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**Sethuramani A**

Assistant Professor, Department of Pharmacognosy, College of Pharmacy, Madurai Medical College, Tamil Nadu, India

**Dharani V**

Postgraduate Scholars, Department of Pharmacognosy, College of Pharmacy, Madurai Medical College, Tamil Nadu, India

**Soundariya R**

Postgraduate Scholars, Department of Pharmacognosy, College of Pharmacy, Madurai Medical College, Tamil Nadu, India

## Foliar mapping of *Ficus carica* Linn., (Moraceae)

Sethuramani A, Dharani V and Soundariya R

**Abstract**

Pharmacognostic parameters of *Ficus carica* (Moraceae) were investigated for standardization of the plant and differentiate it from various species of *Genus ficus*. 700 different species represent in the *Genus ficus*, *Ficus palmata* was said to be closely related species, to differentiate the *Ficus carica* from other species it is important to investigate pharmacognostical properties. The characteristic features observed are, lanceolate broad leaves with rough lamina and multiple reticulate venations with irregular margins. The transverse section of the lamina through midrib and petiole shows various microchemistry parameters, multilayered epidermal cells, bifacial mesophyll, collateral vascular bundle with numerous crystal sheath and leptocentric bundles. Stellate trichomes was first investigated. Few parameters may deviate from literatures due to environmental change. The differential parameter is encountered in this article and the *Ficus carica* Linn is evaluated and differentiated from other species.

**Keywords:** *Ficus carica*, stellate trichomes, cystolith, Microchemistry and physiochemical properties

**Introduction**

Moraceae a family of dicotyledon plants containing 1500 species in 53 genera distributed mainly in warm regions of the world. This family includes *Genus ficus*, represented about 700 species and one of the largest genera of higher plants [1]. The family Moraceae contains 73 genus and 1000 species [2, 3]. The *Genus ficus*, of the Moraceae family, includes wide number of species, with most found in tropics and sub tropics [4]. In traditional medicine the roots of *Ficus carica* are used in curing of leucoderma and ringworms and the fruits of *Ficus carica* are sweet, exhibiting antipyretic, purgative, properties and have shown to be useful in inflammations and paralysis [5, 6].

Pharmacognostic evaluation ensures plant identity, lays down standardization parameter which will help and prevents adulteration. Pharmacognostic studies include parameters such as morphological, microscopical and macroscopical evaluation. Morphological evaluation includes the evaluation of organoleptic characters of plants by size, shape colour, odour, taste and particular characteristics like touch, texture etc. An examination to determine these characteristics is the first step towards establishing the identity and the degree of purity of such materials, and should be carried out before any further tests are undertaken. The present study deals with evaluation of leaves of *Ficus carica* (Moraceae). Macromorphological evaluation such as transverse section, microchemistry, histochemical investigation, powder analysis and quantitative microscopy were evaluated to establish the diagnostic character using standard methods.

**Taxonomy**

Domain	:	Eukaryota
Kingdom	:	Plantae
Sub-kingdom	:	Tracheobionta
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Sub class	:	Hamamelididae
Order	:	Urticales
Family	:	Moraceae
Genus	:	<i>Ficus</i>
Species	:	<i>F. carica</i>

**Synonym :** *Caprificus insectifera*, *C.leucocarpa*, *C.oblangata*, *C.pedunculata*, *C.rugosa*, *C.Sphaerocarpa*, *Ficus albescens*, *F.caprificus*, *F.colchica*, *F.colombra*, *F.communis*, *F.deliciosa*, *F.dottata*, *F.globasa*, *F.latifolia*, *F.leucocarpa*, *F.macrocampa*, *F.pachycarpa*, *F.polymorpha*, *F.regina*, *F.rugosa*, *F.silvestris*.

