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Micromorphological Insights into Leaf Architecture of *Abutilon indicum*

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Abstract: ***The Malvaceae family, commonly known as the mallow family, encompasses a diverse group of plants with significant importance due to their food crops and their medicinal and economic value. Among its members, Abutilon indicum, also known as Indian mallow or country mallow, stands out as a perennial medicinal plant native to tropical and subtropical regions of Asia. This research paper delves into the study of leaf architecture in Abutilon indicum from the Malvaceae family. Leaf architecture serves as a valuable tool for plant identification, particularly when flowers and fruits are not available. By analyzing micromorphological leaf characters, this study aims to contribute to the taxonomy and identification of Abutilon indicum. The methodology involved plant identification through the Flora of Madhya Pradesh BSI (Botanical Survey of India), India. Leaf samples were carefully collected, preserved, and subjected to clearing techniques to reveal their venation patterns and other architectural characteristics. The results and discussion highlight the unique leaf architecture features of Abutilon indicum, including the ovate leaf lamina shape, acuminate apex, cordate base, serrate margin, actinodromous venation pattern with a basal perfect reticulate sub - type, etc. Detailed measurements were recorded, such as lamina length, lamina width, leaf area, and vein characteristics like the number of primary veins, angle of divergence of secondary veins on primary veins, vein order, etc. These findings can contribute to the development of identification keys and aid in the classification of the species. Further investigation of minor venation characteristics is recommended for a more comprehensive understanding of leaf architecture.***

Keywords: Malvaceae, *Abutilon indicum*, leaf architecture, venation

1. Introduction

The Malvaceae family is commonly called the cotton family or the mallow family. The family consists of about 245 genera and 4225 species [1]. The plants are almost cosmopolitan in distribution, but many of them are confined to the tropics and sub - tropics. The majority of its species are found in Mexico, Africa, America, Madagascar and India. Several species of this family hold great medicinal importance. Economically, this family is of great importance because it includes a number of fiber - producing plants. Several of its plants are grown as food crops and ornamentals.

Abutilon indicum, commonly known as Indian mallow or country mallow, is a perennial medicinal plant that belongs to the Malvaceae family. Its scientific name, *Abutilon indicum*, is derived from the genus "*Abutilon*" and the species name "*indicum*, " referring to its origin in India. The Abutilon L. genus of the Malvaceae family comprises about 150 annual or perennial herbs, shrubs or even small trees widely distributed in the tropical and subtropical countries of America, Africa, Asia and Australia. It is found as a weed in sub - Himalayan tracts, hills up to 1200m and in hotter parts of India. An example occurrence is within parts of the 'Great barrier Reef' islands of the 'Coral Sea' [2].

The species is characterised by its erect or semi - erect growth habit, reaching a height of 1 to 2 metres. It features alternate leaves that are broad, heart - shaped, and have serrated edges. The leaves are typically green. It features distinctive, bright yellow flowers that bloom throughout the year, making it an attractive addition to gardens and landscapes. The stem of the plant is stout, branched, about 1 - 2 m tall and 0.3 - 0.9 cm in diameter. It is yellow in colour and often found tinged with purple colour. The fruits are capsule, densely pubescent, with conspicuous and horizontally spreading beaks. The seeds are 3 - 5 mm in size, reniform, tubercled or minutely stellate - hairy, black or dark brown. The root of the plant is with smooth surface, cylindrical, 1.2 to 1.5 cm in diameter, fragrant, salty taste and yellow in colour [3].

Figure 1: *Abutilon indicum* plant

Leaf architecture is the general term used for the study of the venation pattern of a leaf. It is a good tool for plant identification, especially in cases where flowers and fruits are not available. The leaf architecture technique was pioneered by Hickey (1973) to regard the venation pattern, marginal configuration, leaf shape and gland position [4]. The study of leaf architecture is useful as different taxa have consistent patterns of leaf architecture that can be recognised at different taxonomic levels, from subclasses to species (Hickey 1975) [5]. Anatomical foliar data are often useful for solving problems of differentiating closely related taxa or supporting morphological homologies (Stuessy 1990) [6]. In recent years, numerous researchers have successfully used

leaf architecture to classify both extinct and extant plant species into taxonomic groups. The meaningful system of terminology for leaf architecture had been given by Hickey (1973) and Dilcher (1974) [4], [7].

Because they believe that these traits have a high degree of phenotypic plasticity, taxonomists frequently ignore leaf features and other vegetative characters when identifying and classifying plant species. However, it can be pointed out that leaf characters, particularly venation patterns, are, in general, genetically fixed and can be used as a taxonomic tool. This study is an attempt to collect and identify *Abutilon indicum* leaves on the basis of their micromorphological characteristics. This study is aimed at recording the leaf architecture of the *Abutilon indicum* plant of the Malvaceae family.

