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Phytochemical Extraction & Analysis of Leaves, Roots, Flowers, Fruits and Arial Parts of Abutilon indicum (L.)

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Abstract
Abutilon indicum (L.), a medicinal plant widely used in traditional systems of medicine, is known for its diverse therapeutic applications. The present study aimed to perform phytochemical extraction and qualitative as well as quantitative analysis of leaves, roots, flowers, fruits, and aerial parts of *Abutilon indicum* using solvents of varying polarity. Dried and powdered plant materials were subjected to maceration, initially with a hydroalcoholic solvent system (water:ethanol, 1:1), followed by successive extraction using petroleum ether, chloroform, and n-hexane. The obtained extracts were evaluated for physical characteristics, percentage yield, and phytochemical composition. The hydroalcoholic extract exhibited the highest percentage yield and showed the presence of a wide range of phytoconstituents, including alkaloids, flavonoids, phenols, tannins, glycosides, saponins, carbohydrates, along with mild presence of steroids and terpenoids. In contrast, petroleum ether and n-hexane extracts mainly contained non-polar constituents such as steroids and terpenoids, while other phytochemicals were absent. The chloroform extract demonstrated moderate extraction efficiency, containing both polar and non-polar compounds in limited amounts. Quantitative estimation further confirmed higher levels of total alkaloids, flavonoids, and phenolic content in the hydroalcoholic extract compared to other solvent extracts. Overall, the study highlights the critical role of solvent polarity in phytochemical extraction and establishes hydroalcoholic maceration as an efficient method for obtaining a broad spectrum of bioactive constituents from *Abutilon indicum*. The findings provide a scientific basis for further chromatographic and spectroscopic characterization of the plant.

Keywords: *Abutilon indicum*, phytochemical extraction, hydroalcoholic extract, solvent polarity, medicinal plants

Introduction
Medicinal plants have long served as an essential source of therapeutic agents, contributing significantly to traditional and modern healthcare systems. A large proportion of the global population still relies on plant-based medicines due to their accessibility, affordability, and perceived safety. The therapeutic potential of medicinal plants is mainly attributed to the presence of diverse phytochemicals such as alkaloids, flavonoids, phenolic compounds, tannins, saponins, glycosides, terpenoids, and steroids. Systematic extraction and phytochemical analysis of medicinal plants are therefore important steps in validating traditional claims and identifying bioactive constituents that may serve as leads for drug development.

Abutilon indicum (L.), belonging to the family Malvaceae, is a well-known medicinal plant widely distributed in tropical and subtropical regions, including India. It is commonly referred to as Indian mallow and has been extensively used in traditional systems of medicine such as Ayurveda, Siddha, and Unani. Different parts of the plant, including leaves, roots, flowers, fruits, and aerial parts, have been traditionally employed for the management of various ailments such as inflammation, pain, fever, respiratory disorders, gastrointestinal disturbances, diabetes, and skin diseases. The plant is also valued for its demulcent, expectorant, diuretic, and anti-inflammatory properties.

Previous pharmacognostic and phytochemical investigations have reported that *Abutilon indicum* contains a wide range of secondary metabolites, including flavonoids, phenols,

alkaloids, tannins, saponins, steroids, and terpenoids. These compounds are known to exhibit significant biological activities such as antioxidant, antimicrobial, anti-inflammatory, analgesic, hepatoprotective, and antidiabetic effects. However, the qualitative and quantitative distribution of these phytochemicals varies considerably depending on the plant part used, solvent system employed, and extraction technique applied. Therefore, a comparative evaluation of different plant parts using suitable extraction methods is essential to understand their phytochemical diversity and therapeutic relevance.

Extraction is a critical step in phytochemical studies, as it determines the efficiency and selectivity of bioactive compound recovery. Among various extraction techniques, maceration remains one of the simplest and most widely used methods due to its cost-effectiveness, minimal equipment requirement, and suitability for heat-sensitive compounds. The choice of solvent plays a crucial role in the extraction process, as solvent polarity directly influences the solubility of phytochemicals. Hydroalcoholic solvents are particularly effective in extracting a broad range of polar and moderately polar compounds, whereas non-polar solvents such as petroleum ether and n-hexane are useful for isolating lipophilic constituents like steroids and terpenoids.

