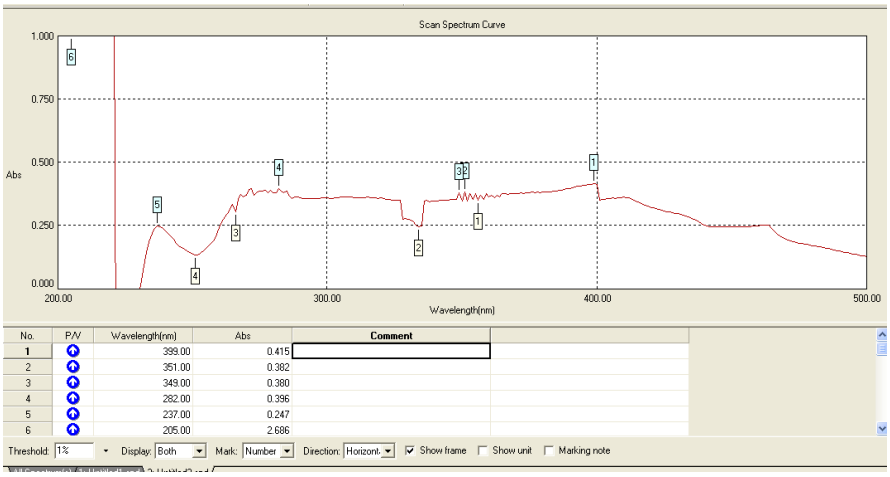

Fig. 3: UV spectrum of Petroleum Ether Extract.

Chloroform Extract

- Distinct peaks observed between **250–320 nm** indicate moderately polar compounds.
- These may correspond to **alkaloids, glycosides, and some flavonoid derivatives**.
- The absorbance intensity suggests better phytochemical solubility than non-polar solvents.

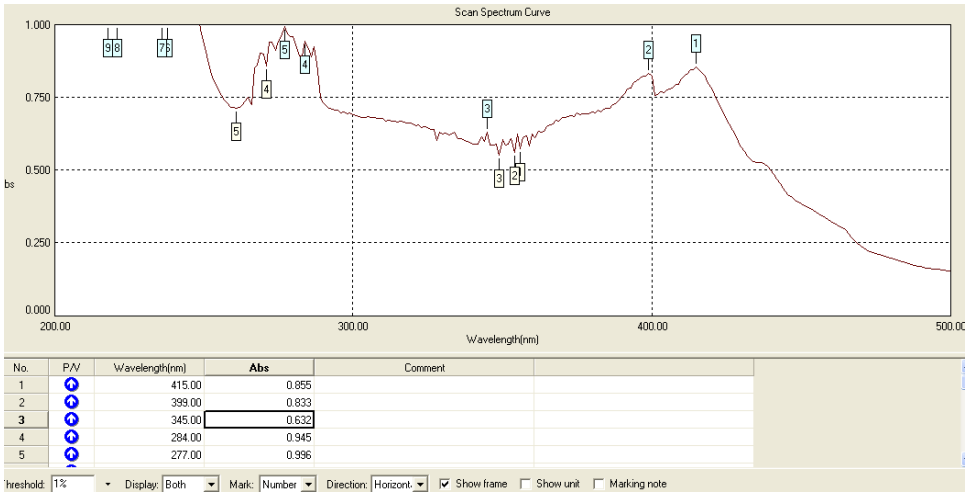

Fig. 4: UV spectrum of Chloroform Extract.

Overlay Spectrum

- The combined spectrum clearly demonstrates variation in absorbance among solvents.
- The **hydro-alcoholic extract showed the highest absorbance**, indicating maximum phytochemical extraction.
- Non-polar solvents exhibited comparatively lower spectral intensity.

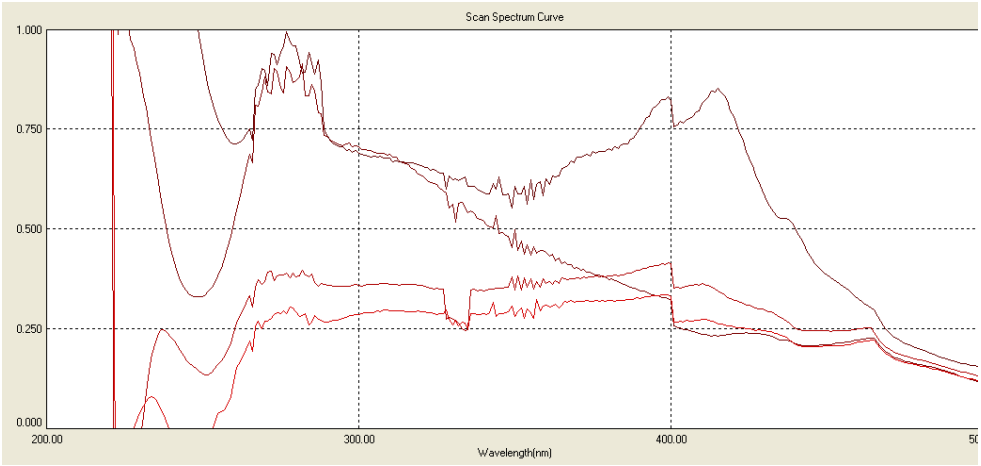

Fig.-5: UV Overlay Spectrum of all extracts.