1.1 Scientific Classification

Kingdom: Plantae
Subkingdom: Tracheobionta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Dilleniidae
Order: Malvales
Family: Malvaceae
Genus: Abutilon
Species: Indicum [8]

1.2 Vernacular names

Sanskrit: Atibala, Bhuribala, Balika
Tamil: Perum Tutti, Paniyara Hutti, □ thuthi
Bengali: Petari, Jhapi
Marathi: Mudra
Gujarati: Khapat, Dabali, Kamsaki
Malayalam: Vellula
Arabian: Masthul Gola
English: Country mallow
Hindi: Kanghi, Kakahi
Kannada: Tutti
Telugu: Tutturu Benda, Duvvenakaya, □ Duvvena Kayalu
Farsi: Darakhtashaan
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English: Country mallow
Hindi: Kanghi, Kakahi
Kannada: Tutti
Telugu: Tutturu Benda, Duvvenakaya, DuvvenaKayalu
Farsi: Darakhtashaan [8], [9]

2. Material and Methods

2.1 Collection of Samples

The leaf samples collected from parts of Indore city (Madhya Pradesh) were examined for the presence of *Abutilon indicum* plants of the Malvaceae family. For further study, the leaf samples were collected in sterile poly bags.

2.2 Plant Identification

The plants were identified with the help of the Flora of Madhya Pradesh BSI (Botanical Survey of India).

2.3 Leaf Preservation

An herbarium was made of the collected leaves. (Miguel N. Alexiades) [10].

2.4 Sample Processing

The study used only analytical - grade chemicals, all of which were purchased from HiMedia, India.

2.5 Leaf Clearing

The leaf clearing and staining technique (Rao, et al., 1980) was used to clear the leaf [11].

2.5.1 Procedure

1) After being kept in 70% alcohol overnight, the preserved leaves are boiled in water for 5 to 10 minutes. Herbarium specimens can be boiled directly in water for five to ten minutes.
2) The entire leaf or portions of the leaf are kept in a 10 to 20% aqueous sodium hydroxide solution for 2 to 3 hours at 40 °C (depending on the texture of the leaf).
3) Place the material in a solution of trichloroacetic acid and phenol (2: 1 by weight) at 50 °C for about 2 to 3 hours until the material is completely transparent. The duration is primarily influenced by the leaf's texture.
4) The specimen is processed through a series of 30%, 50%, and 70% ethyl alcohols after the solution has been decanted.
5) The specimen is now stained with safranin, cut into fragments, and mounted on a clear glass slide. A

coverslip is then carefully placed on top of the mounted specimen, covering the stained leaf fragment. Then it is examined under a microscope.

Figure 2: *Abutilon indicum* leaf after being kept in aqueous Sodium Hydroxide solution

Figure 3: *Abutilon indicum* leaf kept in a solution of trichloroacetic acid and phenol

Figure 4: Cleared *Abutilon indicum* leaf

2.6 Study of Leaf Architecture

Study was done on the various morphological and anatomical characteristics of the leaf. The veins were studied in a dark room to make the minute veins visible in torch light. Their leaf architecture was examined using the terminology and characters proposed by Hickey (1973) and the Leaf Architecture Working Group (1999) [4], [12]. The large measurements, like leaf length, width, etc., were measured using a ruler. Angles of divergence were measured using a protractor. The study of leaf architecture was based on qualitative and quantitative observations. The qualitative observations included leaf lamina shape, apex, base, margin, texture, symmetry, venation pattern, sub - types of venation pattern, course of primary vein, course of secondary vein, marginal ultimate venation and petiole. The quantitative observations included lamina length, lamina width, leaf area, L: W Ratio, number of 1* veins per leaf, angle of divergence of 2* on 1* vein, number of 2* veins along one side of 1* vein, pattern of 3* vein and vein order.

3. Observations

Leaves are one of the most widely used plant organs. They are used by taxonomists, ecologists, and others to classify plants. In this study, the leaves of the plant *Abutilon indicum* belonging to the family Malvaceae were found in the forest area of Indore, M. P., India. The leaf architecture of this plant was analysed and characterized. Leaf architecture characters can help in distinguishing between the members of a taxon, a species, or a genus. Leaf characteristics such as patterns of veins act as powerful markers in classifying plant species. In this study, the defined leaf architectural characters can be effectively used to develop identification keys for future implementation.

