



Research Article

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LEAF STRUCTURAL CHARACTERISTICS OF IMPORTANT MEDICINAL PLANTS

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ABSTRACT

The aim of this study was to provide key distinguishing leaf microscopic features of important medicinal leaves. Epidermal peels, transverse section of leaves were taken and were stained using safranin and fast green, permanent slides were prepared. The structures were studied using compound microscope, Photography of images were saved. 32 leafy drugs belong to 22 families were studied for their pharmacognostic features and their key features were tabulated. Among these 6 drugs were also consumed as food. Prominent macroscopic and microscopic characters were presented. 16 epidermal peel images were shown in the plates. 5 species showed compound leaves. 17 species were herbs, 3 were shrubs 6 were climbers and 6 were trees. 4 were hydrophytes. Anamocytic stomata was found in 12 species, Paracytic type was found in 8 species, diacytic stomata was found in 6 species, anisocytic stomata was found in 5 species. Cystolith crystals observed in 14 species. The leaves were glabrous in 20 species. Some leaves were having unique structure e.g. Stomata and resin canals of *Aegle marmelos*, Stomata, epidermal cells and venation of *Cinnamomum tamala*, two layered epidermal cells of *Lagerstroemia speciosa* and larger guard cells of *Mangifera indica*. In case of *Indigofera tinctoria* and *Tephrosia purpurea* (Fabaceae members) single colorless cell layer separates palisade and spongy tissue. Trichome structure shows so much diversity in the leaves which are often important tool for the identification of the drug when it is in powder form.

Keywords: Anatomy, Crude drug, epidermal peel, Microscopy, Stomata, Trichomes

INTRODUCTION

Leaf macroscopic and microscopic features are very much important as far as taxonomic and pharmacognostical value is concerned. The current study aimed to bring the comparative structural features of 32 leaf drugs. The information is useful in the identification of the genuine drug both in the dried form and powder form. In order to concise the presentation only important features were described. A table with key features of 32 leaf drugs is cited. Some of the common features of leaves which are applicable to several leaves; unequal upper epidermal cells with a cuticle layer, smaller lower epidermal cells, convex lower midrib, plain or grooved upper midrib, laterally elongated upper epidermal cells, nearly c shaped midrib vascular cylinder, collenchymatic hypodermal tissue at the midrib region, sub stomatal chambers adjacent to lower epidermis, vascular tissue parallel to the epidermis in the mesophyll with spiral thickening, pith cells of petiole larger in the middle, smaller at the periphery. Srivastava *et al.* made a bibliographic survey of anatomical studies of Indian medicinal plants¹. Epidermal micromorphology of *Cassia* species was published by Kotresha and Seetharam². Stomatal ontogeny of some Lythraceae members was worked out by Thanki *et al.*³. Pharmacognostical and preliminary phytochemistry of *Basella alba* was done by Shantha *et al.*⁴. Bhadane and Patil studied epidermal features of *Walsura trifolia*⁵. Jadega *et al.* published the epidermal and trichome features of some Solanaceae members⁶. A series of publications^{7,8} from Indian Council of Medical Research (ICMR) provided the leaf microscopic details of several medicinal plants. Saraswathy *et al* studied the pharmacognosy of *Peristrophe paniculata*⁶.

