



ANATOMICAL CHARACTERIZATION OF *PTEROSPERMUM RUBIGINOSUM* B. HEYNE EX G. DON. AS AN AID FOR TAXONOMIC IDENTIFICATION

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(M. Sc Dissertation)

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Abstract

Pterospermum rubiginosum B. Heyne ex G. Don, traditionally belongs to the family Sterculiaceae and as per Angiosperm Phylogeny Group included in the expanded Malvaceae under the subfamily Dombeyoideae. This species has antioxidant and anti-inflammatory properties, so several investigations had been done in this regard. Hence the aim of this study is the anatomical characterization of leaf, petiole and stem of *Pterospermum rubiginosum* B. Heyne ex G. Don, as an aid for taxonomical and systematic identification of the species. The anatomical characteristics such as plano-convex midrib, stellate trichomes in leaves, presence of numerous druses in leaf midrib, lamina, petiole, stem and prismatic crystals throughout the plant are the major anatomical features that could be utilized for the taxonomic identification of the species as a Malvaceae member.

Keywords: Anatomy, Druses, *Pterospermum rubiginosum*, Prismatic crystals, Stellate trichome.

I) Introduction

The evergreen tree *Pterospermum rubiginosum* B. Heyne ex G. Don, traditionally belongs to the family Sterculiaceae and included in the expanded family Malvaceae as per the Angiosperm Phylogeny Group (APG, 2016). 'Ellootti' or 'Edinjil' is the vernacular name (Malayalam) of the taxa. This species is endemic to the Indian sub-continent, specifically in Karnataka, Kerala, Tamil Nadu and Western Ghats (Nayar et al., 2006). The genus *Pterospermum* Schreb. belongs to the eudicot, family Malvaceae under the subfamily Dombeyoideae (Wilkie et al., 2006; APG, 2009). It has 25-30 species and is found from the eastern Himalayas to Southern China, via Southeast Asia to the Moluccas in tropical Asia (Wilki, 2007). *Pterospermum* was classified in Malvaceae by Bayer (2003), APG III (2009) and Chase et al (2016).

The name *Pterospermum* is a mixture of two Greek terms, 'Pteron' and 'Sperma', both of which imply "winged seed." The plant is distinguished by its unusual leaf colour, which is green on the upper side and pale reddish on the lower. *Pterospermum aureum* S.K. Ganesan is unique in that the upper surface of its leaves dries lighter than the lower surface. The upper surface of all other species dries darker than the lower surface (Ganesan et al., 2020). Inflammation and pain alleviation are routinely treated using leaf extract combined with heated oil for rubbing (Devi Prasad and Shyma, 2013; Vijayan et al., 2007). Migraine is treated with flowers (Nirmal and Nimya, 2018) and wounds are treated with tree bark (Latheef and Remashree, 2014). *Pterospermum* species are utilized as wood (Kochummen, 1972) and dyes (Burkill, 1966) and it's conceivable that they're drought tolerant. *Pterospermum* species may recover effectively in disturbed forests, grow quickly, and provide good-quality wood (Sosef and Prawirohatmodjo, 1998). The hydraulic system's effectiveness and safety

are determined by various wood anatomical characteristics, most notably vessel components, but fiber cell wall, fiber and tracheid characteristics (Wheeler et al., 2005; Hacke et al., 2006; Sperry et al., 2006). Thick-walled fibers boost the wood's mechanical strength, induce high density and strengthen the vessels (Jacobson et al., 2005). As previously discovered herbs to trees, Dombeyoideae shrubs have stronger fiberwalls than trees or sub trees in the family (Carlquist, 1958; Devi Prasad Shyma, 2013). The barks of *Pterospermum rubiginosum* B. Heyne ex G. Don is used in traditional medicine, especially for the treatment of wounds, sprains and bone fracture. This species has antioxidant anti-inflammatory medicinal values and several investigations have been reported in this regard (Baye, 1999), but anatomically less explored (Mitra and Maity, 2014). Hence the aim of this study is the anatomical characterization of the leaf, petiole and stem of *Pterospermum rubiginosum* B. Heyne ex G. Don, as an aid for taxonomical and systematic identification of the species.