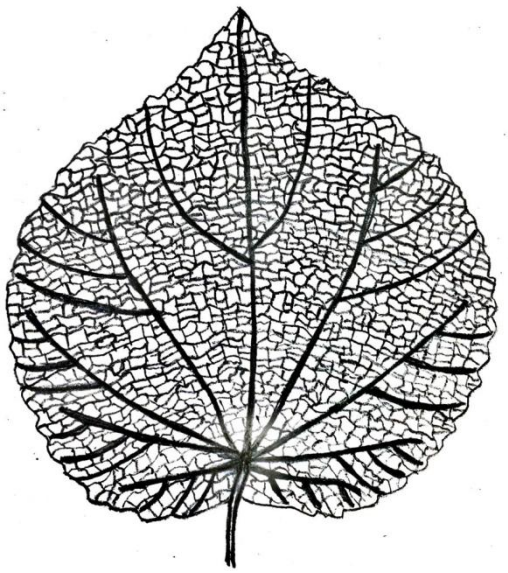

Figure 5: *Abutilon indicum*'s Venation Pattern

The following tables reflect the qualitative and quantitative findings, respectively:

Table 1: Qualitative characters of the Leaf Architecture of *Abutilon indicum*

Locality	Farm near Tejaji Nagar, Indore
Leaf lamina shape/ form	Ovate
Lamina apex	Acuminate
Lamina base	Cordate
Leaf margin	Serrate
Leaf texture	Adaxial - Pubescent Abaxial - Glabrous
Leaf symmetry	Symmetrical
Venation pattern/ Basic venation type	Actinodromous
Sub - types of venation pattern/ Basic venation type	Basal perfect reticulate
Course of the primary vein	Straight
Course of the secondary vein	Uniformly curved
Marginal Ultimate Venation	Complete
Trichome	Stellate
Petiole	Present

Table 2: Quantitative Characters of the Leaf Venation Pattern of *Abutilon indicum*

Lamina length (in mm)	52 mm Approx
Lamina width (in mm)	44 mm Approx
Leaf area (in mm^2)	2, 288 mm^2 Approx
L: W Ratio	1: 1 - 2: 1
No. of 1* veins per leaf	9
Angle of divergence of 2* on a 1* vein	Moderate Acute
No. of 2* veins along one side of 1* vein	3
Pattern of the 3* vein	Random reticulate
Highest degree/ Vein order	4

4. Results and Discussion

The leaf samples were collected from a farm near Tejaji Nagar of Indore city (Madhya Pradesh) and analysed. This study reports that the leaves of *Abutilon indicum* have an ovate leaf lamina shape. This observation is in agreement with the ones made by Larano et al. (2010) [1], Guruvigneshwari M et al. (2020) [8], S. Rajeshwari et al. (2018) [2], A. Saini et al. (2015) [3] and Dharuman A et al. (2023) [13]. However, Mohite M. S. et al. (2012) [14] found the leaf lamina shape to be ovate to orbicular cordate while Archna Sharma et al. (2013) [15] and Ramadoss Karthikeyan et al. (2012) found it to be cordate [16].

In this study, the lamina apex was observed to be acuminate, while the lamina base was cordate. Similarly, Larano et al. (2010) [1], Mohite M. S. et al. (2012) [14] and Guruvigneshwari M et al. (2020) [8] reported the apex to be acuminate and the base to be cordate. On the other hand, Archna Sharma et al. (2013) [15], Dharuman A et al. (2023) [13] and Ramadoss Karthikeyan et al. (2012) [16] reported the apex to be acute to acuminate and the base to be cordate. S. Rajeshwari et al. (2018) [2], A. Saini et al. (2015) [3] and Guno Sindhu Chakraborthy (2009) [17] found the apex to be acuminate.

The leaf is symmetrical and this finding was in agreement with Larano et al. (2010) [1], Guno Sindhu Chakraborthy (2009) [17] and Mohite M. S. et al. (2012) [14]. The leaf margin was found to be serrated in the present study as well as in Larano et al. (2010) 's study [1]. However, Mohite M. S. et al. (2012) [14], Guruvigneshwari M et al. (2020) [8], S. Rajeshwari et al. (2018) [2], A. Saini et al. (2015) [3] and Guno Sindhu Chakraborthy (2009) [17] found the margin to be toothed. Archna Sharma et al. (2013) [15], Dharuman A et al. (2023) [13] and Ramadoss Karthikeyan et al. (2012) [16] reported the margin to be dentate and crenate.

In the present study, the adaxial leaf surface was found to be pubescent in texture, whereas the abaxial leaf surface was found to be glabrous. Similarly, Archna Sharma et al. (2013) [15] and Dharuman A et al. (2023) [13] reported the leaf texture to be hairy above and glaucous below.