MATERIALS AND METHODS

Materials used for the study were collected from the southern states, mostly fresh material was used. The identity of the samples was confirmed at NISCAIR, New Delhi, India. The herbarium specimens and Permanent slides were deposited in the drug repository of R and D Centre, Natural Remedies Private Limited. The herbarium accession numbers were *Acalypha indica* L. - 184, *Achyranthus aspera* L. - 76, *Justicia adhatoda* L. (= *Adhatoda vasica* Nees) - 713, *Aegle marmelos* (L.) Corr.- 375, *Alternanthera sessilis* (L.) R. Br. ex DC. (= *A. triandra* Lam.) - 156, *Andrographis paniculata* (Burm. f) Nees. - 1009, *Azadirachta indica* A. Juss. - 1026, *Bacopa monnieri* (L.) Pennel - 1022, *Basella alba* L. - 1067, *Boerhavia diffusa* L.- 928, *Senna alexandrina* Mill. (= *Cassia angustifolia* Vahl.) - 975, *Centella asiatica* (L.) Urban - 1015, *Cinnamomum tamala* (Buch - Ham) Nees and Ebern. 275, *Coccinia grandis* (L.) J. Voigt -753, *Cyanodon dactylon* (L.) Pers.- 1068, *Eclipta prostrata* (L.) L.- 99, *Gymnema sylvestri* (Retz.) R. Br ex Sm. - 965, *Hibiscus rosa-sinensis* L. - 1069, *Indigofera tinctoria* L. - 917, *Lagerstroemia speciosa* L. -934, *Lawsonia inermis* L. - 1070, *Leucas lavendulifolia* Sm.177, *Mangifera indica* L. - 109, *Moringa oleifera* Lam. - 746, *Ocimum tenuiflorum* L. - 967, *Phyllanthus amarus* Schum and Thonn - 819, *Piper betel* L.- 1071, *Plectranthus amboinicus* (Lour.) Spreng - 1072, *Solanum nigrum* L. - 107, *Solanum virginianum* L. - 782, *Solanum trilobatum* L. - 261, *Tephrosia purpurea* (L.) Pers. - 529, *Tylophora asthmatica* Wight and Arn.- 1073. Hand sections of fresh material was taken, stained with safranin and observed under compound microscope. The epidermal peels were taken from fresh leaves after allowing it to wilt for half a day, wilted leaves when tear into two pieces from basal side to apical side, thin peels

were obtained, which was used for the stomatal structure study. The good sections were selected using stereo dissection microscope and were processed using different grades of ethyl alcohol in order to make permanent mount. Double staining procedure was followed¹⁰. The slides were studied using Olympus microscope with attached camera. Good structural features were photographed in different magnifications. Based on the close observation; the microscopic characters were described. The plants are listed below alphabetically with key microscopic features.

RESULT AND DISCUSSION

Acalypha indica L. (Harithamanjari) – Euphorbiaceae

Leaves alternate, arranged in mosaic pattern, lower with longer petiole, margin finely serrate, veins palmately reticulate, glabrous, herbaceous, greenish – yellowish green. Stomata are paracytic, out of the two subsidiary cells one is larger. Plate 1: *Acalypha indica* leaf peel x 400.

Achyranthus aspera L. (Chirchita)- Amaranthaceae

Leaves opposite, obovate or round, attenuate at base, collateral vascular bundles arranged in a circular manner. Trichomes are 3 cellular, basal segment is bulbous, middle segment is short, the terminal segment is elongated and pointed. Palisade and spongy layers are in 2- 3 tiers. Plate 2: *Achyranthus aspera* leaf peel x 400.

Aegle marmelos (L.) Corr. (Bael) – Rutaceae

Leaf trifoliolate, margin crenate, glabrous, stomata are characteristic subsidiary cells are different from epidermal cells, similar to tetracytic and paracytic, palisade is 2 layers arranged uniformly, 1 or two resin canals observed in between the palisade tissue. Below the palisade are about 4 horizontal rows of thin walled cells. Plate 3: *Aegle marmelos* leaf peel x 400

Alternanthera sessilis (L.) R. Br. ex DC. (=A. triandra Lam. (Matsyakshi) – Amaranthaceae

Leaves opposite, sessile, oblong – lanceolate. Leaf peel shows distinct diacytic stomata and star shaped cytolith. Few septate trichomes present at the upper epidermis. Spongy tissue is with hexagonal rather closely arranged parenchyma cells.

Andrographis paniculata (Burm. f) Nees. (Kalmegh) - Acanthaceae

Leaves opposite, lamina attenuate at base, glabrous, Parenchyma cells are provided with plasmodesmata bridges. Palisade cells single layered, upright and compactly arranged. Plate 4: *Andrographis paniculata* leaf peel x 400

Azadirachta indica A. Juss. (Margosa) –

Meliaceae: Leaves odd pinnate, leaflets falcate. A supportive patch of sclerenchyma is present at the outer side of both vascular bundles, Cells between palisade and

spongy are often larger, air chamber present below the stomata in the upper epidermis. Stomata are absent in the upper epidermis.