Although several studies have focused on individual parts of *Abutilon indicum*, limited reports are available that systematically compare the phytochemical profiles of leaves, roots, flowers, fruits, and aerial parts using multiple solvent systems. Such comparative studies are important for identifying the most pharmaceutically valuable plant parts and optimizing extraction strategies for future pharmacological and analytical investigations. Moreover, preliminary phytochemical screening provides essential baseline information that supports further advanced spectroscopic and chromatographic analyses.

In this context, the present study aims to perform phytochemical extraction and preliminary phytochemical analysis of leaves, roots, flowers, fruits, and aerial parts of *Abutilon indicum* using hydroalcoholic and selected organic solvents by the maceration method. The study is designed to evaluate the influence of solvent polarity and plant part variation on phytochemical composition, thereby contributing to the scientific validation of *Abutilon indicum* as a valuable medicinal plant and providing a foundation for further phytochemical characterization and bioactivity-guided studies.

Fig 1: Abutilon Indicum

2. Materials and Methods

2.1 Collection and Authentication of Plant Material

Fresh plant material of *Abutilon indicum* (L.) was collected from a cultivated area associated with an agricultural university. The collected plant included leaves, roots, flowers, fruits, and aerial parts. The plant specimen was authenticated by a qualified taxonomist from the Department of Botany, Osmania University, Hyderabad. A voucher specimen was prepared and preserved for future reference.

2.2 Preparation of Plant Material

The collected plant parts were thoroughly washed with running tap water to remove adhering soil and impurities. The materials were then shade-dried at room temperature to prevent degradation of thermolabile constituents. After complete drying, each plant part was separately powdered using a mechanical grinder. The powders were sieved to obtain uniform particle size and stored in airtight containers until extraction.

Fig 2: Shade-dried Abutilon Indicum plant material

2.3 Extraction Procedure

2.3.1 Hydroalcoholic Extraction

A weighed quantity of the powdered plant material was subjected to maceration using a hydroalcoholic solvent system (water: ethanol, 1:1 v/v). The powder was soaked in the solvent for 72 hours with occasional shaking to facilitate effective extraction. After maceration, the mixture was filtered first through muslin cloth and then through Whatman No.1 filter paper. The filtrate was concentrated on a water bath to obtain the hydroalcoholic extract.

2.3.2 Successive Solvent Extraction

The residue (marc) remaining after hydroalcoholic extraction was subjected to successive maceration using solvents of increasing non-polarity. Petroleum ether extraction was performed first by soaking the marc for 48 hours, followed by filtration and concentration. The same marc was then extracted sequentially with chloroform and n-hexane using similar maceration conditions. Each extract was concentrated separately and stored in labeled containers for further analysis.

2.4 Storage of Extracts

All obtained extracts, including hydroalcoholic, petroleum ether, chloroform, and n-hexane extracts, were transferred into clean, labeled glass vials and stored under refrigerated conditions until further use.

2.5 Preliminary Phytochemical Screening

Each extract was subjected to standard qualitative phytochemical tests to detect the presence of major classes of phytoconstituents. Alkaloids were identified using Mayer's and Dragendorff's tests, flavonoids using the lead acetate test, tannins and phenols using ferric chloride test, saponins by foam test, glycosides by Bornträger's test, steroids by Liebermann–Burchard test, and carbohydrates by Fehling's and Benedict's tests. The presence or absence of phytochemicals was recorded based on characteristic color changes or precipitate formation.