The petiole of the leaf was found to be present. The trichomes were observed to be stellate and were present on both - adaxial and abaxial surfaces. This finding was consistent with Prakash R. Kanthale (2017) 's findings [18]. Mohite M. S. et al. (2012) [14], Ramadoss Karthikeyan et al. (2012) [16] and Guno Sindhu Chakraborthy (2009) [17] found covering and glandular trichomes to be present on both the surfaces. Archna Sharma et al. (2013) [15] and Dharuman A et al. (2023) [13] reported stellate, pitcher and flask shaped trichomes to be present.

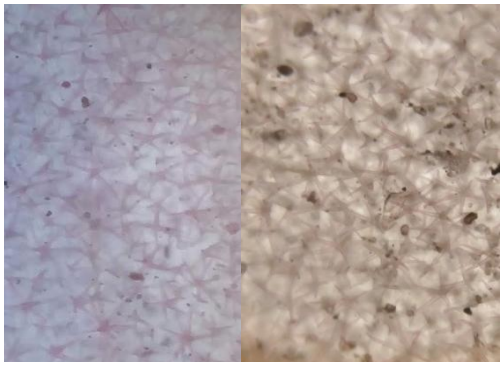

Figure 6: Microscopic Views of Stellate Trichomes

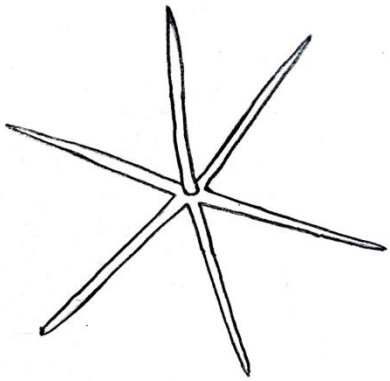

Figure 7: Diagrammatic Representation of Stellate Trichomes

The major venation pattern is observed to be actinodromous, and this observation is consistent with the one given by Larano et al. (2010) [1]. In the present study, the sub - type of venation pattern is basal perfect reticulate. Mohite M. S. et al. (2012) [14], Archna Sharma et al. (2013) [15], Dharuman A et al. (2023) [13], Ramadoss Karthikeyan et al. (2012) [16] and Guno Sindhu Chakraborthy (2009) [17] reported the sub - type of venation pattern to be reticulate. This study reported the marginal ultimate venation to be complete whereas Larano et al. (2010) 's study reported the marginal ultimate venation to be incomplete [1].

It is observed that the course of the primary vein is straight, while that of the secondary vein is uniformly curved. The present findings about the courses of the primary and secondary veins are in accordance with the ones made by Larano et al. (2010) [1].

The angles of divergence of secondary veins on primary veins were found to be moderate acute in this study as well as in the study of Larano et al. (2010) [1].

The vein order observed was 4° and this observation was inconsistent with the one given by Larano et al. (2010) as 5° [1]. The number of primary veins per leaf was calculated to be 9. However, Larano et al. (2010) reported this figure to be 5 [1]. The number of secondary veins along one side of the primary vein was found to be three. The pattern of the tertiary vein was observed to be random reticulate.
The average lamina length and lamina width of the leaves

were calculated to be 52 mm and 44 mm, respectively. The leaf area was found to be 2288 mm^2. The length: width ratio was calculated to be 1: 1 - 2: 1, which is in agreement with the calculations of Larano et al. (2010) [1].

5. Conclusion

In conclusion, the characteristics of the leaf architecture serve as taxonomic characters for the identification of plants. The most significant characters studied were the laminar shape, the base and apex shape, the margin type, the texture, the symmetry of the leaves, and the venation pattern. The marginal ultimate venation was also studied, as were the vein categories of 1°, 2°, and 3°, the angle of divergence, and the highest degree of the vein order. The leaf architectural characters can be highly useful taxonomic characters during the non - flowering period. It is suggested that further investigation of the minor characteristics of the venation of the species will enable a better comprehension of leaf architecture. This research is expected to enable the recognition of the utilisation of leaf architecture and to be a tool for the identification and development of various plant species.

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Author Profile

Madhulika Jadon is a dedicated young researcher currently pursuing her 12th grade education with a focus on the PCB (Physics, Chemistry and Biology) stream at The Shishukunj International School, Indore. Her research journey commenced over the course of her last summer of high school when she conducted an in - depth study on *Abutilon indicum,* a topic that formed the basis of her research paper. She looks forward to continue her academic journey in the field of science and contribute significantly to the scientific community.