

## Pharmacognostical studies of leaf, stem, root and flower of *Abutilon hirtum* (Lam.) Sweet

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### ABSTRACT

*Abutilon hirtum* (Lam.) Sweet, is a perennial herb or shrub, commonly known as Florida Keys Indian mallow and distributed in tropical regions. The present study deals with macro and micromorphological investigations of leaf, stem, root and flower of *A. hirtum*, which assists in identification and standardization of the plant in both entire and powdered forms.

**Keywords:** Malvaceae, *Abutilon hirtum*, macro and micromorphology.

### INTRODUCTION

Malvaceae (the mallow family) is the family of flowering plants containing about 243 genera and 4225 species. It is distributed all over the world in tropical regions and includes the economically important plants such as cotton, okra and other ornamental shrubs.<sup>1</sup> *Abutilon* is a large genus belonging to this family, comprising about 150 annual or perennial herbs, shrubs or even small trees. It is native to tropical and subtropical countries of America, Africa, Asia and Australia.<sup>2,3</sup> The genus has a significant importance which is attributed to valuable fibers obtained from different species of the genus such as *A. theophrastii* and also due to several species grown as garden ornamentals such as *A. ochsenii* and *A. vitifolium*.<sup>4</sup> Phytochemical studies of the genus revealed the presence of flavonoids, sterols, triterpenes, anthocyanins and fatty acids.<sup>5</sup>

*Abutilon hirtum* is a perennial herb or shrub, 0.5-2.5m in height [Synonym: *A. graveolens* (Roxb. Ex Hornem.) Wight & Arn. and *Sida hirta* Lam.]. Traditionally, the roots are used as expectorant, analgesic and antipyretic, while the leaves or flowers are applied to abscesses, in addition to the fruits are eaten raw and the water extract of the bark is given to ease childbirth in Kenya.<sup>3,6</sup> Reviewing the available botanical literature, only one study could be traced concerning the anatomical features of the leaf and stem.<sup>7</sup> The present study includes full description of the macro and micromorphological features of the leaf, stem, root and flower, which could be helpful in authentication and identification of the plant.

#### Taxonomy

*A. hirtum* (Lam.) Sweet belongs to <sup>8,9,10</sup>

Kingdom: Plantae

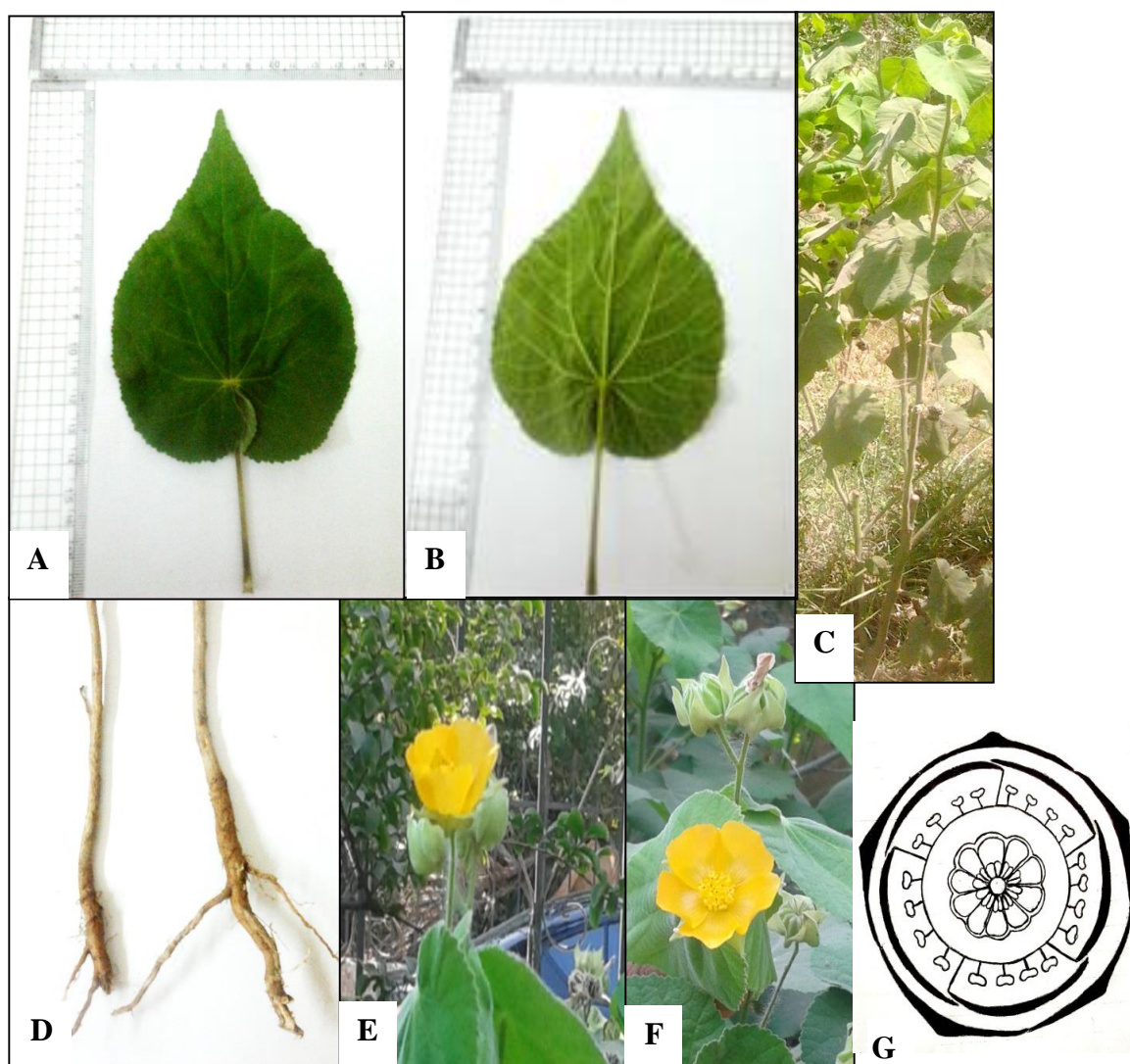
Subkingdom: Viridiplantae (green plants)

Infrakingdom: Streptophyta (land plants)



Figure 1: Photo of *Abutilon hirtum* (x 0.1)

Division: Tracheophyta (vascular plants)  
Subdivision: Spermatophytina (seed plants)  
Infradivision: Angiospermae (flowering plants)  
Class: Magnoliopsida (Dicotyledons)  
Subclass: Dilleniidae  
Superorder: Rosanae  
Order: Malvales  
Family: Malvaceae (mallows)  
Subfamily: Malvoideae  
Tribe: Abutilieae  
Genus: *Abutilon* Mill (Indian mallow)



**Figure. 2:** **A:** Upper surface of the leaf (x 0.34) **B:** Lower surface of the leaf (x 0.34) **C:** The stem (x 0.08) **D:** The root (x 0.36) **E& F:** The flower (x 0.54) **G:** Floral diagram

Species: *Abutilon hirtum* (Lam.) Sweet (Florida Keys Indian mallow)

## MATERIALS AND METHODS

### Plant material

The leaf, stem, root and flower of *A. hirtum* were collected from El-Zohria botanical garden, Giza, Egypt, in November 2012. The plant was kindly identified by Prof. Dr. Mahmoud Abdelhady Hassan, Professor of Horticulture, Faculty of Agriculture, Minia University. A voucher sample (Mn-ph-Cog-016) was kept in the Herbarium of Pharmacognosy Department, Faculty of pharmacy, Minia University, Minia, Egypt. The fresh samples of the plant preserved in a mixture of ethanol – glycerin – water (1:1:1). The plant material was air dried, reduced to fine powder and preserved in closely tight containers.