**Corresponding Author:****Sethuramani A**

Assistant Professor, Department of Pharmacognosy, College of Pharmacy, Madurai Medical College, Tamil Nadu, India

## Material and Methods

### Collection and Preparation of Plant Materials

The leaves are collected in ATB organic fig farm Chinnalampatti, Dindugul. The leaves are collected and shade dried. It was powdered in a mixer. The coarse powder was sieved and was stored in a well closed container. The collected leaves were authenticated by Dr.Chelladurai.V, Research officer- Botany (Scientist-C), Central Council for Research in Ayurveda & Siddha, Govt of India. (retired)

### Pharmacognostical Studies

Morphological and micro morphological check-up and depiction of medicinal plants have always been conferred due authorizations in the pharmacognostical revisions. Botanical identity of the plants is a vital prerequisite for undertaking the analysis of medicinal assets of any plant. A researcher may succeed in getting a new compound or may find many useful pharmacological active properties in the plant. If the botanical identity of the plant happens to be dubious or erratic, the entire work on the plant becomes invalid. Thus, it is needed to study the morphological features in a standard method.

### Macroscopical Evaluation <sup>(7)</sup>

Leaves are studied separately for its morphological characters by organoleptic test like colour, odour, size, shape, taste and cyto-morphological indications.

### Microscopical evaluation

#### Histological Evaluation

Sample was preserved in fixative FAA for more than 48 hr. The preserved specimens were cut into thin transverse section using a sharp blade and the sections were stained with safranin. Transverse sections were photographed using Nikon ECLIPSE E200 trinocular microscope attached with Zeiss AxioCam Erc5s digital camera under bright field light. Magnifications were indicated by scale bar.

### Quantitative Microscopy of *Ficus carica* Linn <sup>(8)</sup>

The fresh leaf samples were boiled with 0.1% cholral hydrate solution and slides prepared. Vein islets, vein termination, epidermal number, stomatal number, stomatal index and palisade ratio were determined. The results were presented in (table 10, Fig 13).

### Stomatal Index

It is the percentage, which the numbers of stomata from the total number of epidermal cells, each stoma being counted as one cell.

$$\text{Stomatal index} = \frac{S}{S+E} \times 100$$

Where, S = Number of stomata per unit area

E = Number of epidermal cells in the same unit area

### Determination of Stomatal Index

The procedure adopted in the determinations of stomatal number was observed under high power (45 X). The epidermal cells and the stomata were counted. From these values the stomatal index was calculated using the above formula.

### Determination of Vein Islet Number and Vein Termination Number

It is the number of vein islets per sq. mm of the leaf surface midway between midrib and margin. The vein islet numbers are used to distinguish closely related plants. The number of

vein islets  $\text{mm}^{-2}$  calculated from four contiguous square millimetres in the central part of the lamina, midway between the midrib and margin is termed vein islet number, when determined on whole leaves the area examined should be from central part of lamina midway between margin and midrib. Vein termination number is defined as number of vein termination present in 1 sq mm area of photosynthetic tissue.

### Powder Microscopy

A pinch of the powdered sample was mounted on a microscopic slide with a drop of 50% glycerol. Characters were observed using Nikon ECLIPSE E200 trinocular microscope attached with Zeiss ERc5s digital camera under bright field light. Photomicrographs of diagnostic characters were captured and documented. The photomicrographs were presented in (Fig 8-12).

## Results

### Botanical description of *Ficus carica* leaves

The leaves are simple; alternate; green; shaped broad and lanceolate with more or less deep sinuately 3-5 lobed, with acute apex, subcordate base and irregular margin. The lamina of the dorsal surface is rough and lower surface is soft. The length and width of the leaves may differ, approximately the size may vary between 8-15 cm long and 10-20 cm wide. The venation is multi convergent reticulate venation. (fig 1)

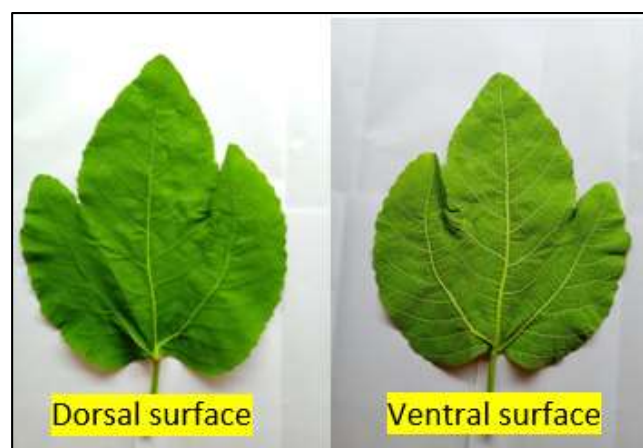


Fig 1: Leaf of *Ficus carica*.