II) Research Methodology

The material was collected from C M S College Kottayam campus (9°35'54.2" N 76°31'15.5"E) Kottayam district in Kerala (Plate-1). The leaf and the stem were collected from healthy mature plant for anatomical studies. The mother plant was provisionally identified with the help of Florill, Flora on the campus hill (Thomas et al., 2014).

General Information.

Family : Malvaceae.

Habit : Large tree up to 28m tall.

Flowering and fruiting : November- April.

Habitat : Evergreen-Semi evergreen Forests.

Distribution: Endemic to the Western Ghats, South and Central Sahyadris (up to Coorg Region).

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Plate-1. Habit of *Pterospermum rubiginosum* B. Heyne ex G. Don

Determination of Organoleptic Characters.

To analyze the micro-morphological features of leaves, mature leaves were collected. The leaf area, length and width measurements were made using graph paper.

Scanning Electron Microscopy (SEM).

The leaf surface characteristics were examined by SEM analysis. The SEM images of the leaf were taken by using JSM-6390, model SEM at Sophisticated Test and Instrumentation Centre (STIC), Cochin University of Science And Technology (CUSAT), Kerala, India.

Anatomical studies.

The distribution of different histological layers of cells like epidermis, cortex, vascular bundles and pith, etc. were observed from the microscopic examination. All the samples were analyzed by using Magnus MLXi Plus microscope equipped with Magnus camera adapter. The terminology was followed by Wheeler et al (1989) and Metcalfe and Chalk (1950).

Leaf:-Thin transverse sections of the midrib, petiole and lamina were taken, stained with Safranin and mounted in 50% glycerin, then observed under the microscope. The epidermal peel was taken to study the leaf surface characteristics and the stomatal index was also calculated (Salisbury, 1927).

$$\text{Stomatal index (\%)} = (S/S+E) \times 100.$$

Stem:-The microscopic observations through the transverse section (T.S), radial longitudinal sections (R.L.S) and tangential longitudinal section (T.L.S) of the stem (around 1cm diameter) had been done. All the sections were treated in 30% sodium hypochlorite solution (NaOCl) for 3-5 minutes and washed repeatedly in distilled water to remove the traces of the bleaching agent. Safranin was used for staining the sections. The sections were mounted in 50% glycerine and observed under microscope (Carlquist, 2013).

III) Result and Discussion

The Malvaceae members are characterized by the presence of stellate hairs and secretory canals containing mucilage in the ground tissue of axis and leaf; vessels with simple perforation plate, diffuse wood parenchyma, deposition of oxalate of lime in the form of solitary and clustered crystals and broader multiserial ray parenchyma (Solereider, 1908).

a) Organoleptic Characters of leaf and stem.

The external micro-morphological characteristics of the leaf and the stem were specific in this selected species (Table-1). Organoleptic evaluation can be done using sense organs, which are the easiest and fastest way for the identification the plant (Sumitra, 2014).

Table-1: The organoleptic characters of *Pterospermum rubiginosum* B. Heyne ex G. Don

Characters	<i>Pterospermum rubiginosum</i> B. Heyne ex G. Don
Colour	Upper surface green, lower surface pale reddish colour
Odour	No
Shape	Elliptic -ovate
Texture	Adaxial surface-smooth Abaxial surface-rough
Apex	Acuminate
Base	Oblique
Margin	Entire
Venation	Reticulate
Petiole	Stout
Leaf arrangement	Simple- alternate
Average leaf area	1256.2mm ²
Average leaf length	7.1cm
Average leaf width	2.5cm
Stem colour	Brown
Stem odour	Nil