Bacopa monnieri (L.) Pennel. (Jal brahmi) - Scrophulariaceae

Leaves are smooth, sub succulent, obovate, entire, obtuse, rosette crystals found in the epidermis. Vascular bundle covered by bundle sheath. Plate 5: *Bacopa monnieri* leaf peel x 400

Basella alba L.(Poi, Indian spinach)- Basellaceae

Leaves, alternate, petiole short, ovate, entire, acute to sub acuminate, 5 pairs of veins, palisade 2-3 layers, short, spongy 3-4 layers, distinct bundle sheath at the mid rib region. Plate 6: *Basella alba* leaf peel x100

Boerhavia diffusa L. (Shanthi, Punarnava) - Nyctaginaceae

Leaves opposite, petiole short, one leaf is smaller, ovate or orbicular, undulate, leaf pale below, square cells, 3 vascular bundles present in the centre. Acicular fine needles of calcium oxalate formed a bundle, this crystal bundle is vertical or oblique, another type of crystal is discoid with two to three orbicular pieces. Plate 7: *Boerhavia diffusa* leaf peel x 400

Centella asiatica (L.) Urban (mandukaparni)- Apiaceae

Leaf alternate with a long pedicel, leaf base has short sheath, lamina reniform, margin dentate, leaf cordate at base, stoma is paracytic, Plate 8: *Centella asiatica* leaf peel x 400

Cinnamomum tamala (Buch - Ham) Nees and Ebern. (Tej) - Lauraceae

Leaves petiolate, opposite – alternate, ovate to lanceolate, entire, acute – obtuse, 3 main veins arising from leaf base, spicy aroma, coriaceous. Upper epidermis is with abnormal suberin deposition, gives reticulate appearance in surface view, vascular bundle is enclosed by a sclerenchymatic sheath. Phloem tissue is just below the xylem, it has some secretory canals. Transverse veins linking the main nerves are visible in the transverse section.

Coccinia grandis (L.) J. Voigt (Bimbi) – Cucurbitaceae

Petiole is circular in outline, 6 bi-collateral vascular bundles are in a ring, the epidermal cells are nearly angular, few trichomes are present. Palisade cells are in 1- 2 tiers.

Cyanodon dactylon (L.)Pers. (Durva) – Poaceae

Oblong linear leaves, base with sheath enclosing the stem; veins parallel, between adjacent bundles near the lower epidermis 1- 3 larger globular parenchyma cells seen, vascular bundles contain 2 meta xylem, 1 proto xylem and a round air chamber (Characteristic feature of monocot vascular bundles).

***Eclipta prostrata* L. (Bringaraj) –**

Asteraceae

Leaves scabrous, entire, obtuse, trichome tuberculated, apex pointed, starch grains in the spongy tissue. Plate 9: *Eclipta prostrata* leaf peel x 400

***Gymnema sylvestre* (Retz.) R. Br (Gudmar) -
Asclepiadaceae**

Petiole is 0.3- 0.5 cm, lamina is often slightly cordate at base, acute, margin entire, veins convergent towards tip, Spongy parenchyma is 7- 8 layers thick, cells are arranged compactly in uniform rows, several rosette calcium oxalate crystal (Druces) present in the ventral side. Plate 10: *Gymnema sylvestre* leaf peel x 400

***Hibiscus rosa – sinensis* L. (Jatru) –**

Malvaceae

Petiole 2-3 cm long, greenish with stellate trichomes. Leaves ovate lanceolate, margin serrate, acute to sub acuminate; veins palmately reticulate. Petiole triangular in out line, Sclerenchyma layer is covering the vascular tissue. Semicircular chambers present at different places just below the epidermis. Plate 11: *Hibiscus rosa- sinensis* leaf peel x 400

***Indigofera tinctoria* L. (Neelini) –**

Fabaceae

Leaves alternate, odd pinnate, leaflets opposite, 4-5 pairs, green – bluish green. Epidermal cells are with undulate walls. Palisade is 2- 3 tiers thick, there is a colorless demarking parenchyma layer between palisade and spongy. Prismatic crystals are specifically present at the phloem region. Plate 12: *Indigofera tinctoria* leaf peel x 400.