### Dyes

Safranin, iodine solution and ruthenium red were used for staining the plant sections and the powder.

### Microscopic studies

Transverse, longitudinal sections and the powder of the leaf, stem, root and flower were examined using microscope with camera, Leica® (Germany) and digital, 10 megapixels camera, Canon (Japan).

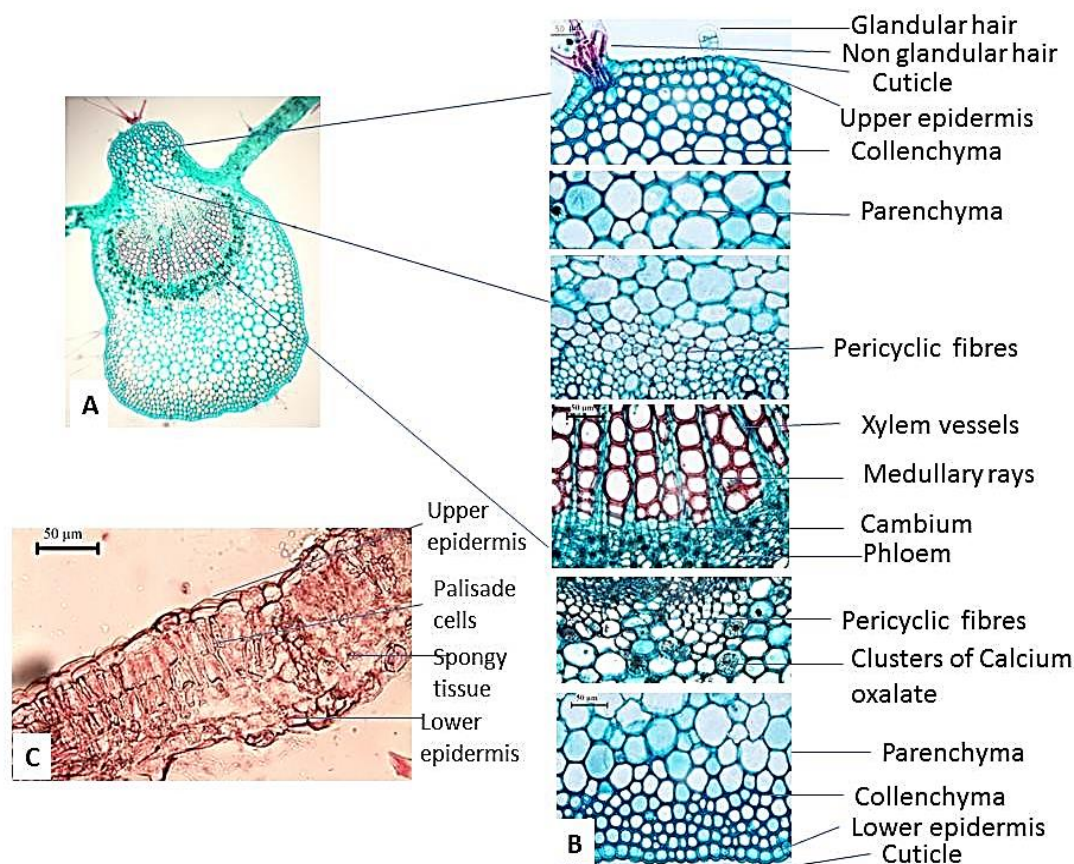
## RESULTS AND DISCUSSION

### Macromorphology

**The leaves** are simple, petiolate, alternate, cordate with acuminate apex, fine serrate margin and symmetric base, green in colour with the upper surface is darker than lower one, having a hairy surface, a coriaceous texture, a faint odour and a mucilaginous taste and showing palmately reticulate venation. The midrib is more prominent on the lower surface. The leaves measure 11-13 cm in length and 8-10 cm in width (Fig. 2A&B).

**The petiole** is cylindrical, green in colour with hairy surface and measures 1.5 – 22 cm in length and 0.1 – 0.6 cm in diameter (Fig. 2A&B).

**The stem** is erect, cylindrical, green in colour with monopodial branching having internodes of 0.5 - 7 cm in length. Many hairs cover the stem and lateral branches. The stem measures 0.5 – 1 m in length and 0.2 - 1 cm in

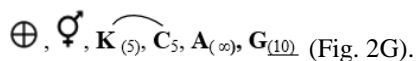


**Figure 3:** **A:** T.S of the leaf (x 40), **B:** Detailed T.S. of the leaf in the midrib region (x 200), **C:** Detailed T. S. of the leaf in the lamina region (x 200).

diameter. It has a mucilaginous taste and faint odour with a fibrous fracture when dry (Fig. 2C).

**The root** is a tap root carrying several lateral rootlets, yellowish brown in colour, cylindrical in shape, odourless with mucilaginous taste. It measures 6-11cm in length and 0.5-1cm in diameter. It is thick, woody with a longitudinally wrinkled surface and a fibrous fracture (Fig. 2D).

**The flowers** are solitary, axillary and pedicellated. They are yellow in colour, odourless, mucilaginous in taste with hairy pedicels. They measure 1-2.2 cm in length and 0.9-2 cm in diameter. They are hermaphrodite, actinomorphic, hypogenous, pentamerous and ebracteate (Fig. 2E&F). The floral formula is represented by:



**The pedicel** is cylindrical, green and hairy and measures 0.4-0.8 cm in length and 0.1- 0.2 cm in diameter.

**The calyx** is persistent, consisting of five united sepals. The sepals are lanceolate in shape with acute apex and a green colour, showing valvate aestivation and hairy surface. The calyx is 1.1-1.7 cm long and 0.8-1 cm wide.

**The corolla** is polypetalous formed of five contorted free petals. The petals are cup shaped and yellow. It measures 0.9-1.8cm in length and 0.8-1cm in width. The corolla surface is glabrous.

**The androecium** is formed of numerous epipetalous stamens and the filaments are fused to form a staminal tube measuring 0.5 cm in length. The filament is glabrous,

yellow in colour and 0.2-0.23 cm long, carrying small reniform, yellow two lobed anthers measuring 1.4 mm in length and 0.9 mm in width.

**The gynoecium** is syncarpous formed of ten united carpels. The ovary is superior showing ten locules. Each locule contains 1-3 ovules arranged on axial placentation. The ovary is hairy and measuring 0.2-0.4 cm in length and 0.2-0.3 cm in width. The style is long, yellow and passes through the staminal tube ending in ten round stigmas. The stigmas are red becoming black in colour. The style and stigma measure 0.4-0.6 cm in length.