b) Anatomy of leaf

The transverse section (T.S.) of *Pterospermum rubiginosum* B. Heyne ex G. Don shows plano-convex midrib (Plate-2). The vascular bundle encircled by sclerenchymatous ring. A layer of cavities is present at the basal portion of the midrib. Numerous druses were present throughout the cortex, vascular region and the pith. The T.S. of the leaflet shows an upper and lower thin cuticle and unlayered epidermis (Plate-2). The lower epidermis possesses stellate trichomes. According to the study on *Ardisiacrispa* Family Primulaceae, Miller et al (1984), reported the presence of numerous trichomes on both the upper and lower surface of leaves. Stellate trichome is one of the main features of the family Malvaceae. Celka et al (2009) reported the importance of trichomes in taxonomy. The Stomata are anisocytic and the index was 24.5%. The vascular bundles of the leaf were provided with enlarged terminal tracheids. Microscopic analysis of T.S. of leaf lamina, midrib and petiole was useful for preparing qualitative as well as quantitative anatomical data reported by Vigi and Hari (2021). The leaf lamina showed thick cuticle with rectangular shaped uniseriate epidermis. In the mesophyll, highly enlarged bilayered palisade and with few layer of loosely arranged spongy parenchyma and group of tracheidal cells were present. The druses were present throughout the lamina. The SEM analysis showed the thick layer of trichomes on the lower epidermis, where the stomata are not directly visible (Plate-2). The trichomes observed as star shaped, non-glandular and are belonging to the category of stellate trichomes.

c) Anatomy of petiole.

The transverse section of petiole showed circular outline with single layered epidermis and consist of numerous stellate trichomes (Plate-2). Presence of curved, closed and omega shaped vascular strand in the petiole is highly specific. Metcalfe and Chalk (1950) reported the peculiar nature of vascular strand in this species. Anatomy of petiole showed numerous druses present throughout the cortex and few in the pith region. Vascular bundles in the petiole have been investigated by several researchers in various families. Ergen et al. (2011), identified seven types of vascular bundles in Lamiaceae and the importance of hairs and the structure of vascular bundles in the systematics.

d) Anatomy of stem.

The transverse section of stem showed the presence of a wide cortex and an outer periderm (Plate-2). The cortex consists of collenchymatous hypodermis; chlorenchyma and patches of parenchymatous cells. The xylem vessels became solitary to clustered, radially arranged and round in shape (Plate-2g). The vascular cylinder consists of both uniseriate to multiseriate medullary rays (Plate-2h). Numerous druses were present in the cortex and also in the pith. According to Metcalf and Chalk (1950), generally in dicotyledonous plants the distribution of epidermal, hypodermal and vascular tissue systems is valid for systematics. The phloem dilatations were prominent (Plate-2g) and the secondary phloem with phloem fibers. Trockenbrodt and Parameswaran (1986), reported that in *Inga huberi*, the dilatation is mostly limited to the phloem rays and is often uneven. However, the parenchyma cells dilate to a significant degree. The secretory canals were restricted to the pith region and were lined by epithelium. According to Hari et al (2019), the secretory canals have epithelial lining as in *Brownea ariza* Benth. According to Rodrigues et al (2011) the secretory canals and cavities present in *Copaifera langsdorffii* is one of the key characteristics for the identification of species.

The radial longitudinal section (R.L.S) of *P. rubiginosum* showed alternative inter-vessel pittings and a simple perforation plate (Plate-2j). The vessel wall showed distinctly bordered perforations. Alternate intervessel pits were most likely chosen as the most structurally efficient method to put cracks in the wall, with the equivalent of a honeycomb structure being stronger than horizontally positioned pits (Carlquist, 2013). The multiseriate heterocellular ray parenchyma cells are composed of central procumbent cells and 2-3 layered marginal upright cells (Plate-2j). The ray cells also contain prismatic crystals and starch grains. The transverse longitudinal section (T.L.S) of *P. rubiginosum* B. Heyne ex G. Don showed the non-septate fibers having simple pits, tracheids and prismatic crystals (Plate-2k). Joyce et al (2020), reported the characteristic distinction of *Paullinia* species from the other *Paullinieae* genera that the rays and the axial parenchyma have septate fibers and crystals. The study was helped for systematic characterization through the anatomy of leaf, petiole and stem of *Pterospermum rubiginosum* B. Heyne ex G. Don.

IV) Conclusion

The anatomical characteristics such as multiseriate medullary rays, secretory cavities, wedge-shaped phloem fibers, plano-convex midrib, stellate trichomes in leaves, presence of numerous druses in leaf midrib, lamina, petiole, stem, and presence of prismatic crystals are used as the key characters to this selected plant.

