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Micro- Evaluation of the Peripheral Leaf Architecture of *Triumfetta rhomboidea*

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Abstract: ***A valuable medicinal plant, Triumfetta rhomboidea, hails from the Malvaceae family and boasts a rich therapeutic profile. Through a systematic analysis of the leaf system of T. rhomboidea, this study endeavours to uncover a deeper knowledge of its anatomical details. Leaf samples taken from Indore region were incorporated into the research. Following established protocols, the leaves underwent analysis using sectioning, staining, and microscopy to gain insights into their peripheral layout. The investigation focused on various elements, including the analysis of the layer, venous progression, angle of veins, and pattern development, laminar study, leaf shape, trichome and various other factors. Both sides of the leaf were discovered to be covered in fine hair, with the highest venation degree reaching a level of 4, the trichome was found to be hairy non-glandular type, the petiole was winged and the pattern of the tertiary vein was found to be orthogonal reticulate. The intricate venation design revealed increased mechanical support and efficient nutrient diffusion. Uncovering the detailed leaf architecture of T. rhomboidea exposes valuable information regarding its resilience, holding potential for implementation in domains including pharmaceutical research, agricultural practices, and environmental stewardship.***

Keywords: *Triumfetta rhomboidea*, leaf architecture, venation patterns, Malvaceae

1. Introduction

From herbs to shrubs to trees, the Malvaceae family encompasses a broad variety of flowering plantsestimated to contain 244 genera with 4225 known species [1]. Commonly referred to as the mallow family it boasts plant species with lobed leaves, venation on the palmar surface, and vibrant, cup-shaped flowers. The diversity of plant life within the Malvaceae family is celebrated for its multiple practical applications.

Triumfetta rhomboidea, typically identified as Burmese grape or diamond burr, belongs to the Malvaceae tribe. The distribution of this species covers a large portion of both Asian and African landmasses while it is thought that to have come to Austraila from China [2].*Triumfetta rhomboidea* boasts a dual purpose in traditional healing arts and gastronomy. Across various regional medical systems, *Triumfetta rhomboidea* has been a valued remedy. The potential therapeutic benefits of this substance are highly regarded. Extracts obtained from diverse sections of the plant have been exploited to treat a range of health issues, including skin disorders, inflammation, digestion difficulties, and respiratory problems. Medicinally, the plant has been leveraged for numerous purposes beyond its primary function.

Figure 1: *Triumfetta rhomboidea* plant

The study of leaf architecture or the study of leaf anatomy is important for various ecological, environmental, and scientific reasons. Tropical botanists were challenged with the necessity to identify and classify plants through their vegetative characteristics (Amanda Ash *et al*. 1999) [3]. The structure of leaves helps tell apart various plant kinds.The analysis of fossilised leaves enables scientists to chronicle the evolutionary progression of diverse plant clades through geological periods. Investigating leaves from distinct historical times allows researchers to infer transformations in environmental circumstances such as temperature, humidity, and more. Plant activities like photosynthesis, respiration, and nutrient intake are influenced by the shape of leaves. Ecosystems often exhibit initial indications of the consequences of environmental pressure, pollution, or climate alterations through changes in leaf structure. Leaf features help phylogenetic studies, which help researchers clarify the evolutionary links between plant species, when combined with genetic data.

Here, samples were collected from the forest of Indore city region and their qualitative and quantitative characteristics were analysed.

The study on *Triumfetta rhomboidea* has been done by various other researchers such as Rashmi Rani *et al* (2020) [4], S. Alexandar *et al.* (2022) [5], Robert *et al.* (2022) [6], etc. But the study on leaf architecture of *Triumfetta rhomboidea* from Indore region has not been carried out yet. This study aims to evaluate the leaf architecture of *Triumfetta rhomboidea*.

1.1 Scientific Classification

Table 1: Shows the scientific classification of *T. rhomboidea*

Kingdom	Plantae
Subkingdom	Tracheophytes
Division	Angiosperms
Class	Eudicots
Subclass	Rosids
Order	Malvales
Family	Malvaceae
Genus	*Triumfetta*
Species	*Triumfetta rhomboideaJacq. [7]*

1.2 Vernacular Names

Table 2: Shows some common names of *T. rhomboidea*

English	Diamond burrbark, Burr Bush
Hindi	Chikti
Sanskrit	jhinjhirita
Bengali	ban okra
Kannada	Kadu Bende
Tamil	Ottu-p-pullu
Nepali	Dalle Kuro
Mizo	Semeibawm-suak
Telugu	Dekki, chiru sitrika, kusangi [8]

2. Materials and Methods

2.1 Collection of samples:

The leaves were collected from Indore region (Madhya Pradesh). They were analysed for the presence of *Triumfetta rhomboidea* plant of the Malvaceae family. The leaf samples were collected in sterile poly bags for further study.