***Justicia adhatoda* L. (= *A. vasica* Nees) (vasaka) -
Acanthaceae**

Leaves are large, oblong – lanceolate, subcoriaceous, entire, acute – acuminate, 10- 20 x 4-6 cm. One middle big vascular bundle and three smaller vascular bundles present in the mid rib zone. Few trichomes present in the lower epidermis. Plate 13: *Justicia adhatoda* leaf peel x 400

***Lagerstroemia speciosa* L. (Banaba)-**

Lythraceae

Leaf opposite, petiolate, oblong, margin entire, apex acute, glabrous, coriaceous, about 10 pairs of thick veins, leaf midrib nearly fan shaped at the ventral side, vascular tissue is well developed, nearly square shape, pericyclic sclerenchyma patches surrounding vascular tissue, sclerenchyma patches also found inner side of xylem, good amount xylem vessels present in radial multiples, central pith with 2 resin canals, few resin ducts present in the cortical zone, the upper epidermal cells are larger, often 2 layered, palisade is in two rows, vascular traces supported by sclerenchyma tissue which often extends up to the epidermis. Plate 14: *Lagerstroemia speciosa* leaf peel x 400.

***Lawsonia inermis* L. (Henna) –**

Lythraceae

Leaves opposite, sessile, elliptic or ovate, narrow at base, entire, acute, pinnately reticulate, glabrous, subcoriaceous, small. Epidermal cells slightly undulating, stomata are anisocytic, 3-5 epidermal cells found adjacent to stomata, in the midrib 15-17 xylem strands are surrounded by phloem which is surrounded by 2-3 layers of sclerenchyma at the lower side. Palisade layer is 2- 3 layered, spongy layer also 3-4 layers thick, compactly arranged. Several rosette crystals are scattered in the spongy region. Plate 15: *Lawsonia inermis* leaf peel x 400

***Leucas lavendulifolia* Sm. (Dronapushpi) –**

Lamiaceae

3 species of Leucas are used as drona pushpi. Leaves linear to lanceolate, narrow, serrate, acute to acuminate with strong aroma,

***Mangifera indica* L. (Mango) –**

Anacardiaceae

Leaf simple, petiolate, petiole 3-4 cm long, pulvinate at base, leaf blade is oblong some times lanceolate, margin entire, apex acute to acuminate, pinnately reticulate, glabrous coriaceous, greenish, 10-20 x 3-5 cm. Lower epidermis consists of anamocytic stomata, the guard cells are exceptionally larger and semicircular surrounding the stomatal aperture, plenty of star shaped crystals found in the epidermal cells adjacent to stoma; Palisade is 2-3 vertical rows, spongy cells in horizontal rows adjacent to the lower epidermis. At the inner part mesophyll cells forms vertical chambers. Mid rib zone has 6-7 collateral vascular bundles, at the outer zone 6- 7 resin canals are present surrounding the vascular bundle. Resin canal present at the centre of mid rib also is lined by parenchyma layer.

***Moringa oleifera* Lam. (Sahjan) –**

Moringaceae

Leaves are tripinnately compound, alternate, rachis pulvinate at base, leaf with characteristic odour, leaflets are with short filiform petiolule, elliptic, entire, obtuse - mucronate, glabrous, short trichomes, aseptate, pointed, stoma anamocytic, palisade is 2-3 layers thick, circular or oval resin ducts are present just below the upper epidermis. Rosette crystals are found in multiples near the lower epidermis.

***Ocimum tenuiflorum* L. (Tulasi) –**

Lamiaceae

Lamina ovate, serrate, obtuse to acute, glandular pubescent, odour aromatic, epidermal cells are normally undulate, medium sized, stomata are diacytic, Phloem cells located below the xylem. Palisade is made up of single vertical layer of cells.