### Microscopical description of petiole

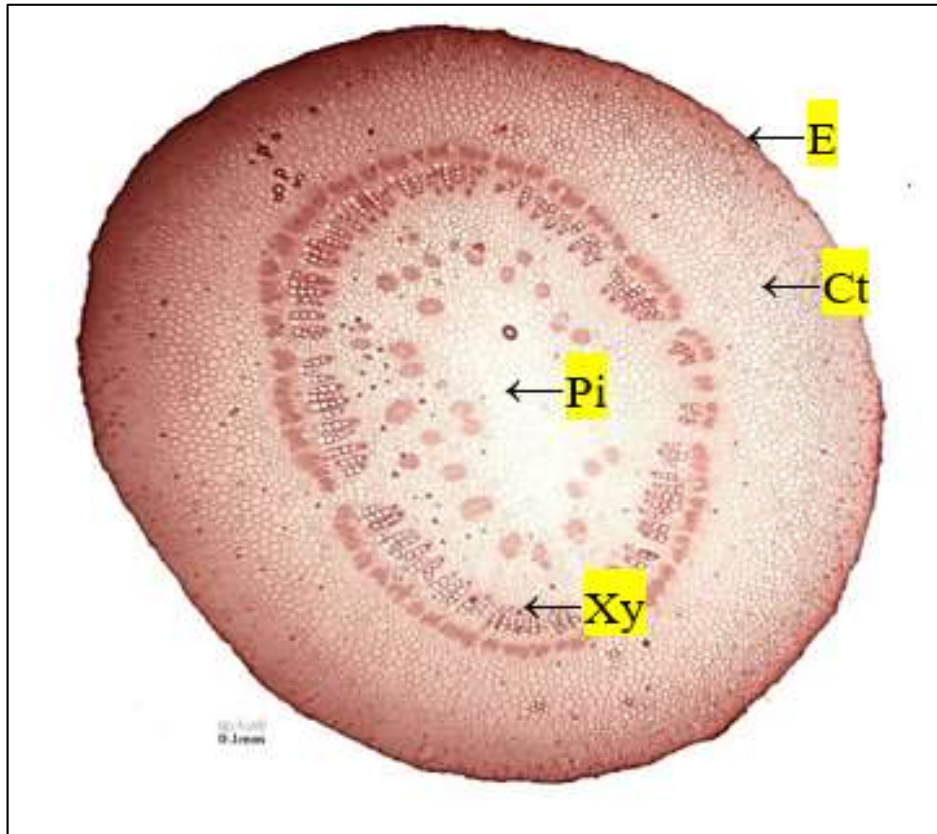
The transverse section (fig 2) of the petiole is sinuous and nearly circular in outline. The outer layer is covered with thick cuticle, followed by single layered rounded epidermis (E) with thickened lateral walls carrying abundant, long simple unicellular non-glandular indumentums (T).

**Cortex:** The epidermis is followed by cortex (CC), differentiated into two regions; a) the external zone; consists of 7-8 layers of collenchymas (Col) (fig 2a). b) The internal zone; consists of 10-12 layers of parenchyma cells (Pa). Cluster of calcium oxalate crystals and druses are scattered in the inner cortex region (fig 2b).