Table 1: UV–Visible Spectral Interpretation of *Abutilon indicum* Extracts.

Extract	λmax (nm)	Type of Electronic Transition	Probable Phytoconstituents	Inference
Hydro-alcoholic	225–235	π → π*	Phenolic acids	Indicates aromatic rings with strong conjugation.
	265–280	π → π*	Flavonoids, tannins	Suggests presence of polyphenolic compounds with antioxidant potential.
	320–340	n → π*	Coumarins, flavone derivatives	Confirms highly conjugated systems extracted by polar solvent.
Hexane	205–215	σ → σ*	Alkanes, lipids	Represents saturated hydrocarbons with low chromophoric activity.
	230–245	n → σ*	Terpenoids, sterols	Indicates non-polar bioactive molecules.
Petroleum Ether	210–220	σ → σ*	Fatty acids	Typical absorption of long-chain hydrocarbons.
	240–255	n → π*	Unsaturated lipids	Shows slight conjugation in extracted compounds.
Chloroform	235–250	π → π*	Alkaloids	Suggests aromatic heterocyclic structures.
	270–290	n → π*	Glycosides, flavonoid derivatives	Indicates moderately polar phytochemicals.
	300–315	π → π*	Phenolic derivatives	Confirms presence of conjugated double-bond systems.

GC–MS Analysis of Hydro-Alcoholic Whole Plant Extract of *Abutilon indicum* for Identification of Bioactive Compounds

GC–MS Analysis

The prepared hydro-alcoholic extract was subjected to Gas Chromatography–Mass Spectrometry using a triple quadrupole GC–MS system equipped with a capillary column. A small volume of the extract was injected into the instrument. Helium served as the carrier gas, and the oven temperature was programmed from lower to higher temperatures to allow proper separation of phytoconstituents.

Compounds eluted at different retention times were detected by the mass spectrometer and identified by comparing their spectral patterns with standard library databases.

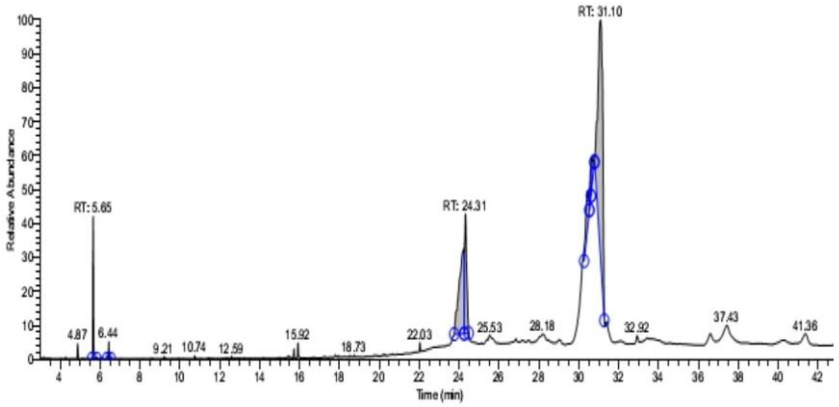

Fig. 6: GCMS chromatogram of Hydro-alcoholic extract of Abutilon indicum extract.

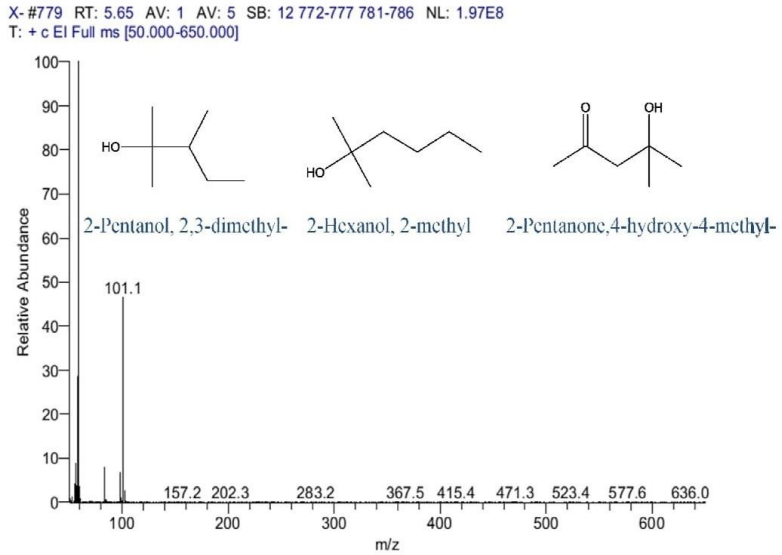

Fig. 7: Mass spectrum and structure of compounds identified at retention time 5.65.