Table 1: Qualitative Phytochemical Analysis – Test Procedures

S. No.	Test Name	Procedure
1	Test for Alkaloids (Mayer's Test)	About 2 mL of the extract was treated with a few drops of Mayer's reagent. Formation of a cream or white precipitate indicated the presence of alkaloids.
2	Test for Alkaloids (Dragendorff's Test)	To 2 mL of the extract, a few drops of Dragendorff's reagent were added. Appearance of an orange or reddish-brown precipitate confirmed alkaloids.
3	Test for Flavonoids (Lead Acetate Test)	The extract was treated with a few drops of lead acetate solution. Formation of a yellow precipitate indicated the presence of flavonoids.
4	Test for Tannins	To the extract, a few drops of 5% ferric chloride solution were added. Appearance of a blue-black or green coloration indicated tannins.
5	Test for Phenols	The extract was treated with ferric chloride solution. Formation of deep blue or green coloration confirmed the presence of phenolic compounds.
6	Test for Saponins (Foam Test)	About 1 mL of extract was diluted with distilled water and shaken vigorously. Formation of persistent foam indicated the presence of saponins.
7	Test for Glycosides (Bornträger's Test)	The extract was hydrolyzed with dilute acid, cooled, and extracted with chloroform. The chloroform layer was treated with ammonia solution. Appearance of pink or red color indicated glycosides.
8	Test for Steroids (Liebermann–Burchard Test)	The extract was treated with acetic anhydride followed by concentrated sulfuric acid along the side of the test tube. Formation of a green or blue color indicated steroids.
9	Test for Terpenoids (Salkowski Test)	The extract was mixed with chloroform and concentrated sulfuric acid was carefully added. Formation of a reddish-brown interface indicated terpenoids.
10	Test for Carbohydrates (Fehling's Test)	Equal volumes of Fehling's A and B solutions were added to the extract and heated. Formation of a brick-red precipitate indicated carbohydrates.
11	Test for Carbohydrates (Benedict's Test)	The extract was treated with Benedict's reagent and heated. Appearance of green, yellow, or red precipitate confirmed reducing sugars.

2.6 Quantitative Estimation of Phytochemicals

Quantitative estimation of selected phytochemical constituents was carried out for the different solvent extracts of *Abutilon indicum* (L.) leaves, roots, flowers, fruits, and aerial parts using standard analytical procedures. The estimations focused on major bioactive groups, namely alkaloids, flavonoids, and total phenolic content. All analyses were performed in triplicate, and the results were expressed as mean values.

2.6.1 Determination of Total Alkaloids

The total alkaloid content was determined using the acid–base extraction method. Accurately weighed dried plant extract (1 g) was dispersed in 40 mL of 10% acetic acid in ethanol. The mixture was allowed to stand for 4 hours with intermittent shaking to ensure complete extraction. The solution was then filtered, and the filtrate was concentrated to one-quarter of its original volume on a water bath. Concentrated ammonium hydroxide solution was added dropwise until complete precipitation of alkaloids occurred. The precipitate was allowed to settle, collected by filtration, washed with dilute ammonium hydroxide, dried to constant weight, and weighed. The total alkaloid content was calculated and expressed as percentage (% w/w) of the dried extract.

2.6.2 Determination of Total Flavonoids

Total flavonoid content was estimated using the aluminum chloride colorimetric method. A known volume of extract solution was mixed with distilled water followed by the addition of sodium nitrite solution. After 5 minutes, aluminum chloride solution was added, and the mixture was allowed to stand for another 6 minutes. Sodium hydroxide solution was then added to develop the color, and the final volume was adjusted with distilled water. The absorbance was measured at 510 nm using a UV–Visible spectrophotometer. Total flavonoid content was calculated using a quercetin standard calibration curve and expressed as milligrams of quercetin equivalents per gram of extract (mg QE/g).

2.6.3 Determination of Total Phenolic Content

The total phenolic content was determined using the Folin–Ciocalteu method. A measured volume of plant extract was mixed with Folin–Ciocalteu reagent and allowed to react for 5 minutes. Sodium carbonate solution was then added, and the mixture was incubated at room temperature for 30 minutes for color development. The absorbance was measured at 765 nm using a UV–Visible spectrophotometer. Gallic acid was used as the reference standard, and total phenolic content was expressed as milligrams of gallic acid equivalents per gram of extract (mg GAE/g).