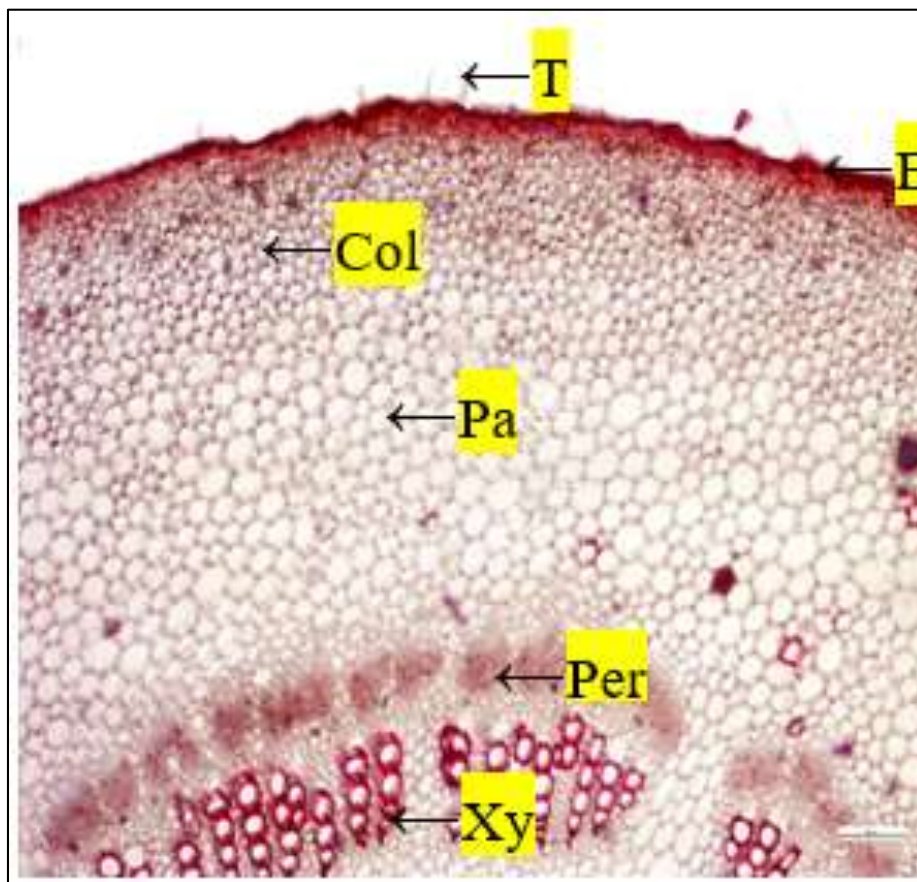
**Vascular bundle:** The vascular system consists of 10 to 11 isolated collateral vascular bundles enclosing wide parenchymatous pith. Cluster crystals of calcium oxalate and idioblasts containing mucilage are scattered in the parenchymatous tissues, phloem and pericycle. The xylem consists of lignified vessels, fibers and parenchyma. Pericycle is represented by groups of lignified fibers.

**Pith:** Wide parenchymatous pith (Pi), formed of large thin walled parenchyma cells and some clusters of calcium

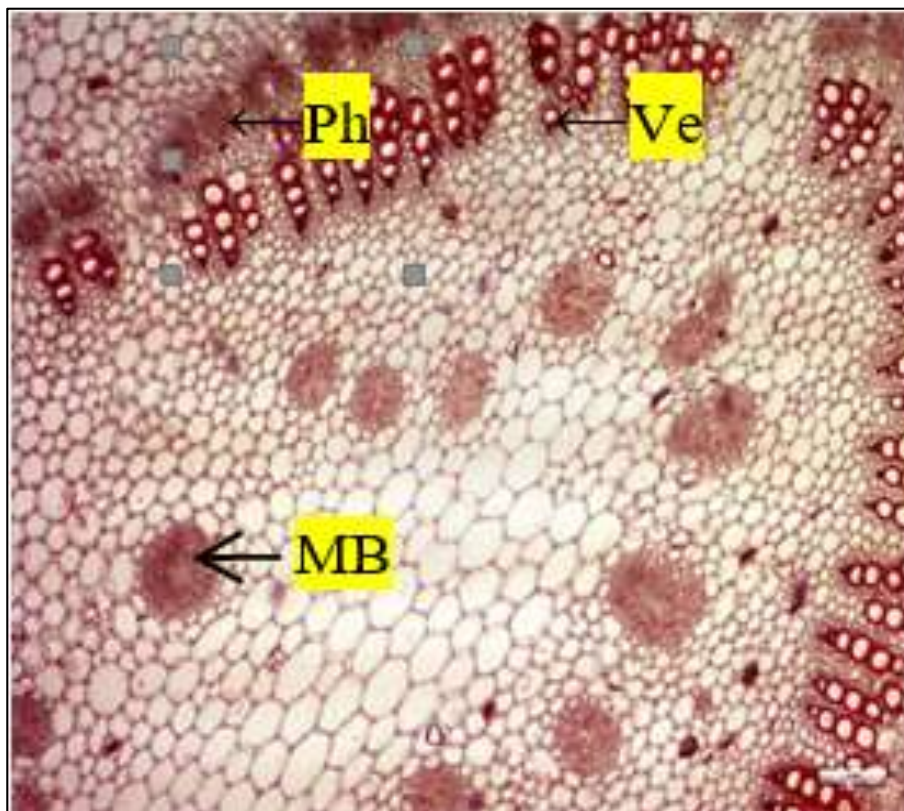
oxalate. In the inner basic parenchyma leptocentric bundles are present.