2.2 Plant identification:

The identification of the plant was done with the help of the flora of Madhya PradeshBSI (Botanical Survey of India).

2.3 Leaf preservation:

The collected leaves were then made into a herbarium (Miguel N. Alexiades and K. Maden Tribhuvan) [9]

2.4 Sample processing:

The chemicals involved in this study were of analytical grade and were purchased from HiMedia, India.

2.5 Leaf clearing

Here the leaf clearing and staining technique was used (Rao et al 1980) [10] to clear the leaf. The following steps are involved in the procedure:

1) The fresh and preserved leaves are stored in an alcohol solution for an extended period before boiling them in water. Soaking herbarium samples in water for 5 to 10 minutes is possible directly.
2) The whole leaf or portions of leaf is kept in 10 to 20% aqueous sodium hydroxide solution. Time needed to heat the leaf varies between 2 and 3 hours depending on its texture.
3) Transfer the material to a solution of trichloroacetic acid and phenol after 2-3 hours of heating the material (2:1 by weight) till it becomes fully transparent. The duration mainly depends upon the texture of the leaf. Generally, the fresh leaves are cleared within an hour. Although preserved and herbarium specimens are processed gradually.
4) After decanting the solution, the specimen is processed through a series of 30%, 50% and 70% ethyl alcohol.
5) The leaf is ready to observed under the microscope. Stain the leaf with diluted saffronin(make sure the stain is very light), section the leaf and observe it under the microscope.

Figure 2: *Triumfetta rhomboidea* leaf kept in trichloroacetic acid and phenol in the ratio 2:1

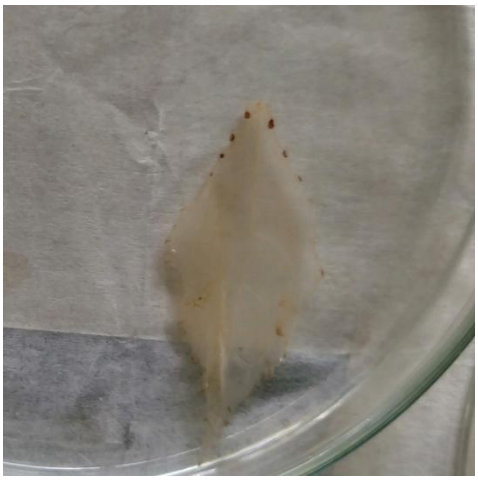

Figure 3: *Triumfetta rhomboidea* leaf cleared.

3. Study of Leaf Architecture

Numerous anatomical and morphological traits of the leaf have been studied. Under the illumination of a torch, the veins were examined in a completely darkened environment. Hickey (1973) [11] and the Leaf Architecture Working Group (1999) [12] provided terms and characters that were used to analyze their leaf architecture. A ruler was used to measure the big dimensions, such as the length and width of the leaf. Utilizing a protractor, the angles of divergence were determined. In order to research leaf architecture, both qualitative and quantitative observations were used. Form, apex, base, margin, texture, symmetry, venation pattern, sub-types of venation pattern, primary vein course, secondary vein course, marginal ultimate venation, and petiole were among the qualitative observations made on leaf lamina. Lamina length, lamina breadth, leaf area, and other quantitative observations were observed.

4. Observations

Leaves are indispensable instruments for taxonomists and ecologists, facilitating species classification, interplant interactions, ecosystem wellness evaluation, and the unravelling of complex ecological interactions.The leaf architecture of of *Triumfetta rhomboidea* was studied and analysed. The leaf samples were collected from the forest region of Indore (MP), India. Observation, measurement, and characterisation of *Triumfetta rhomboidea* leaves constitute the present investigation. Numerous leaf traits were studied and contrasted. The qualitative and quantitative findings are shown in the following tables, respectively:

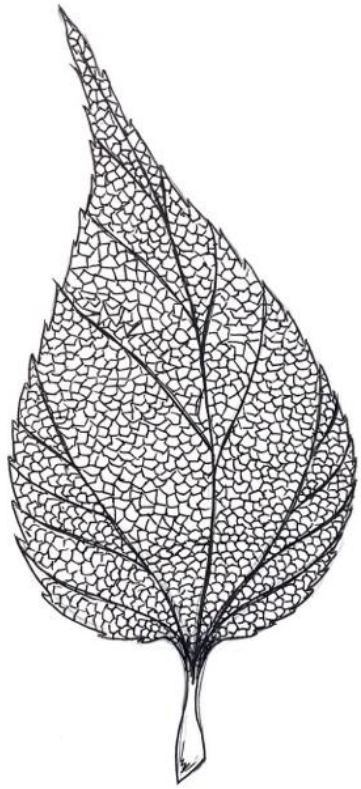

Figure 4: Diagrammatic illustration of *Triumfetta rhomboideas* venation pattern.

Table 3: Details of leaf architecture of Triumfetta rhomboidea

Species	Triumfetta rhomoidea
Locality	Khandwa Road
Leaf Lamina Shape/ Form	Elliptic
Lamina Apex	Broadly Acuminate
Lamina Base	Acute
Leaf Margin	Serrate
Leaf Texture	Pubescent
Laminar Symmetry	Symmetrical
Trichome	Hairy, non-glandular type
Venation Pattern/ Basic Venation Type	Camptodromus / actinodromus
Sub Type of Venation Pattern/ Basic Venation Type	klado-dromus
Course of Primary (1°) Vein	Straight
Course of Secondary (2°) Vein	Uniformly curved
Marginal Ultimate Venation	Complete
Type of Petiole	Winged petiole

Table 4: Details of leaf venation pattern in *Triumfetta rhomboidea*

Average Lamina Length (cm)	3.66 cm
Average Lamina Width (cm)	1.63 cm
Average Leaf Area (cm)	9.62 cm
Length: Width Ratio	9:4
Numer of Primary (1°) Veins	3
Angle of Divergence of Secondary (2°) Vein on Primary (1°) Vein	Moderate acute
Number Of Secondary (2°) Vein along One Side of Primary (1°) Vein	3
Pattern of Tertiary (3°) Vein	Orthogonal reticulate
Highest Order of Vein Order	4

5. Results and Discussion

The leaf samples of *Triumfetta rhomboidea* were collected from Khandwa Road, Indore and analysed. According to Robert *et al.* (2022) [6], Dr. N Sasidharan(2004) [13], Rashmi Rani *et al* (2020) [4] and WFO (2023) [14] the leaf margin was found to be serrate, according to the current study of S. Alexandar*et al.* (2022) [5] the leaf margin on lower leaves were crenate and serrate on the leaf margin of upper leaves, Mike Bingham *et al* (2011-13) [15] and F Areces-Berazain (2018) [16] drew the conclusion that the leaf margin is irregularly serrate. This study was in favor of Robert et al. (2022) [6], Dr. N Sasidharan (2004) [13], S. Alexandar *et al.* (2022) [5], Rashmi Rani et al (2020) [4] and WFO (2023) [14] and was concluded to be serrate. In this study the leaf lamina was found to be elliptic, the study conducted by Rashmi Rani et al (2020) [4]also deduced the leaf lamina to be elliptic, whereas, Robert et al. (2022) [6] concluded it to be ovate to cordate, S. Alexandar et al. (2022) [5] concluded it to be cordate or narrowly lanceolate, Dr. N Sasidharan (2004) [13] found the lamina shape to be generally rhomboid-ovate, according to C.H. Bosch et al (2011) [19]the leaf lamina was found to be rhomboid to ovate, S. Rajkumar (2001) [18] drew the conclusion that the lamina shape was ovate-orbicular, Mike Bingham et al (2011-13) [15] drew the inference that the leaf lamina was ovate-lanceolate, C.H. Bosch et al (2011) [19] concluded that the lamina shape was rhombic, elliptic or ovate and F Areces-Berazain (2018) [16] found the blade to be typically