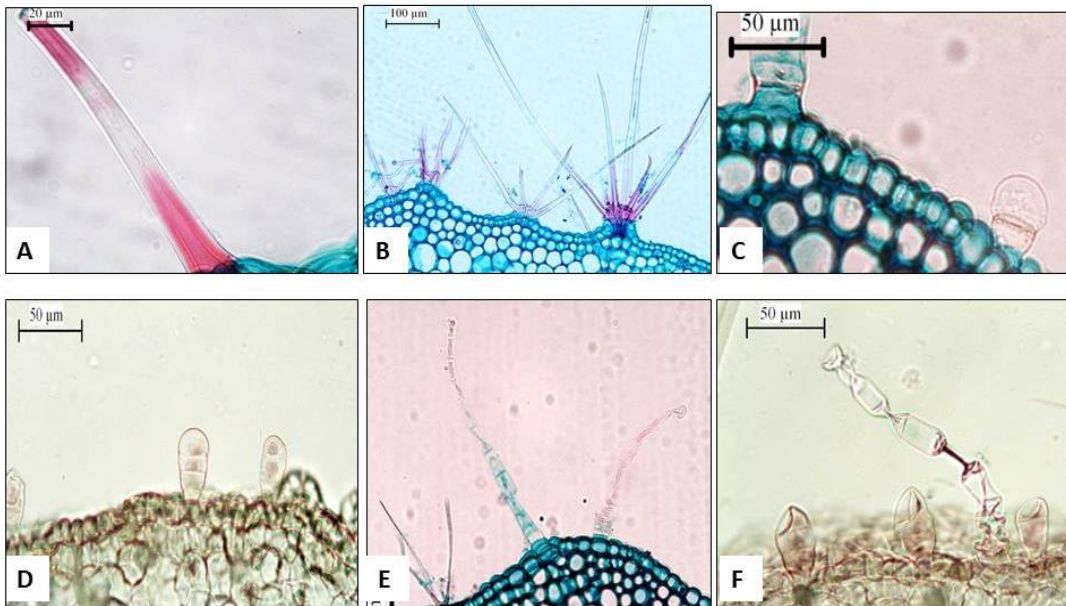
#### Micromorphology

##### The leaf

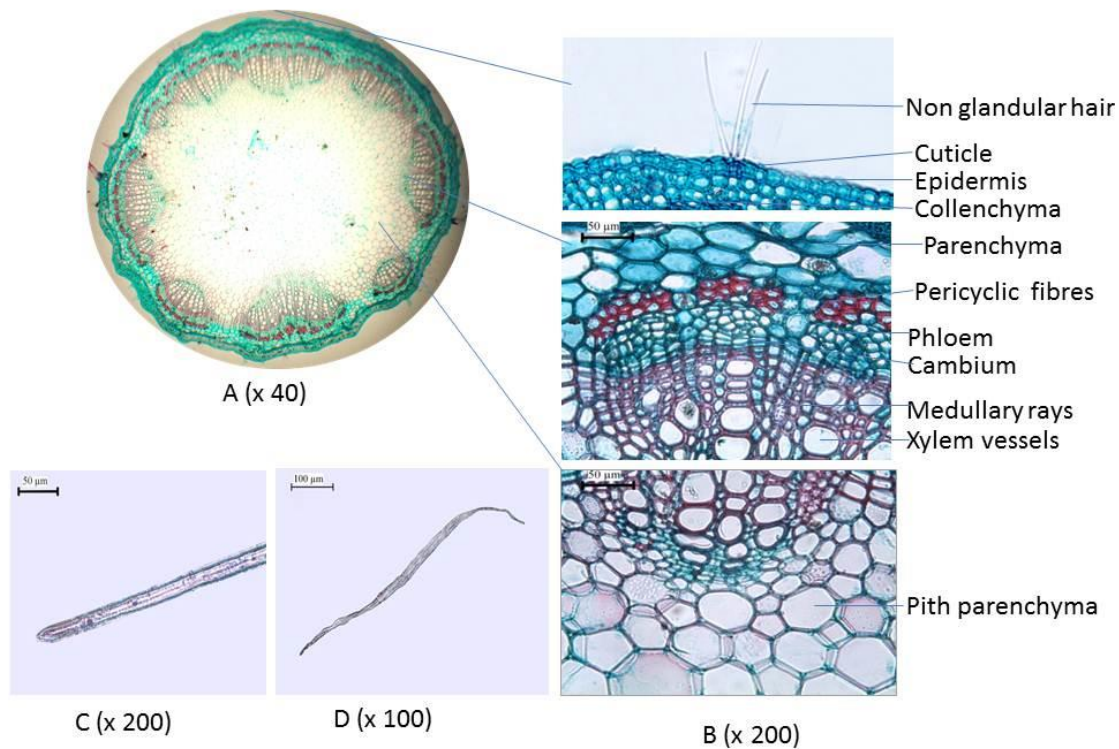
A transverse section of the leaf is biconvex in outline (Fig. 3), showing the midrib is more prominent on the lower surface. It shows the upper and lower epidermises carrying glandular and non-glandular trichomes more distributed on the midrib region. It also displayed a dorsiventral mesophyll interrupted in the midrib region by the cortical and vascular tissue. It shows a mass of subepidermal collenchyma under the upper and lower epidermises in the midrib region. The vascular system of the midrib is formed of a large collateral vascular bundle with islets of non-lignified pericyclic fibers below it. Idioblasts containing mucilage and numerous clusters of calcium oxalate are present in the lamina and midrib regions.

##### The upper epidermis

The upper epidermis is formed of one row of rectangular cells and covered with thin cuticle as seen in the transverse



**Figure 4:** A: Non-glandular unicellular hairs (x 400) B: Stellate hair (x 100), C: Capitulate hair (x 200), D: Glandular hairs with unicellular stalk and multicellular uniseriate head (3-5 cells), E & F: Glandular hairs with multicellular uniseriate stalk with collapsed cells (5-12 cells) and unicellular globular head.