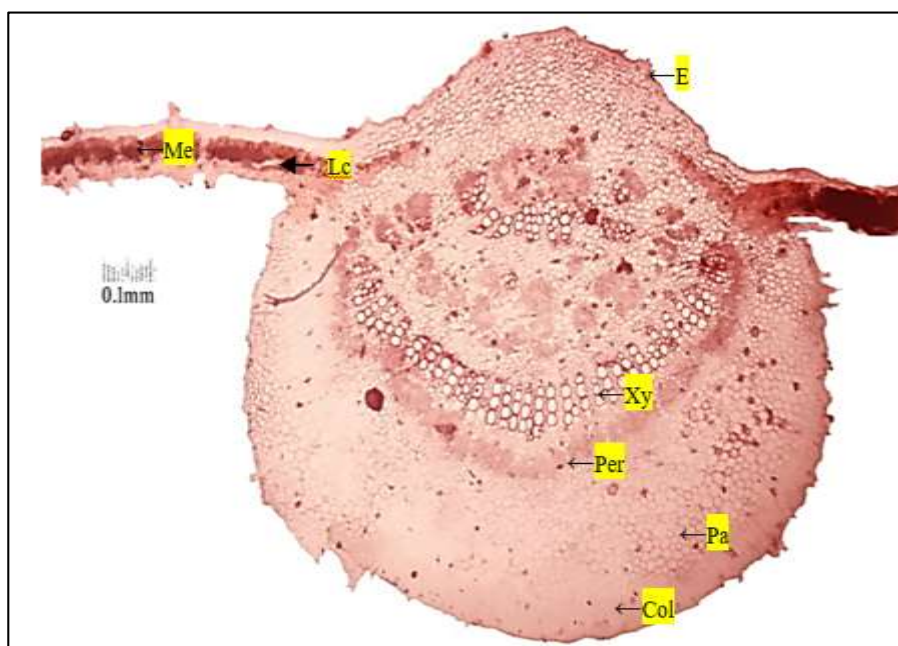
**Fig 2:** Transverse section of *Ficus carica* petiole



**Fig 2a:** Outer region.



**Fig 2b:** Inner region. E-Epidermis, Ct- cortex, Pi- pith, Xy- xylem, T- trichomes, Col - collenchyma, Pa - parenchyma, Per-pericyclic fibre, Xy- xylem, MB - Medullary bundle, Ve- vessels.



**Fig 3:** Transverse section of lamina through midrib of *Ficus carica* Me- Mesophyll, Lc- Laticifer, E-epidermis, Xy- Xylem, Per- Pericyclic fiber, Pa- Parenchyma, Col- Collenchyma.