2.7 Data Analysis

The results of the phytochemical screening were tabulated and compared across different extracts to assess the influence of solvent polarity and plant part variation on phytochemical composition. The observations provided a qualitative understanding of the phytochemical diversity present in *Abutilon indicum*.

3. Results and Discussion

The physical characteristics and percentage yield of different solvent extracts of *Abutilon indicum* are summarized in Table 2. The hydroalcoholic extract was dark brown in color, thick, and semi-solid with an aromatic odor, and it showed the highest yield (8–10%). Petroleum ether and n-hexane extracts were yellowish to pale yellow, oily in nature, and produced very low yields (1–2% and 1%, respectively). The chloroform extract appeared light green, sticky, and showed a moderate yield (2–3%). These variations indicate that solvent polarity significantly influences extractive yield and physical properties.

Table 2: Physical Characteristics of Different Extracts of *Abutilon indicum* (L.)

Extract	Colour	Consistency	Odour	% Yield (Approx.)
Hydroalcoholic	Dark brown	Thick, semi-solid	Aromatic	8–10%
Petroleum Ether	Yellowish	Oily	Mild aromatic	1–2%
Chloroform	Light green	Sticky	Characteristic	2–3%
n-Hexane	Pale yellow	Oily	Mild	1%

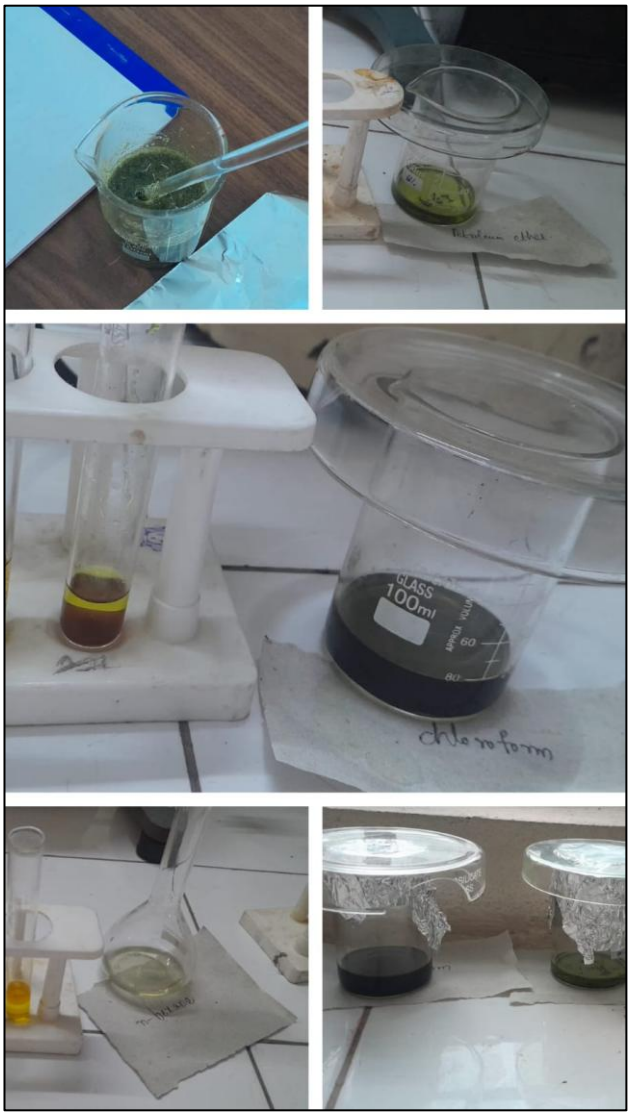

Fig 3: Extracts of *Abutilon indicum* (L.)

Preliminary phytochemical screening results are presented in Table 3. The hydroalcoholic extract showed the presence of alkaloids, flavonoids, tannins, saponins, glycosides, phenols, carbohydrates, along with mild presence of steroids and terpenoids. This confirms that polar solvents are capable of extracting a broad range of phytochemical classes. Petroleum ether and n-hexane extracts showed the presence of steroids and terpenoids, while other phytoconstituents were absent, indicating selective extraction of non-polar compounds. The chloroform extract showed limited presence of alkaloids, flavonoids, glycosides, steroids, and terpenoids, reflecting its semi-polar extraction behavior.