***Phyllanthus amarus* Schum and Thonn. (Bhumiamla) -
Euphorbiaceae**

Leaves are looking like pinnately compound. It is a short branchlet with several leaves. Leaves are alternate with short petiole, oblong, entire, obtuse – acute, veins pinnately reticulate, faint, glabrous, herbaceous 0.9 x 0.5

cm. Palisade usually with one tier cells, spongy also with one or two row of cells. Stomata are anisocytic, epidermal cells are with deeply undulating walls.

***Piper betel* L. (Pan, Nagavalli)**

Piperaceae

The leaf has pale green petiole. Lamina is cordate, entire acute to acuminate, black and white varieties are available, white variety is relatively narrower sub coriaceous, aromatic. Petiole has ring of 7-8 peripheral vascular traces and middle bigger vascular trace, oil canal and calcium oxalate rosette crystals. The crystals present on the cortex and inside vascular bundles. Vascular bundles are collateral, more xylem vessels are seen in the xylem zone. Distinct oil canal is present in the cortex. Lamina peel shows numerous stomata with tetracytic type subsidiary cells, dotted oil glands also found intermixed with stomata, Stomata are found both on the upper and lower side of the leaf, the arrangement of subsidiary cells some times changing. The leaf upper epidermis 3 layered, lower epidermis two layered; lamina differentiated in to palisade and spongy, Palisade layer is with single vertical row of cells; spongy layer with 3-4 row of cells. Numerous rosette crystals of calcium oxalate and oil ducts are present.

***Plectranthus amboinicus* (Lour.) Spreng (Patharchur) – Lamiaceae**

Leaves aromatic, gives the odour of ajwain, are succulent, hairy, petiolate, round to ovate, crenate, obtuse to sub acute, septate and glandular trichomes are present. Stomata are diacytic.

***Senna alexandrina* Gars. ex Mill. (= *Cassia angustifolia* Vahl.) (Senna) - Caesalpinaceae**

Leaf pinnately compound, impairy pinnate, terminal leaf let slightly larger, leaflets ovate to lanceolate, narrow, round at base, margin entire, acute, veins indistinct, glabrous, greenish above, glossy green beneath. Plate 16: *Senna alexandrina* leaf peel x100.

***Solanum nigrum* L. (Makoy) – Solanaceae**

Lamina is petiolate, leaf base attenuate, ovate lanceolate, coarsely serrate, basal teeth larger, apex obtuse - acute, nearly glabrous, sometimes pubescent, herbaceous greenish above, glossy or reddish beneath. Glandular and septate trichomes present both the upper and lower epidermis. Palisade is with one layer of upright cells. Xylem vessels are with annular or spiral thickening.

***Solanum virginianum* L. (Kantakari) – Solanaceae**

Leaves alternate, pinnately lobed, pale spines on both sides of the blade, glabrous, spongy tissue made up of 4 horizontal rows.

***Solanum trilobatum* L. (Vallikantakarika) – Solanaceae**

Leaves alternate, petiole with prickles, lamina ovate, margin entire, deeply lobed, apex obtuse, glabrous, prickles on the veins, glabrous 4-6 x 2-4 cm. Petiole is

round shaped in cross section, in the middle a c shaped vascular bundle covered with bundle sheath, 8-10 xylem strands each with about 5-6 xylem vessels. 2 small round vascular traces at the adaxial side near the epidermis. Stomata is anamocytic, 4-5 subsidiary covering the guard cells, palisade is made up of single vertical layer of cells.

***Tephrosia purpurea* (L.) Pers. (Sharphonka) - Fabaceae**

Leaf is pinnately compound, unipinnate, 5-7 pairs of leaflets obovate, obtuse or retuse at apex. Margin is entire, veins parallel, 6-8 cm long leaf, leaflets 1-1.8 x 0.5 – 1 cm coriaceous. Epidermal cells are nearly polygonal, stomata are nearly paracytic, sometimes 3 subsidiary cells are observed. A distinct thin walled cell layer separates the palisade and spongy layer. Lower epiderm is with bicellular glandular trichome and septate uniseriate trichome. Palisade area is wider than spongy area. Leaf vascular bundle is also with sclerenchyma cap.