### Microscopical description of lamina

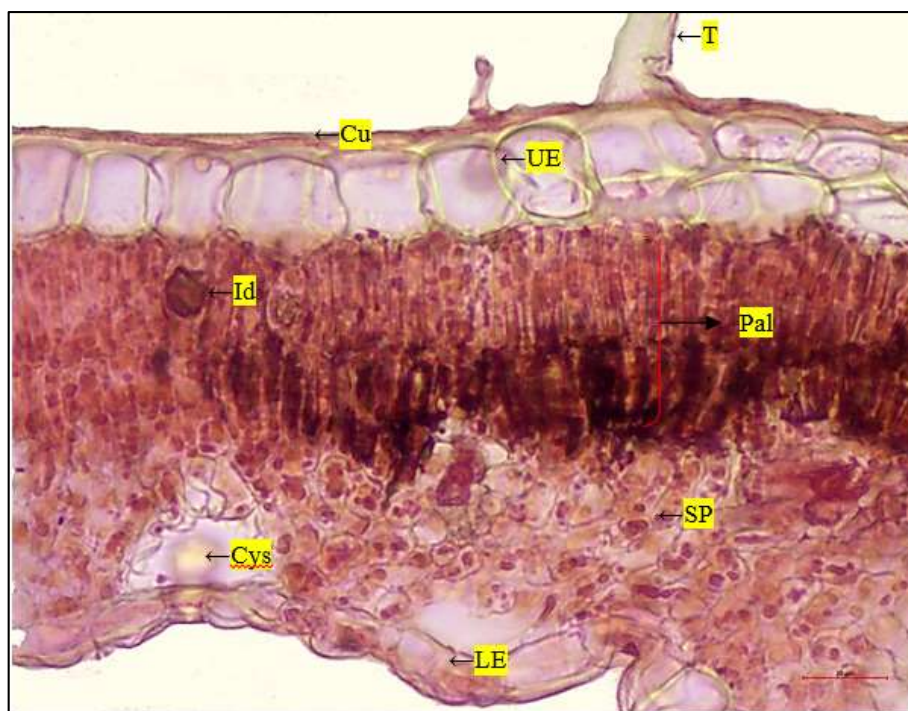
**Cuticle:** The leaf of *Ficus carica* has scabrous cuticle (Cu) in the adaxial surface and pubescent cuticle in the abaxial surface (fig 4).

**Epidermis:** Epidermal cells(E) are compound, diseriata and polygonal in shape with anticlinal walls. The adaxial surface have large and sinuate epidermal cells (UE) while in the abaxial surface is smaller and sinuate(LE).(Fig 4)

**Mesophyll:** The leaf of *Ficus carica* has bifacial mesophyll (Me) where the palisade parenchyma is restricted to the adaxial surface and spongy parenchyma to the abaxial surface. Numerous crystal bearing idioblasts (Id) are present in the first layer of the palisade layer. The crystals present in the *Ficus carica* is of two types. a) prismatic crystals; found in the palisade cells in the adaxial layer. b) cystolith;(Cys) present in the abaxial surface in the spongy parenchyma.(SP) (Fig 4)

**Midrib:** The midrib is very prominent on the lower surface of the blade, and less at the upper one. The midrib is fascicular type and quadrilateral shaped with crescent shaped collateral vascular bundle followed by pericyclic fiber. The midrib

portion has 5-6 layers of collenchymas and 4-5 layers of tightly packed parenchyma. The angular collenchyma is more developed in adaxial surface. Crystal sheath are present in the parenchymatous cell in the midrib region.



**Fig 4:** Transverse section of Lamina of *Ficus carica* (Enlarged) T -trichome, Cu- Cuticle, UE- Upper epidermis, Id - Idioblast, Pal- palisade parenchyma, SP- spongy parenchyma, Cys-Cystolith, LE- Lower epidermis.

**Microchemistry**

**Indumentums:** Trichomes (T) are present both in adaxial and abaxial surface. The trichomes in *Ficus carica* is unicellular, uniseriate, soft walled, single, sharp peak and non-lignified (Fig 6)

**Crystals:** The crystals present in the *Ficus carica* is of two types. a) prismatic crystals; found in the palisade cells in the adaxial layer. b) cystolith; present in the abaxial surface in the spongy parenchyma. Numerous crystal bearing idioblasts are present in the first layer of the palisade layer (fig 12)

**Laticifer:** Laticifer(Lc) is present between palisade parenchyma and spongy parenchyma in the adaxial surface. Laticifer is considered as extension of bundle sheath.(Fig 3)

**Stomata:** *Ficus carica* leaf is hypostomatic where stomata is present only in the abaxial surface. The leaf contains anomocytic stomata, guard cells are surrounded with 5-6 pavement cells (fig 7)