Table 3. Preliminary Phytochemical Screening (Qualitative) of Extracts

Phytochemical Test	Hydroalcoholic Extract	Petroleum Ether Extract	Chloroform Extract	n-Hexane Extract
Alkaloids	+	–	+	–
Flavonoids	+	–	+	–
Tannins	+	–	–	–
Saponins	+	–	–	–
Glycosides	+	–	+	–
Phenols	+	–	–	–
Steroids	+	+	+	+
Terpenoids	+	+	+	+
Carbohydrates	+	–	–	–

Key: (+) Present, (–) Absent

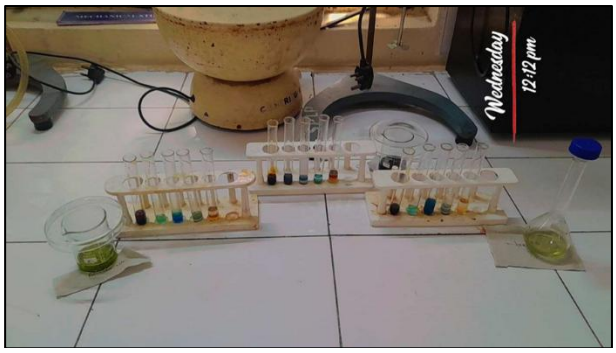

Fig 4: Phytochemical Screening (Qualitative) of Extracts

The efficiency of different solvents based on polarity is summarized in Table 4. The hydroalcoholic extract, being polar, showed high efficiency in extracting major phytochemicals such as flavonoids, tannins, phenols, glycosides, and carbohydrates. Petroleum ether and n-hexane, both non-polar solvents, exhibited moderate to low efficiency and mainly extracted lipophilic compounds like steroids and terpenoids. Chloroform, a semi-polar solvent, showed moderate efficiency by extracting both polar and non-polar constituents in limited amounts.

Table 4: Solvent Polarity and Extraction Efficiency

Extract Type	Polarity Nature	Major Phytochemicals Extracted	Efficiency Level
Hydroalcoholic	Polar	Flavonoids, tannins, phenols, glycosides, carbohydrates	High
Petroleum Ether	Non-polar	Steroids, terpenoids	Moderate
Chloroform	Semi-polar	Steroids, terpenoids, few alkaloids/flavonoids	Moderate
n-Hexane	Non-polar	Steroids, terpenoids	Low–Moderate

Table 5: Solvent Efficiency Based on Phytochemical Diversity

Extract Type	Polarity Nature	Major Phytochemicals Extracted	Efficiency Level
Hydroalcoholic	Polar	Flavonoids, tannins, phenols, glycosides, carbohydrates	High
Petroleum Ether	Non-polar	Steroids, terpenoids	Moderate
Chloroform	Semi-polar	Steroids, terpenoids, few alkaloids/flavonoids	Moderate
n-Hexane	Non-polar	Steroids, terpenoids	Low–Moderate

Overall, the results clearly demonstrate that the nature of the solvent plays a crucial role in determining the phytochemical profile and extraction efficiency of *Abutilon indicum*. Among all solvents used, the hydroalcoholic system proved to be the most effective for obtaining a wide spectrum of phytochemicals, while non-polar solvents selectively extracted lipophilic constituents.

Conclusion

The present study confirms that solvent polarity significantly influences the extraction of phytochemicals from *Abutilon indicum* (L.). Among the solvents used, the hydroalcoholic system proved most effective, yielding the highest extractive value and a broad range of phytoconstituents, including flavonoids, phenols, tannins, glycosides, and carbohydrates. Non-polar solvents mainly extracted lipophilic compounds such as steroids and terpenoids. These findings support hydroalcoholic extraction as a suitable method for comprehensive phytochemical profiling of *Abutilon indicum*.

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