***Tylophora asthmatica* Wight and Arn. (Antamul) - Asclepiadaceae**

Leaves opposite, petiolate, ovate, cordate at base, margin entire, apex acute – acuminate, sub succulent, glabrous above, pubescent beneath, veins indistinct, yellowish green. Upper epidermal cells are angular and with out stomata, lower epidermal cells are slightly undulate, trichomes septate, comprises three cells, stomata are paracytic. Vascular bundle is bicollateral. Palisade is made up of two layers of upright cells. Rosette crystals present in the mesophyll.

CONCLUSION

This was a remarkable study of its kind because it aims for a detailed study of commonly used leafy drugs. This study provided a comparative picture of 32 different species of medicinal leaves with illustration of some important plants (Plates 1-16) and tabulated the key anatomical features of 32 species (Table 1). Except *Cyanodon dactylon* all others are dicotyledonous plants. 6 drugs are also consumed as food. 5 species shown compound leaves. 16 species were herbs, 3 were shrubs six were climbers and 6 were trees. 4 were hydrophytes. Anamocytic stomata was found in 12 species, Paracytic was found in 8 species, diacytic stomata was found in 6 species, anisocytic stomata was found in 5 species. Cystolith crystals observed in 14 species. The leaves were glabrous in 20 species. Some leaves were having unique structure e.g. stomata and resin canals of *Aegle marmelos*; stomata, epidermal cells and venation of *Cinnamomum tamala*; two layered epidermal cells of *Lagerstroemia speciosa*, larger guard cells of *Mangifera indica* and in case of *Indigofera tinctoria* and *Tephrosia purpurea* (Fabaceae members) single colorless cell layer separates palisade and spongy tissue. Trichome structure shows so much diversity in the leaves which were often important tool for the identification of the species. Single layered palisade was found in 7 species, In *Basella*, *Plectranthus* and *Bacopa* mesophyll tissue was not differentiated in to palisade and spongy.