S.no	Microscopical characters	<i>Ficus carica</i> Linn leaves.
1	Petiole	<ul style="list-style-type: none"> <li>• Sinuate and circular petiole section</li> <li>• Multi layered epidermis with cuticle.</li> <li>• Long simple unicellular indumentums.</li> <li>• Cortex with multilayered collenchymas and parenchyma.</li> <li>• Calcium oxalate crystals, druses and lignified fibres.</li> <li>• Leptocentric bundles in the inner region of the pith.</li> </ul>
2	Lamina	<ul style="list-style-type: none"> <li>• Compound, diseriarte, multiple layered epidermis.</li> <li>• Cluster crystals in palisade parenchyma at adaxial surface.</li> <li>• Bifacil mesophyll.</li> <li>• Quadrilateral shaped midrib.</li> <li>• Crescent shaped vascular bundle.</li> <li>• Non glandular, unicellular, soft walled, sharp peaked lignified trichomes.</li> <li>• Anomocytic stomata at abaxial surface only.</li> <li>• Cystolith is present in abaxial surface.</li> </ul>

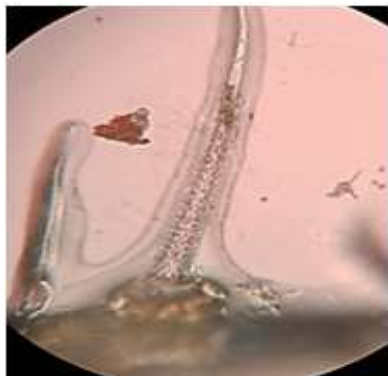
**Powder microscopy**

The powder is dull green colored with characteristic odor and sour mucilaginous taste. The powder shows characters like stellate trichomes (fig 5) with size 20µm. Stellate trichome was investigated for the first time in *Ficus carica* leaves. Lower epidermis with anomocytic stomata (fig 7). Palisade

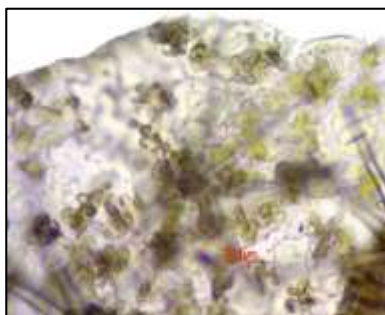
parenchyma (fig 8) are present in the adaxial surface of the bifacial mesophyll. Spongy parenchyma cells are present in the abaxial surface and consist of numerous cystolith. Pitted and reticulate vessels are observed (fig 9, 10). Numerous rosette crystals are seen (fig 12).



**Fig 5:** Stellate trichomes



**Fig 6:** Unicellular trichomes



**Fig 7:** Lower epidermis with anomocytic stomata



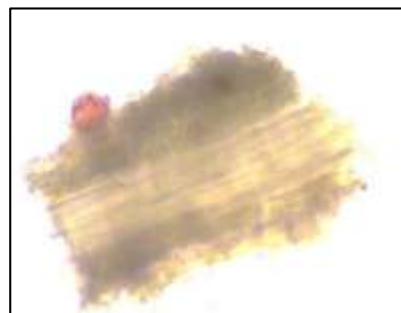
**Fig 8:** Upper epidermis with palisade parenchyma



**Fig 9:** Spiral vessels



**Fig 10:** Reticulate vessels



**Fig 11:** Fibre bundles



**Fig 12:** Rosette crystal

**Table 1:** Quantitative microscopical parameters of *Ficus carica* leaves.

Parameters	Upper epidermis (/mm <sup>2</sup> )	Lower epidermis(/mm <sup>2</sup> )
Epidermal number	960 – 980	480 - 520
Stomatal number	-	165-185
Stomatal index	-	25.9
Palisade ratio	110-120	
Vein islets number	108	
Vein termination number	320	

The above result reveals that the epidermal number of adaxial and abaxial surface are 960-980 mm<sup>-2</sup>, whereas the stomatal number and stomatal index of abaxial surface are 165-185 mm<sup>-2</sup> and 25.9 mm<sup>-2</sup> respectively. The length of stomata is 12 μm and the width of the stomata is 11 μm. Palisade ratio of the leaves was found to be in the range 110-120 mm<sup>-2</sup>. The vein islet number and vein termination number of the leaf was found to be 108 and 320 respectively.