broadly ovate to rhombic-ovate. The lamina apex according to the study by Dr. N Sasidharan (2004) [13] was acute or acuminate, WFO (2023), Robert et al. (2022) [6], S. Alexandar et al. (2022) [5] and Mike Bingham et al (2011-13) [15] concluded the apex to be acute, Rashmi Rani et al (2020) [4]concluded the leaf apex to be acute or acuminate, C.H. Bosch et al (2011) [19] concluded the apex to be acute or shortly acuminate, F Areces-Berazain (2018) [16] found the leaf to be acute to abruptly acuminate at the apex, whereas, this study concluded the apex to be broadly acuminate. When identifying the lamina base, this study concluded it to be acute, according to , Dr. N Sasidharan (2004) [13] the lamina base was rounded or cordate, Robert et al. (2022) [6] concluded the leaf to be rounded at the base, the study by WFO (2023) [14]concluded the base to be cuneate-cordate, S. Rajkumar (2001) [18]and Rashmi Rani et al (2020) [4]concluded that the lamina base is cordate, S. Alexandar et al. (2022) [5] concluded the lamina base to be crenate, Mike Bingham et al (2011-13) [15] deduced the base to be cordite to truncate, C.H. Bosch et al (2011) [19] found the base to be cuneate to obtuse and F Areces-Berazain (2018) [16] found the leaf to be obtuse or rounded at the base. This study found that the trichome was hairy, non-glandular type whereas Chandan Das and Prateekshya Mishra *et al* (2015)[22] concludedthat the trichome is simple and stellate type, Elsa Lattar (2009) [20] concluded the trichome to be glandular and study by Robert, Imo U. (2022) [5]deduced the trichome to be stellate. This study drew the inference that the leaf texture is pubescent, agreeing with my study Robert et al. (2022) [6] and C.H. Bosch et al (2011) [19]also concluded the leaf texture to be pubescent, the study conducted by, Dr. N Sasidharan (2004) [13] concluded the leaf texture to be stellate-pubescent to glabrescent, WFO (2023) [14]concluded the leaf texture to be stellate or simple hairy to glabrescent and S. Alexandar et al. (2022) [5] and S. Rajkumar (2001) [18]drew the conclusion that the leaf texture is stellate-pubescent and S. Rajkumar (2001) [18][18]described itas “dense velvety on both sides”. Thus, this study is in support of the study conducted by Robert et al. (2022) [6] and C.H. Bosch et al (2011) [19]. This study concluded the laminar symmetry to be symmetrical.This study came to conclusion that the venation pattern is camptodromus or actinodromus, but the study conducted by Rashmi Rani et al (2020) [4]deduced the venation pattern to be ctinodromous. The course of primary vein was found to be straight with the secondary vein as uniformly curved and marginal ultimate venation to be complete. This study found that the petiole of the leaf of T. rhomboidea was winged but C.H. Bosch et al (2011) [19] found the petiole to be terete.

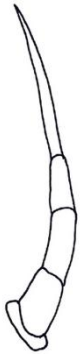

Figure 5: Diammgramatic illustration of *Triumfetta rhomboideas trichome*.

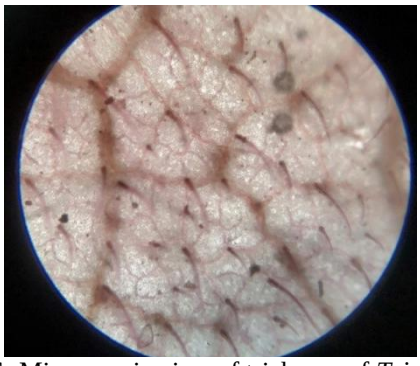

Figure 6: Microscopic view of trichome of *Triumfetta rhomboidea* leaf

The current study found that the length of the leaf was 3.3cm-4.2cm with an average of 3.66cm and the width of the leaf was found to be 1.2cm-2cm with an average of 1.63cm, the study conducted by Robert et al. (2022) [6] deduced the length to be 1-7cm and width to be 0.44cm, Dr. N Sasidharan (2004) [13] concluded the length to be 2.5-7cm and width to be 2.5-6 cm, WFO (2023) [14]found the length of the leaf to be 3-9 cm and width to be 2.5-7.5 cm, S. Alexandar et al. (2022) [5] concluded the lower leaves had a length of 4.5-7cm and width 4.5-7.2cm and upper leaves had a length of 2-2.5cm and width 0.6-0.8cm. The average leaf area was found to be 9.62cm (3.66cm x 1.63cm). The current study found that the length to width ratio was 9:4. Number of primary (1°) veins were found to be 3, the study conducted by Rashmi Rani et al (2020) [4] concluded number of primary (1°) veins to be 3 or 5. Angle of divergence of secondary (2°) vein on primary (1°) vein was moderate accurate. The number of secondary (2°) vein along one side of primary (1°) vein were found to be 3. Pattern of tertiary (3°) vein was found to be orthogonal reticulate and the highest degree vein order was 4.