Table 1: Comparative Leaf Characteristic Features of 32 Species

S. No.	Botanical name	Trichomes	Stomatal type	Other characteristic features
1	<i>Acalypha indica</i> ,	Aseptate, short	Paracytic	1- layered palisade, big bunch of crystals
2	<i>Achyranthus aspera</i>	Septate trichomes.	Anamocytic	Rosette crystals dispersed.
3	<i>Aegle marmelos.</i>	glabrous	Special type of paracytic	Resin duct, compact 3tier mesophyll tissue, 8 layers below palisade.
4	<i>Alternanthera sessilis,</i>	Sub glabrous	Diacytic	2-3 layered palisade, distinct bundle sheath
5	<i>Andrographis paniculata,</i>	Lithocysts	Diacytic	1-layer palisade , 3-4 layer spongy
6	<i>Azadirachta indica,</i>	glabrous	Anamocytic	3 tier tissue, rosette crystals
7	<i>Bacopa monnieri,</i>	8 celled Glandular	Anisocytic	Not differentiated into palisade and spongy
8	<i>Basella alba</i>	Glabrous, succulent	Paracytic	Star shaped crystal in the mesophyll
9	<i>Boerhavia diffusa</i>	Septate trichomes	Anisocytic	Rosette crystals, 3 layered palisade
10	<i>Centella asiatica,</i>	Glabrous	Paracytic	2 layered palisade, substomatal chamber
11	<i>Cinnamomum tamala</i>	glabrous	Anamocytic	Extraordinary epidermal deposition
12	<i>Coccinia grandis</i>	glabrous	Anamocytic	Angular epidermal cells
13	<i>Cyanodon dactylon</i>	Glabrous	Dumbbell	5-6 big bundle sheath cells.
14	<i>Eclipta prostrata,</i>	Septate trichomes	Anisocytic	Single layered palisade.
15	<i>Gymnema sylvestre,</i>	Septate trichomes	Paracytic	Rosette calcium oxalate crystals
16	<i>Hibiscus rosa sinensis</i>	Stellar trichomes	Anisocytic	Sub stomatal chamber, hypodermal idioblast
17	<i>Indigofera tinctoria</i>	T- shaped trichome	Paracytic	Multi tier palisade, calcium oxalate crystals
18	<i>Justicia adhatoda</i>	Lithocysts, septate hairs	Diacytic	Air space in the palisade, epidermis often in 2 rows
19	<i>Lagerstroemia speciosa</i>	glabrous	Anamocytic	Sclerenchyma below the xylem.
20	<i>Lawsonia inermis</i>	glabrous	Anisocytic	Several layers of palisade and spongy, rosette crystals, sclerenchyma at the midrib
21	<i>Leucas lavendulifolia</i>	Glandular and septate	Diacytic	Single layered palisade
22	<i>Mangifera indica,</i>	Glabrous	Anamocytic	Guard cells exceptionally larger, epidermal cells often split in to two, crystals
23	<i>Moringa oleifera,</i>	Septate short hairs	anamocytic	Substomatal chamber, crystals in multiples
24	<i>Ocimum tenuiflorum,</i>	Septate and glandular	Diacytic	Single layered palisade
25	<i>Phyllanthus amarus,</i>	Glabrous	Anisocytic	Single tier palisade.
26	<i>Piper betel</i>	Glandular trichome	Tetracytic	3-layered epidermis, crystals, resin ducts.
27	<i>Plectranthus amboinicus</i>	Glandular, septate	Diacytic	Mesophyll not differentiated into palisade
28	<i>Senna alexandrina</i>	Short septate , blunt	paracytic	4-5 tier palisade, sclerenchyma, druces
29	<i>Solanum nigrum,</i>	Septate trichomes	Anamocytic	Single layered palisade
30	<i>Solanum trilobatum,</i>	Glabrous ,prickles	Anamocytic	Single layered palisade
31	<i>Tephrosia purpurea</i>	aseptate, glandular	Para/anamocytic	Demarking layer between palisade and spongy
32	<i>Tylophora asthmatica,</i>	Septate trichomes	Paracytic	2 layered palisade, bicollateral vascular bundle. Rosette crystals