**Discussion**

The adaxial leaf surface is smooth and shiny in most of the studied taxa, but rough and matt in *Ficus carica* Linn<sup>[9]</sup>. The plant *Ficus palmata* is regarded as Indian form or Eastern representative of *Ficus carica*<sup>[10]</sup>. *Ficus carica* is very close to *Ficus palmata* ssp. *virgata* (Roxb) Browicz<sup>[11]</sup> Critical examination of the morphology of the leaves differentiate

*Ficus carica* from *Ficus palmata* and other species of *Ficus* genus. Hypostomatic leaf with ranunculaceous stomata, 2-3 layers of epidermis in the adaxial surface locally or throughout the leaf with idioblasts in the palisade parenchyma, crescent vascular bundle is present. Solerode records circle of bundles in the petiole are the characteristic feature of plants in Moraceae family. Calcium crystals are found to be the common characteristic features of Moraceae family species<sup>[12]</sup>. An almost closed cylinder xylem accompanied externally by numerous phloem groups in the abaxial part of the pith, by other small phloem strands, a few of the phloem being accompanied by a small amount of xylem in *Ficus carica* Linn<sup>[13]</sup>. True hydathodes, appearing to naked eye as spots, small pits, warts, recorded on the adaxial surface, where the veins join one another in species of *Ficus*<sup>[13]</sup>. Lithocyst along with cystolith is present in the abaxial surface<sup>[9]</sup>. Hydathodes are absent both in adaxial and abaxial surfaces, while in contrary<sup>[14]</sup> observed hydathodes both in adaxial and abaxial surfaces. The results mentioned above are similar to that of the observations recorded in different literature. Presence or absence of hydathodes set by *Solreder* to be little diagnostic value owing to their occurrence in single species<sup>[13]</sup>. Laticifers are generally present in the adaxial surface of the mesophyll<sup>[15]</sup>. Glands with long stalk were recorded only in *Genus ficus*. Glandular spots sometimes described as wax glands, present in many species of *Ficus* in the abaxial surface of the leaf either singly on the midrib or at the base of lamina or in the angle between lateral veins of first order and principal veins<sup>[12]</sup>. The trichomes present in the adaxial surface are prickly, unicellular and non glandular, whereas on abaxial surface the trichomes are thin and dense. Prickly and non glandular bulbous based trichomes are present in *Ficus palmate*<sup>[1]</sup>. The study of foliar anatomy of *Ficus carica* leaves revealed a number of important anatomical characters and these characters exhibit interesting interspecific variation that are taxonomically significant. These characters differentiate *Ficus carica* from *Ficus palmata* and other species of *Ficus*. The study conferred the presence of trichomes, ranunculaceous stomata, rosette crystals, vessels and fibre bundles were found, stellate trichome was investigated for the first time in *Ficus carica*. Based on the study the epidermal number and size in the adaxial surface is higher than the abaxial surface. Since *Ficus carica* is a hypostomatic leaves the stomata is restricted to the abaxial surface. The presence of palisade parenchyma is restricted to the adaxial surface which is the evidence for bifacial mesophyll<sup>[2]</sup>. The length and width of stomata in *Ficus carica* is recorded between 11.25-17.5 and 10-13.75 respectively<sup>[1]</sup>. Based on the previous investigational reports and present observation, the quantitative constants were predicted significantly and they are considered as valued taxonomical facts of *Ficus carica* leaves, that might be useful tools for delimiting the taxa.

## Conclusion

Pharmacognostical evaluation is an important monograph index of therapeutically important medicinal plants, for future reference for the researcher and pharmaceutical industry and also an evidence based reference and guidance for the future scope of research development and formulation for pharmaceutical industry. Moraceae a family of dicotyledon plants includes the *Genus ficus*, many *Ficus* species consists of numerous varieties, significant genetic diversity and outstanding therapeutic effects that are remarkable commercial importance. It has been widely used to cure the

disorders and diseases traditionally. Foliar morphology, anatomy and other pharmacognostical studies serves as good taxonomical tool for delimiting taxa. The study interrogate the unique characters of *Ficus carica* for identification of *Ficus* and differentiating it from its closely related species *Ficus palmate* and other species of *Genus ficus*.

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