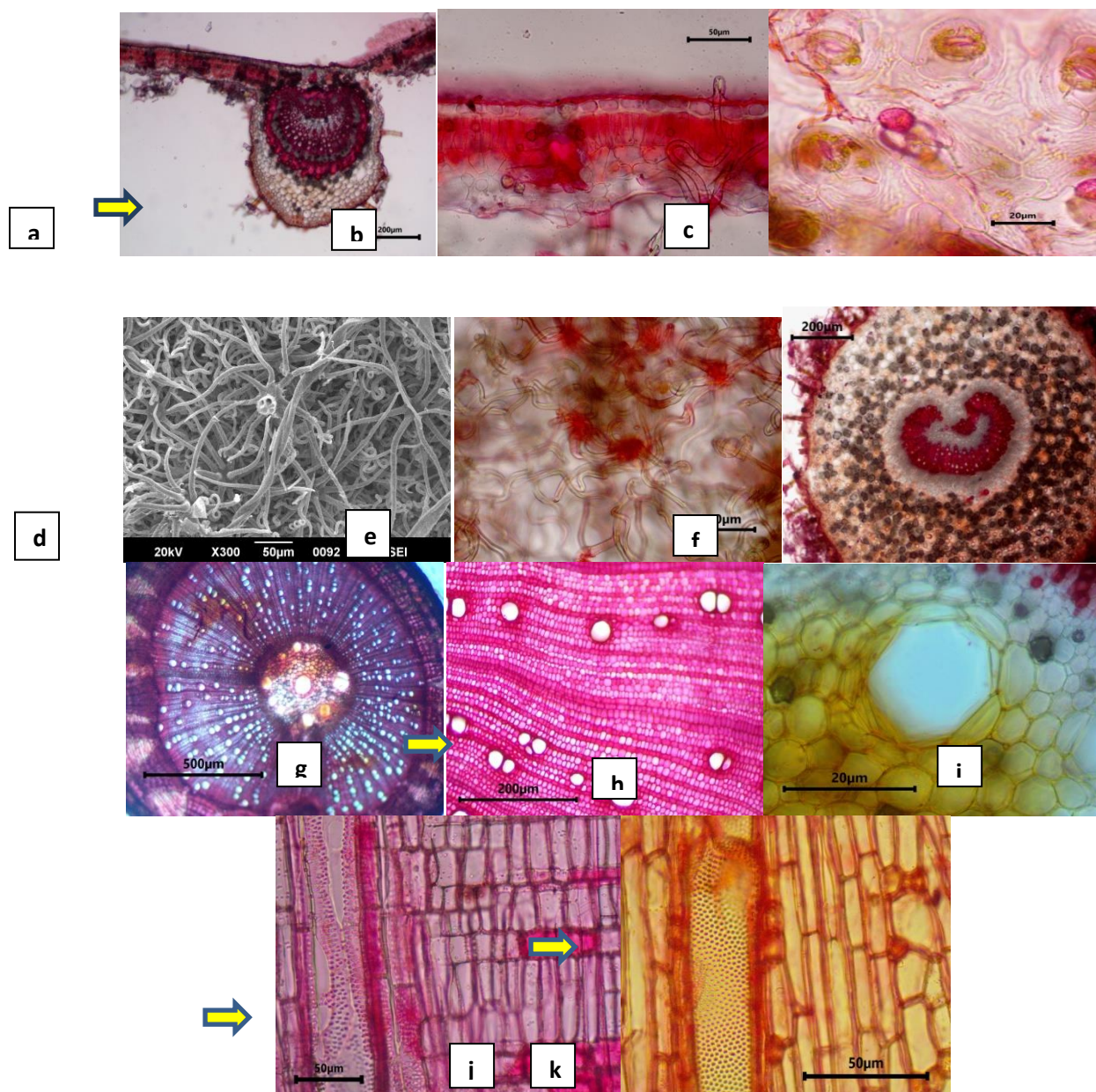


Plate- 2. Microphotographs of Leaf, stem and petiole of *Pterospermum rubiginosum* B. Heyne ex G. Don [a= T. S of midrib showing druses in cortex, b= T. S Lamina, c= anisocytic stomata, d= SEM image of abaxial surface with numerous trichomes, e= stellate trichome, f= T.S of petiole, g= T.S of stem showing pith and phloem dilatation at cortex, h= uniseriate to multiseriate rays, i= secretory canal, j= R.L.S of stem with xylem vessels showing alternate intervessel pitting, k= T.L.S of stem with multiseriate ray parenchyma with starch, tracheids with prismatic crystals.]

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