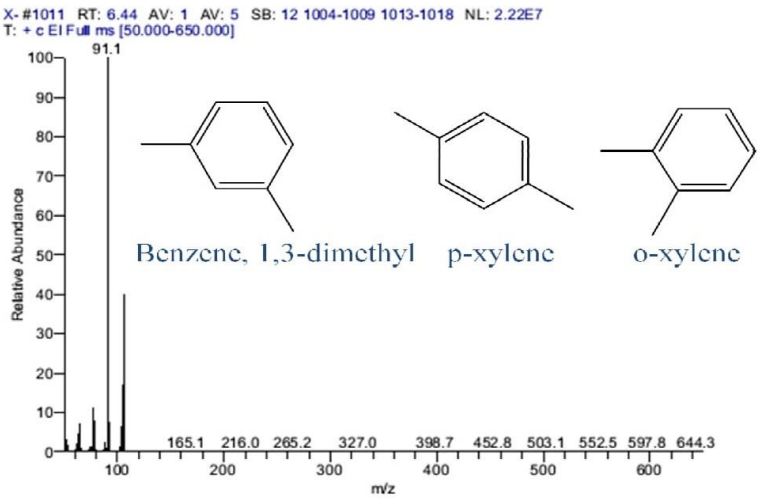

Fig. 8: Mass spectrum and structure of compounds identified at retention time 6.44.

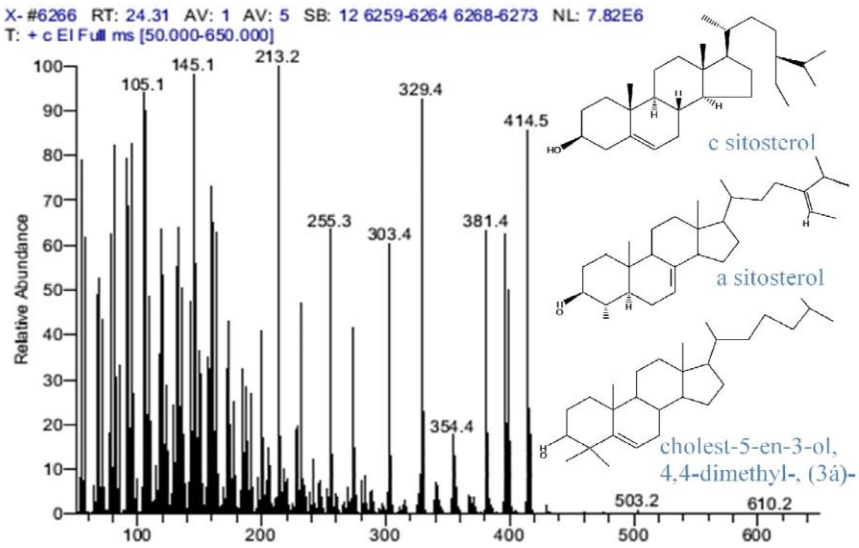

Fig. 9: Mass spectrum and structure of compounds identified at retention time 24.31.