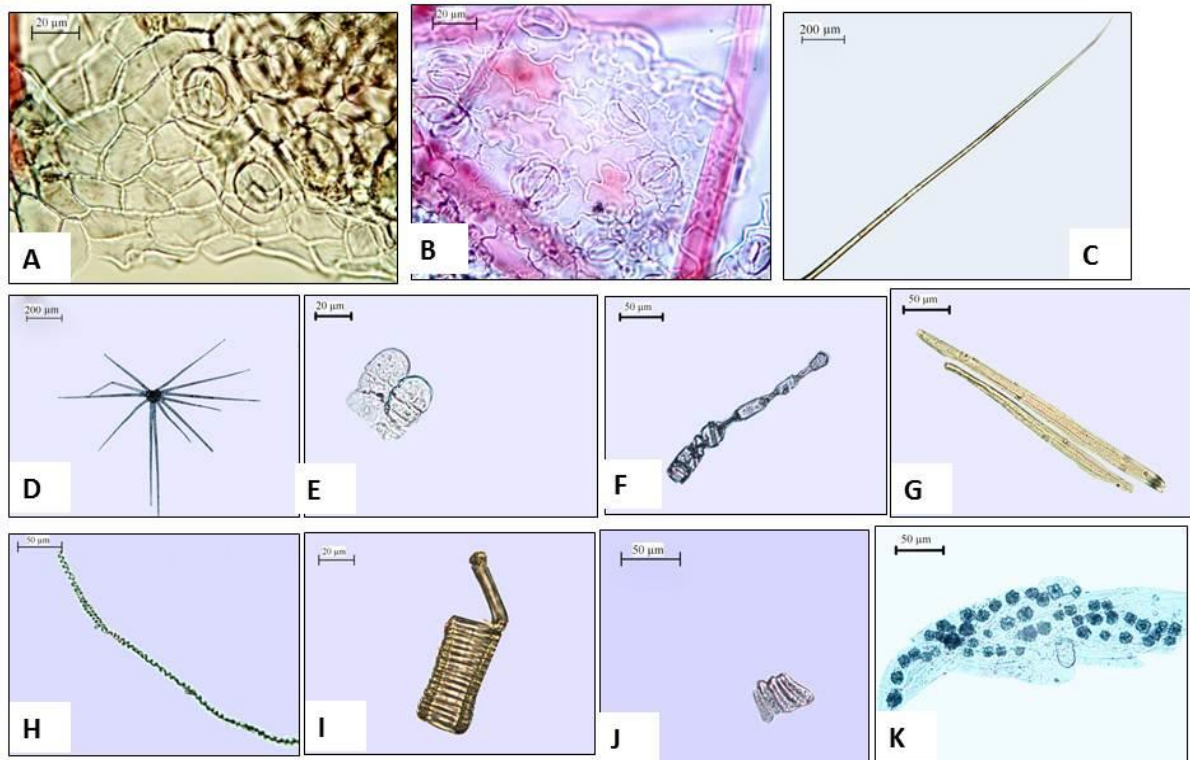


**Figure 5:** A: T.S of the petiole (x 40), B: Detailed T.S. of the petiole (x 200), C: pericyclic fiber (x 200), D: wood fiber (x 100).

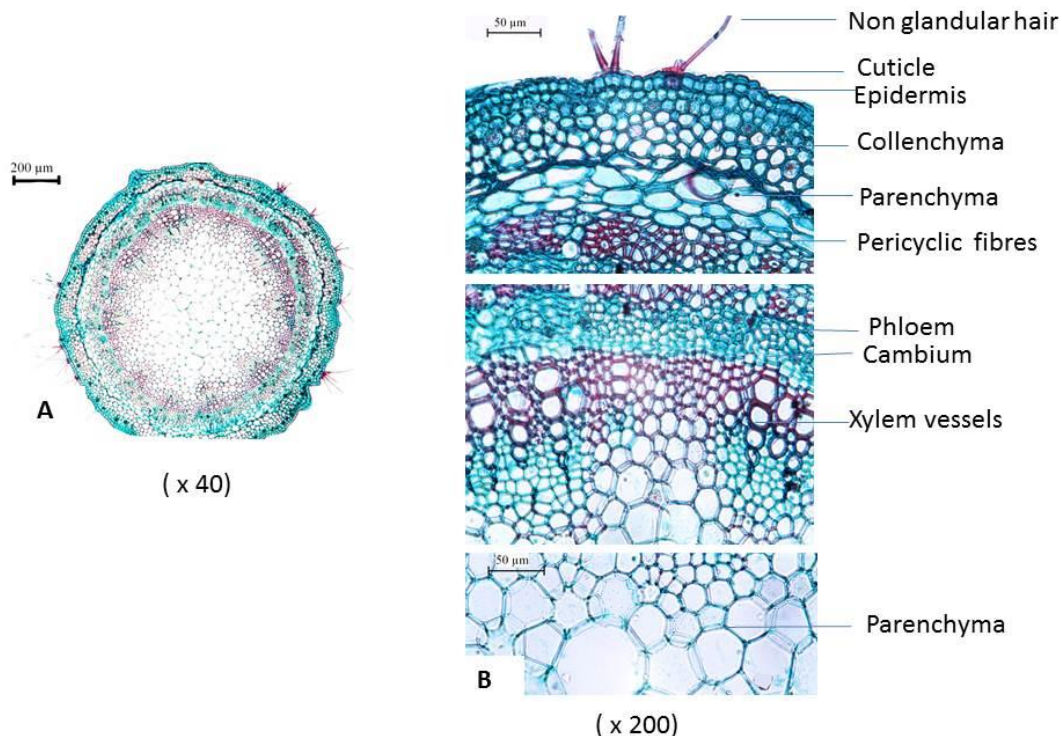
section (Fig. 3), while in surface view the cells appear polygonal, isodiametric to slightly elongated cells with straight anticlinal walls, covered with striated cuticle showing anomocytic stomata (Fig. 6). The stomata are rounded in shape with wide ostioles and surrounded by 3-5 subsidiary cells. The upper epidermis shows glandular and non-glandular hairs. It has glandular hairs with unicellular, stalks and heads covered with a smooth cuticle

(capitate hair) and glandular hairs with unicellular stalks and multicellular uniseriate heads (3-5 cells) covered with smooth cuticle. In addition to, the presence of numerous non-glandular hairs which are unicellular, simple, long and stellate (branched, multicellular 2-12 cells) hairs having thick walls, narrow lumina with tapering apices and covered with a smooth cuticle (Fig. 4).

**The lower epidermis**



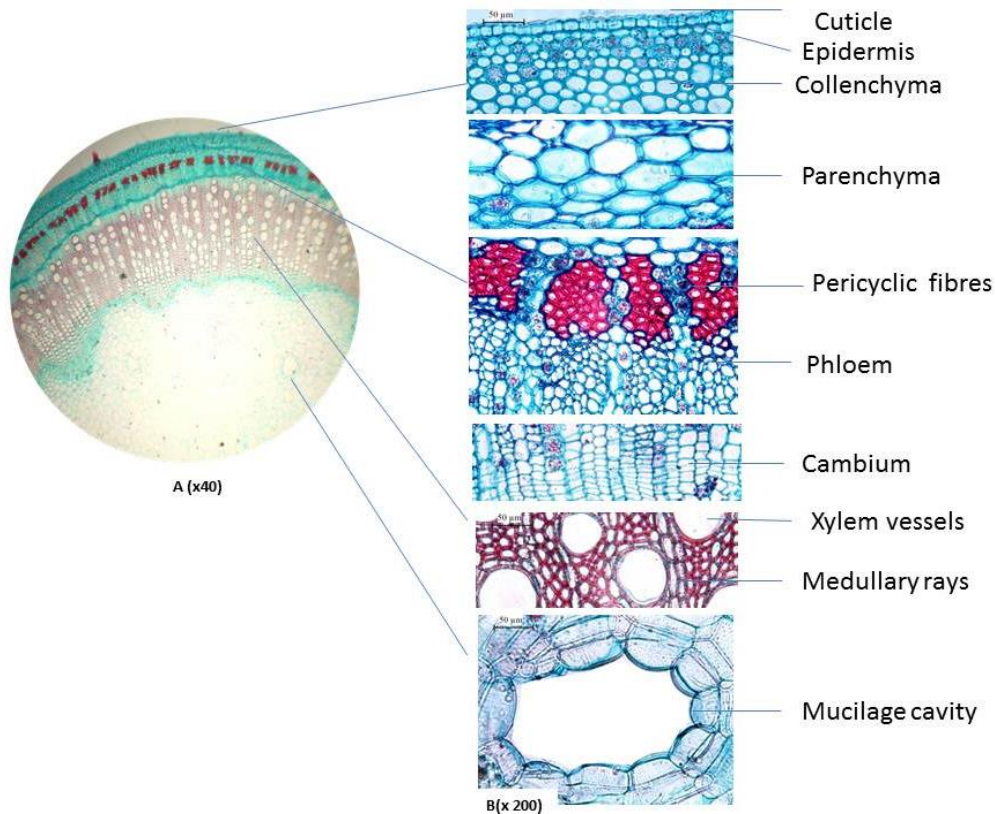
**Figure 6:** **A:** Upper epidermis (x 400), **B:** Lower epidermis (x 400), **C:** Non-glandular hair (x 40), **D:** Stellate hair (x 40), **E:** Glandular hairs with unicellular stalk and multicellular uniseriate head (3-5 cells) (x 400), **F:** Glandular hair with uniseriate multicellular (5-12 cells) stalk and unicellular globular head (x 200), **G:** Pericyclic fibers (x 200), **H:** Spiral xylem vessel (x 200), **I:** Scalariform xylem vessel (x 400), **J:** Palisade cells (x 200), **K:** Clusters of calcium oxalate (x 200).