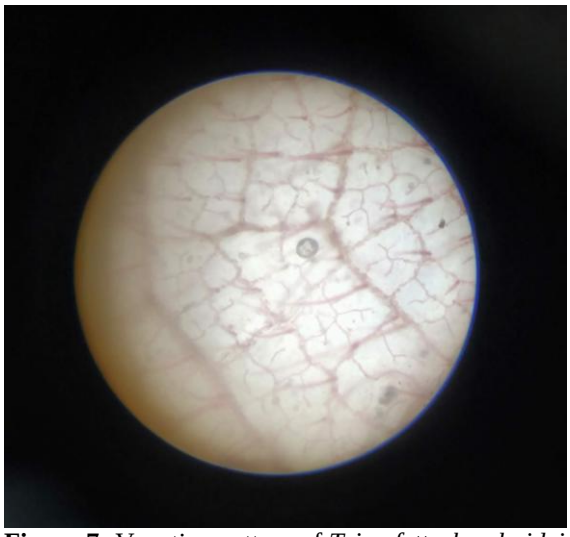

Figure 7: Venation pattern of *Triumfettarhomboidei*

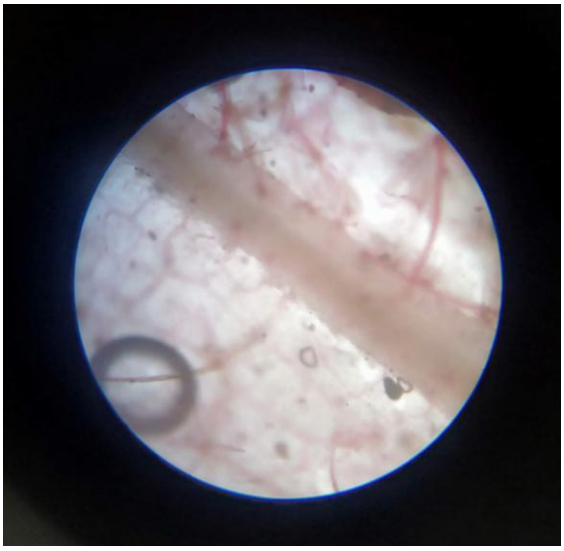

Figure 8: Midrib of *Triumfetta rhomboidea*

6. Conclusion

Ultimately, our investigation uncovered the intricate features of *Triumfetta rhomboidea's* leaves, revealing their extraordinary anatomy and vein patterns. Primary and secondary veins collaborate in providing the leaf with essential mechanical backing and transportation capabilities.

The significance of this research lies in its potential to impact ecological and environmental studies beyond this specific study. *Triumfetta rhomboidea's* architectural features offer valuable lessons on how plants can withstand difficult circumstances. While *Triumfetta rhomboidea's* leaf architecture is illuminated through this study, more areas of exploration remain untouched. Conducting studies to identify genetic underpinnings, investigate variations, and conduct comparative analyses could uncover deeper insights into the evolutionary history and adaptive significance of these features.

A key component of taxonomic classification is leaf architecture. Primary characters in this study are lamina identification, venation patterns, and leaf texture. The research yields expected recognition due to its application of leaf architecture and identification of various plant species through knowledge of their architectural features. In simpler terms, this study not only sheds light on the intricacies of *Triumfetta rhomboidea* but also contributes to the broader realm ofplant biology and its significance for ecology and conservation.

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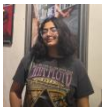
Author Profile



Ada Sharma is a passionate and creative young researcher currently in 12th-grade hailing from The Shishukunj International School in Indore, she is specializing in the PCMB (Physics, Chemistry, Mathematics, and Biology) stream. Her academic journey is fueled by a profound love for the natural world, with a special passion for the field of biology. Her unrelenting curiosity and commitment to scientific pursuits have enabled her to develop strong scientific skills. Ada's research paper on *Triumfetta rhomboidea* showcases not only her dedication to the field but also her ability to delve into complex biological concepts and present them in a coherent and engaging manner. She aspires to contribute significantly to the realm of biological research in the future, with a firm belief in her potential to make a meaningful impact.