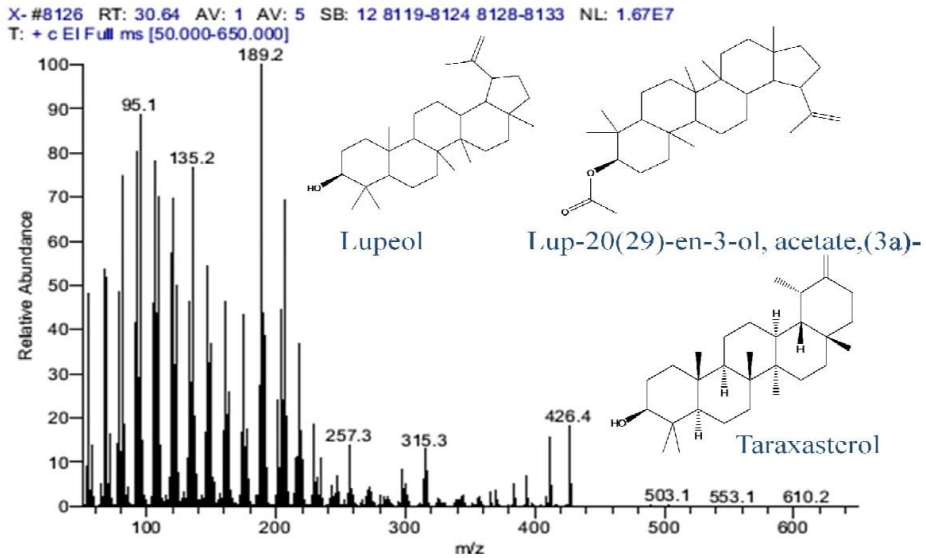

Fig. 10: Mass spectrum and structure of compounds identified at retention time 30.64.

Table 2: Interpretation Table of Identified Compounds.

S.No	Retention Time (min)	Compound	Molecular Formula	Molecular Weight	Probability (%)	Pharmacological Activity
1	5.65	2-Pentanone, 4-hydroxy-4-methyl	C6H12O2	116	70.72	Antimicrobial
2	5.65	2-Hexanol, 2-methyl	C7H16O	116	18.51	—
3	5.65	2-Pentanol, 2,3-dimethyl	C7H16O	116	3.59	—
4	6.44	m-Xylene	C8H10	106	34.35	—
5	6.44	p-Xylene	C8H10	106	23.57	Antioxidant, antimicrobial
6	6.44	o-Xylene	C8H10	106	19.91	Antifungal, antimicrobial
7	24.21	γ-Sitosterol	C29H50O	414	86.81	Hypocholesterolemic potential
8	24.21	α-Sitosterol	C29H50O	414	4.55	Anti-inflammatory, anticancer
9	24.21	Cholest-5-en-3-ol	C29H50O	386	0.97	Cardioprotective

		derivative				potential
10	30.41	Lupeol	C30H50O	426	76.74	Anti-inflammatory, antitumor
11	30.41	Lup-20(29)-en-3-ol acetate	C32H52O2	468	3.02	—
12	30.41	Cyclo-lanostane diol	C30H52O2	444	2.90	—
13	30.64	Taraxasterol	C30H50O	426	2.55	Anti-ulcer, chemoprotective

Interpretation of GCMS

GC–MS profiling of the hydro-alcoholic whole plant extract revealed the presence of multiple phytoconstituents belonging to different chemical classes such as **oxygenated compounds, aromatic hydrocarbons, phytosterols, and triterpenoids**.

Compounds detected at lower retention times represent volatile molecules with smaller molecular weights, whereas those appearing at higher retention times correspond to heavier sterols and triterpenes. Among the identified constituents, **γ-sitosterol and lupeol showed higher peak probabilities**, suggesting that they are major components of the extract.

The presence of sterols and triterpenoids indicates potential therapeutic properties including **anti-inflammatory, antimicrobial, antioxidant, and anticancer activities**. The hydro-alcoholic solvent likely enhanced extraction efficiency by dissolving both polar and moderately non-polar phytochemicals.

CONCLUSION

The present study successfully characterized the phytochemical profile of *Abutilon indicum* (L.) hydroalcoholic extract using UV–Visible spectroscopy and GC–MS analysis. UV–Visible spectral evaluation revealed characteristic absorption bands corresponding to phenolic compounds, flavonoids, tannins, and other conjugated phytochemicals. Among the solvent extracts examined, the hydroalcoholic extract exhibited the highest absorbance intensity, indicating superior extraction efficiency and enhanced recovery of bioactive constituents. These findings highlight the importance of solvent polarity in maximizing phytochemical extraction from medicinal plants.

GC–MS profiling further confirmed the presence of diverse secondary metabolites belonging to different chemical classes, including oxygenated compounds, phytosterols, and triterpenoids. Major constituents identified in the extract were γ-sitosterol, lupeol, α-sitosterol, and taraxasterol, which are widely recognized for their anti-inflammatory, antioxidant, antimicrobial, hypocholesterolemic, and chemoprotective properties. The predominance of phytosterols and triterpenoids suggests that *Abutilon indicum* possesses significant therapeutic potential and may serve as a valuable source of naturally occurring bioactive molecules.

The combined application of UV–Visible spectroscopy and GC–MS proved to be an effective approach for comprehensive phytochemical characterization and chemical fingerprinting of the plant extract. The results provide scientific support for the traditional medicinal use of *Abutilon indicum* and establish a foundation for its standardization and quality assessment. Further studies involving isolation, purification, and pharmacological evaluation of the identified compounds are warranted to explore their therapeutic efficacy and potential development into plant-based pharmaceutical formulations.

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