Plate 1: *Acalypha indica* leaf peel x 400

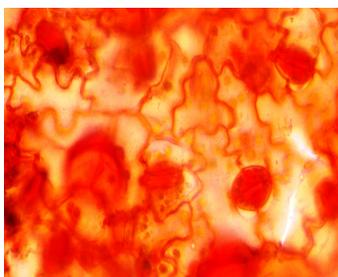


Plate 2: *Achyranthus aspera* leaf peel x 400

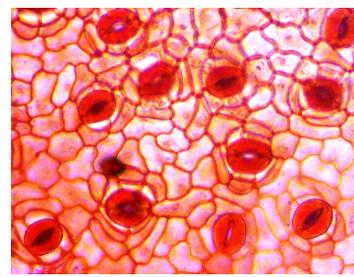


Plate 3: *Aegle marmelos* leaf peel x 400



Plate 4: *Andrographis paniculata* leaf peel x 400 – Diacytic stoma, Lithocyst

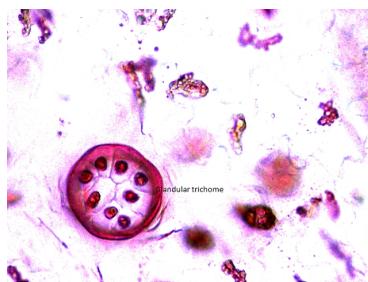


Plate 5: *Bacopa monnieri* leaf peel x 400 – Glandular trichome

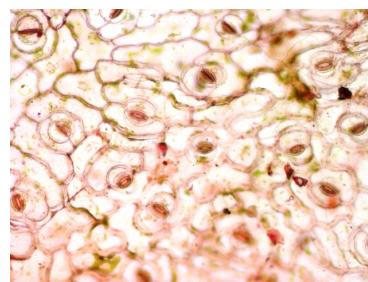


Plate 6: *Basella alba* leaf peel x 100

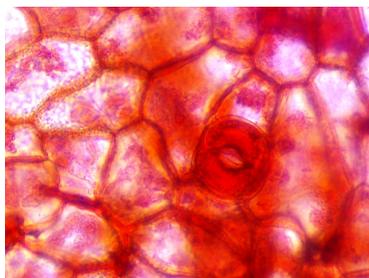


Plate 7: *Boerhavia diffusa* leaf peel x 400

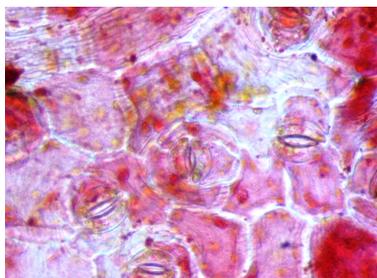


Plate 8: *Centella asiatica* leaf peel x 400



Plate 9: *Eclipta prostrata* leaf peel x 400

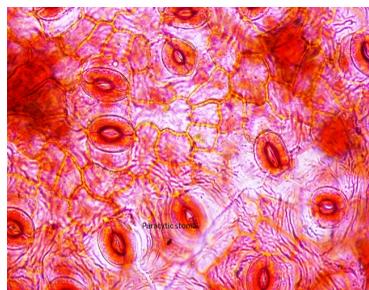


Plate 10: *Gymnema sylvestre* leaf peel x 400

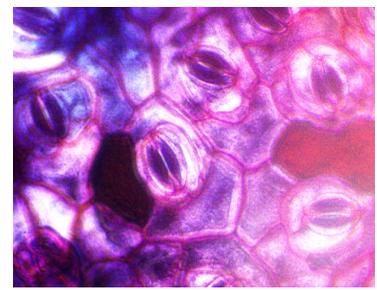


Plate 11: *Hibiscus rosa-sinensis* leaf peel x 400

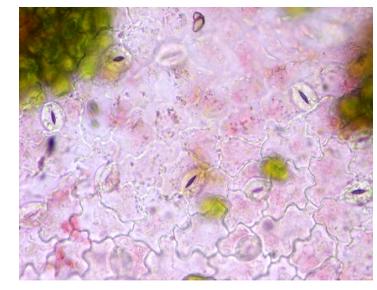


Plate 12: *Indigofera tinctoria* leaf peel x 400

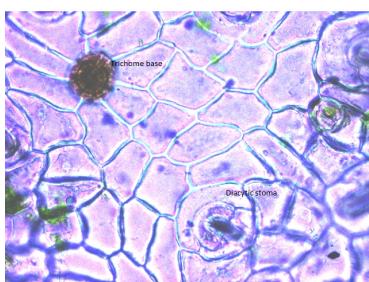


Plate 13: *Justicia adhatoda* leaf peel x 400

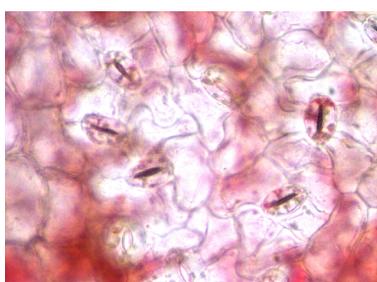


Plate 14: *Lagerstroemia speciosa* leaf peel x 400

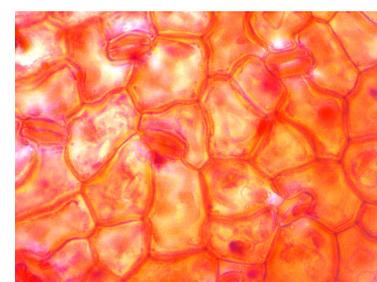


Plate 15: *Lawsonia inermis* leaf peel x 400

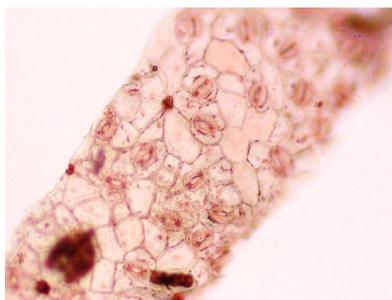


Plate 16: *Senna alexandrina* leaf peel x 100

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