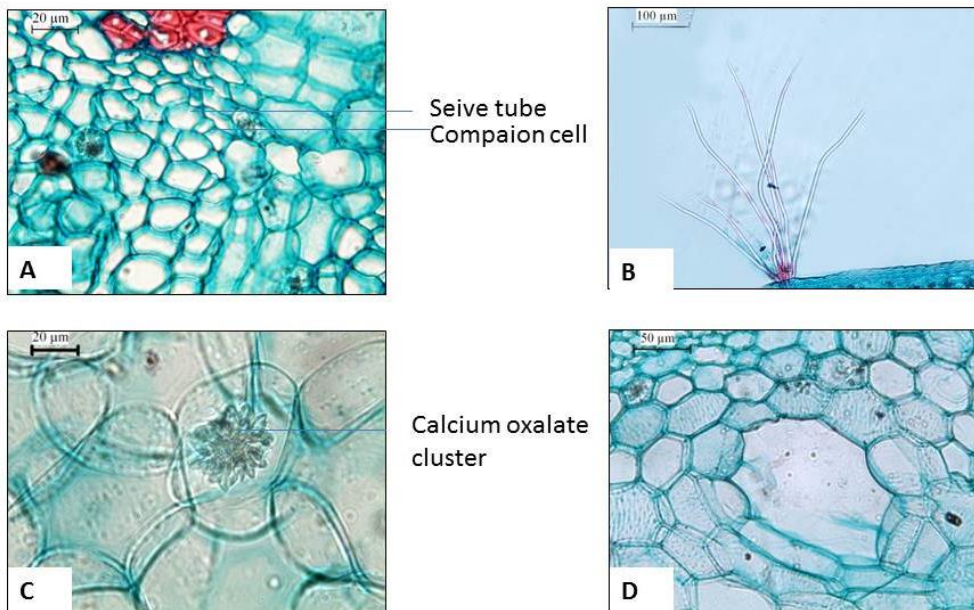
**Figure 7:** **A:** T.S of the upper part of the stem (x 40), **B:** Detailed T.S. of upper part of the stem (x 200).

The lower epidermis is formed of one row of rectangular cells covered with a thin cuticle as seen in the transverse section, while in surface view the cells appear polygonal,

isodiametric cells with wavy anticlinal walls covered with a smooth cuticle and showing anomocytic stomata (Fig. 6). The stomata, glandular and non-glandular hairs are similar



**Figure 8:** **A:** T.S of the lower part of the stem (x 40), **B:** Detailed T.S. of the lower part of the stem (x 200).



**Figure 9:** **A:** Phloem region showing sieve tube and companion (x 400), **B:** Stellate hair (x 100), **C:** Pith parenchyma containing cluster of calcium oxalate (x 200), **D:** Mucilage cavity (x 200).

to those of the upper epidermis but more abundant, in addition to presence of glandular hairs with uniseriate multicellular stalks (5-12 cells) and unicellular globular heads (some of these hairs have collapsed cells).

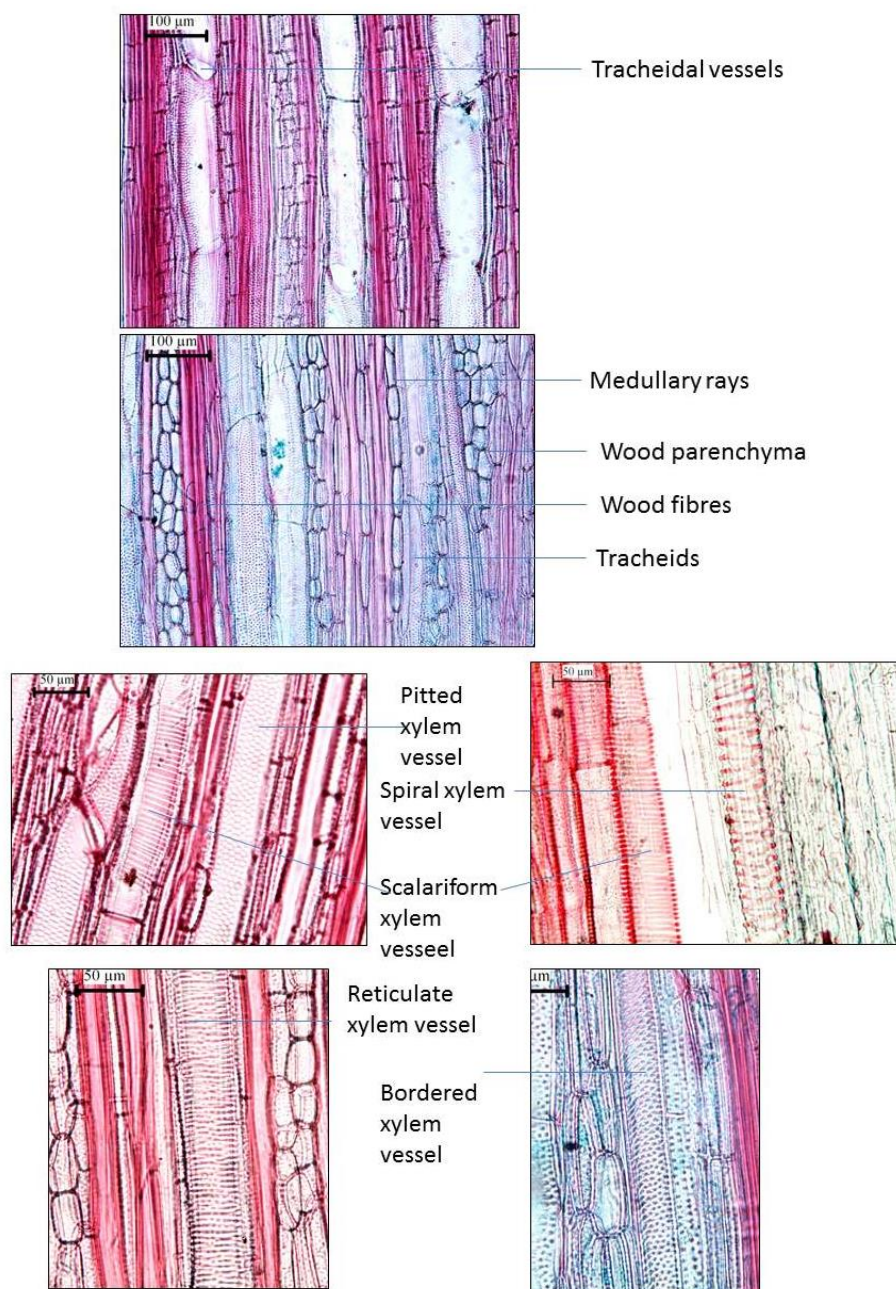
**The mesophyll**

The mesophyll is dorsiventral and shows two rows of upper palisade that consist of cylindrical columnar cells containing chloroplasts and discontinuous in the midrib

region (Fig. 3). The spongy tissue is formed of 3-5 rows of thin walled, rounded and slightly irregular chlorenchymatous cells with wide intercellular spaces and numerous clusters of calcium oxalate are scattered throughout the lamina region.

**The cortical tissue**

The cortical tissue of the midrib region (Fig. 3) shows an upper and lower subepidermal collenchymatous layers.



**Figure 10:** L.S. in the lower part of the stem showing tracheids, tracheidal vessels, wood fibers, wood parenchyma (x 100), pitted, spiral, bordered pitted, scalariform and reticulate xylem vessels (x 200).

The upper layer is formed of 4-7 rows and the lower one is formed of 3-4 rows of small rounded cells having thick cellulosic walls with no intercellular spaces, followed by several rows of polygonal, large parenchymatous cells with thin cellulosic walls and small intercellular spaces containing clusters of calcium oxalate. Idioblasts containing mucilage are present throughout the lower parenchyma cells. The endodermis is parenchymatous and indistinguishable.

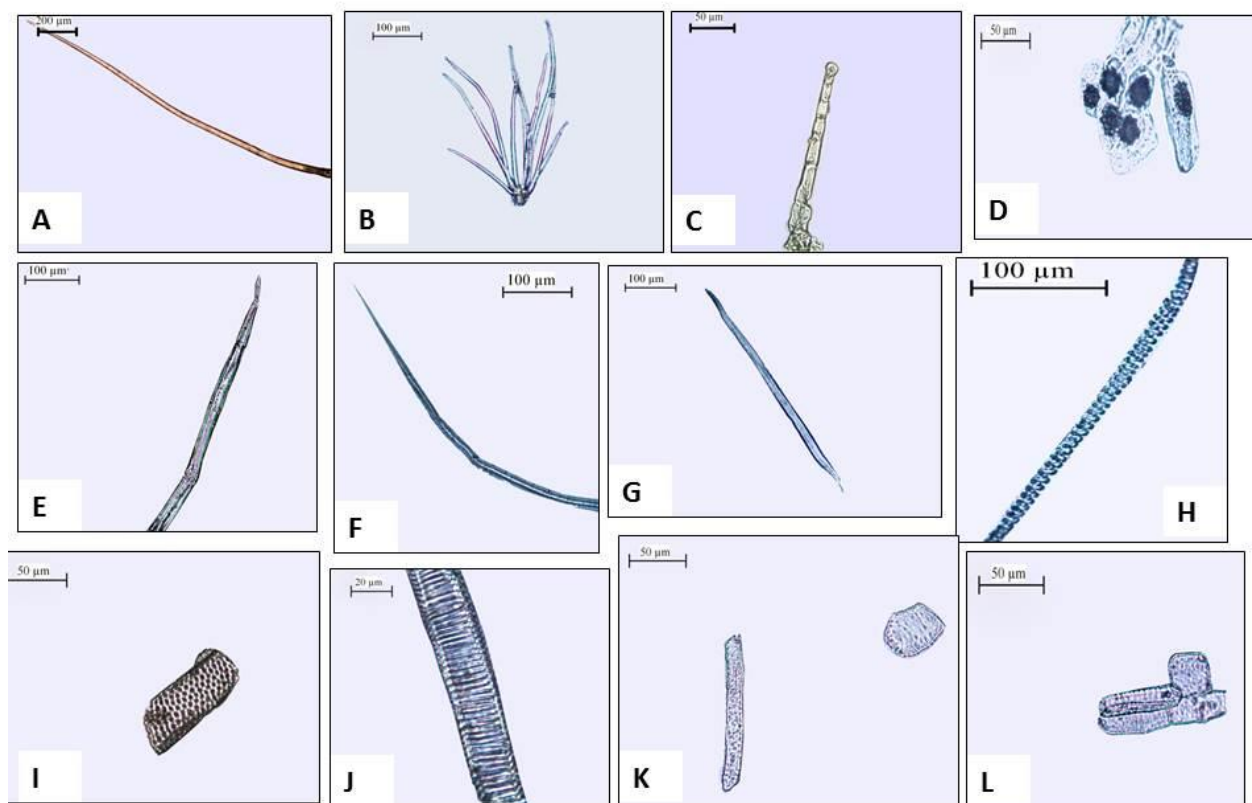
#### The vascular system

The pericycle is formed of a few fibers separated by parenchyma cells which form a continuous arc above the vascular bundle, while it appears as islets below the vascular bundle each group containing 9-15 fibers and the pericyclic fibers are fusiform with thick non lignified walls

and wide lumena with blunt apices as shown in the powder (Fig. 6). The phloem consists of thin walled, soft cellulosic tissue differentiated into sieve tubes, companion cells and phloem parenchyma. Small clusters of calcium oxalate are scattered in the phloem parenchyma. The cambium is represented by 2-3 rows of tangentially elongated, thin walled, cellulosic, meristematic cells. The xylem is formed of lignified vessels and pitted thin walled wood parenchyma. The vessels have spiral and scalariform thickenings as shown in the powder (Fig. 6). The medullary rays are uni, bi and multiseriate of elongated thin walled cellulosic parenchyma cells.

#### The petiole

A transverse section in the petiole is nearly circular in outline (Fig. 5). It is formed of an epidermal layer carrying



**Figure 11:** **A:** Non-glandular hair (x 40) **B:** Stellate hair (x 100), **C:** Glandular hairs with uniseriate multicellular (5-12 cells) and stalk unicellular globular head(x 200), **D:** Clusters of calcium oxalate (x 200), **E & F:** Pericyclic fibers (x 100), **G:** Wood fiber (x 100), **H:** Spiral xylem vessel (x 100), **I:** Pitted xylem vessel (x 200), **J:** Scalariform xylem vessel, **K:** Tracheid and wood parenchyma (x 200), **L:** Medullary rays and wood parenchyma (x 200).

abundant, non-glandular hairs and few glandular hairs, followed by cortical tissue which is formed of collenchymatous and parenchymatous cells. The pericycle is represented by groups of lignified fibers. The vascular system consists of 10-11 isolated collateral vascular bundles enclosing wide parenchymatous pith. The endodermis is parenchymatous and indistinguishable. Cluster crystals of calcium oxalate and idioblasts containing mucilage are scattered in the parenchymatous tissues.

#### The epidermis

It is similar in structure to the upper epidermis of the leaf except for the absence of glandular hairs with unicellular stalk and unicellular head.

#### The cortex

It consists of 3-4 rows of small, thick walled collenchymatous cells with no intercellular spaces followed by 2-4 rows of large thin walled parenchymatous cells with small intercellular spaces. The clusters of calcium oxalate are scattered in the cortex (Fig. 5).

#### The vascular system

The pericycle is formed of parenchymatous cells interrupted by small islets of fibers. Each group is formed of 5-17 fibers. The pericyclic fibers are long with thick lignified walls, wide lumina and acute ends (Fig. 5). The phloem is formed of thin walled soft cellulosic elements. The phloem and pericyclic parenchyma contain clusters of calcium oxalate. The cambium is represented by 1-2 rows

of tangentially elongated, thin walled meristematic cells. The xylem consists of lignified vessels, wood fibers and wood parenchyma. The wood parenchyma is polygonal cells with thick lignified walls. The wood fibers are fusiform having thick lignified walls with wide lumina and tapering ends (Fig. 5). The medullary rays are uni, biseriate of elongated thick, lignified walled cells. The pith is formed of large thin walled parenchyma cells and some clusters of calcium oxalate are scattered in the pith region (Fig. 5).

**The power of the leaf** is dark green in colour with faint characteristic odour and mucilaginous taste. The elements of the powdered leaf are shown in Fig.6.

#### The stem

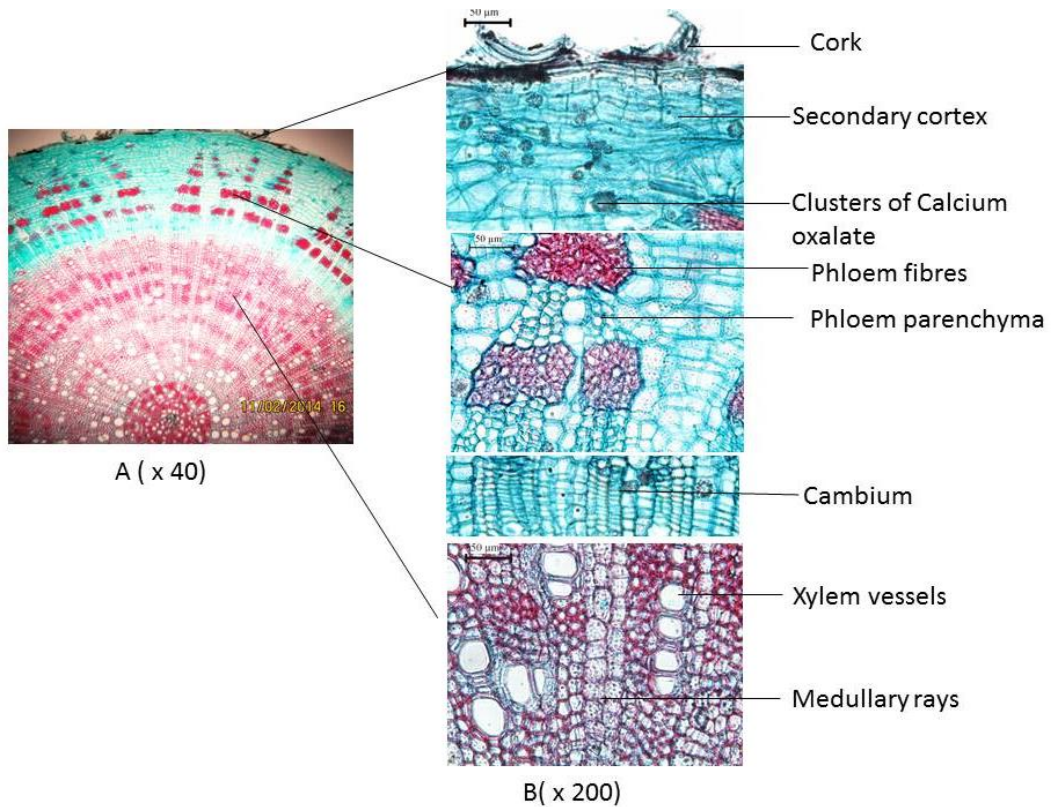
##### The upper part of the stem

A transverse section in the upper part of the stem is nearly circular in outline (Fig. 7). It shows a similar structure to that of the petiole with a continuous ring of collateral vascular bundle.

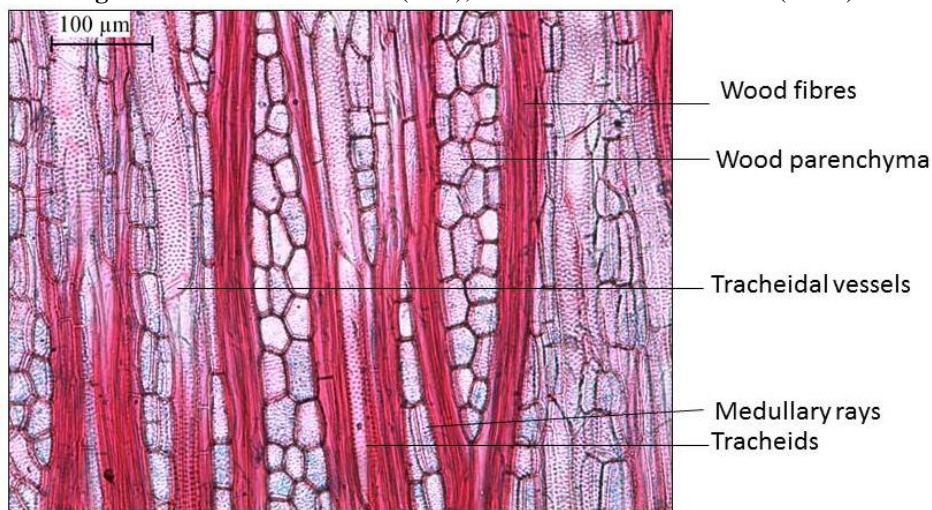
##### The lower part of the stem

A transverse section in the lower part of the stem is nearly circular in outline (Fig. 8). It exhibits an epidermis carrying non glandular and few glandular hairs, followed by a narrow cortex differentiated into collenchyma and parenchyma, then parenchymatous pericycle interrupted by groups of lignified pericyclic fibers surrounding a continuous ring of vascular tissue with wide parenchymatous pith. Clusters of calcium oxalate and





**Figure. 12:** A: T.S of the root (x 40), B: Detailed T.S. of the root (x 200).



**Figure. 13:** L.S. in the root showing tracheids, tracheidal vessels, wood fibers, wood parenchyma (x 100)

mucilage cells are scattered in the cortex and pith. Secretory cavities containing mucilage are observed in the pith (Fig. 7 & 8). The cork is not observed.

*The epidermis*

The epidermis is formed of one row of rectangular cells covered with thin cuticle carrying numerous non glandular and few glandular hairs similar to those of the leaf (Fig. 8).

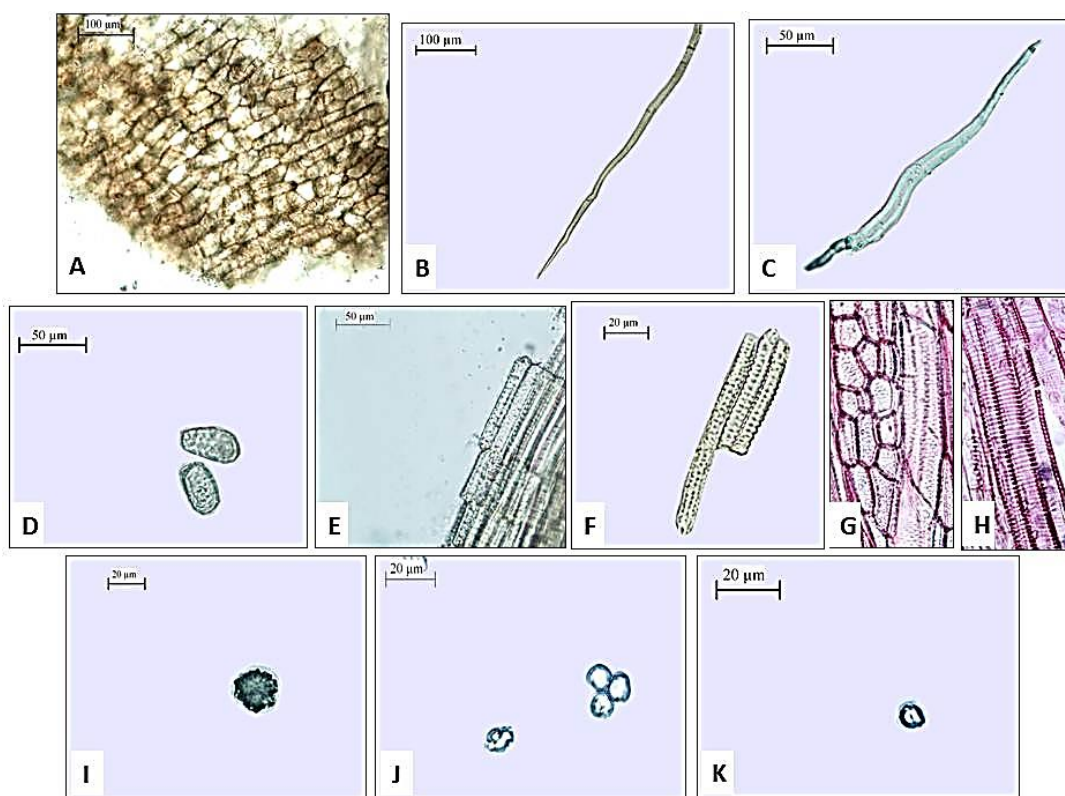
*The cortex*

The cortical tissue consists of an outer collenchymatous zone and an inner parenchymatous one. The collenchymatous layer is formed of 8-12 rows of small, rounded thick walled cells with no intercellular spaces. The parenchymatous layer is formed of 4-7 rows of polygonal to oval, large thin walled cells with intercellular

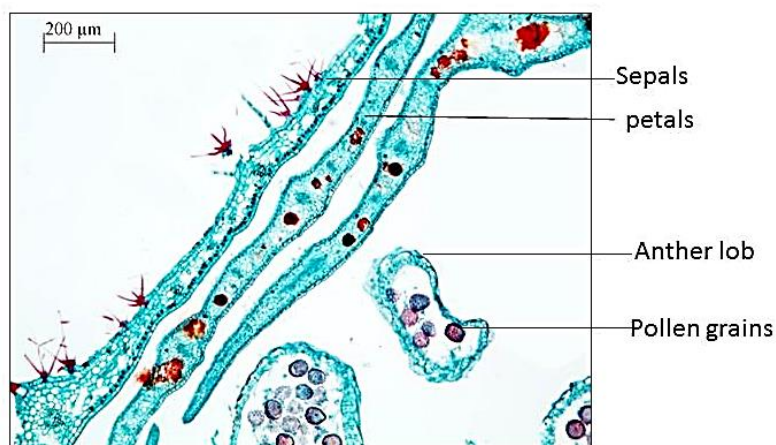
spaces. Some of parenchyma cells contain clusters of calcium oxalate in addition to idioblasts of mucilage cells. The endodermis is parenchymatous and indistinguishable (Fig. 8).

*The vascular system*

The pericycle is formed of parenchymatous cells interrupted by scattered groups of lignified pericyclic fibers. Each group is formed of 10-25 fibers (Fig. 8). The fibers are long with heavy lignified thick walled, wide and narrow lumena and tapering ends as shown in Fig. 11E & F. The clusters of calcium oxalate are scattered in the pericycle. The phloem consists of thin walled, soft cellulosic elements of sieve tubes, companion cells and phloem parenchyma. Some of the phloem parenchyma



**Fig. 14:** **A:** Cork (x 100) **B:** Phloem fibers (x 100), **C:** Wood fibers (x 200), **D:** Wood parenchyma (x 200), **E:** Medullary rays (x 200), **F:** Spiral xylem vessels (x 400), **G:** Pitted xylem vessel and wood parenchyma (x 200) **H:** Scalariform xylem vessel (x 200), **I:** Cluster of Calcium oxalate (x 400) **J & K:** Starch granules (x 400).



**Fig. 15:** T.S of the flower (x 40)

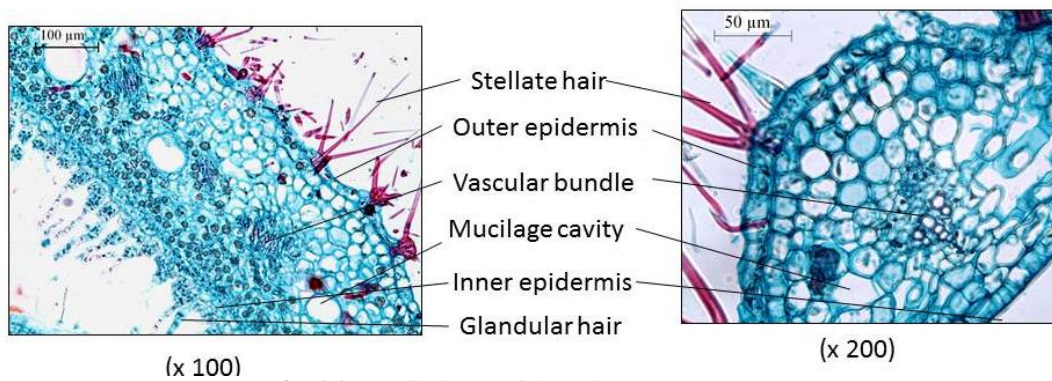
contains clusters of calcium oxalate (Fig. 8 & 9A). The cambium is formed of 4-6 rows of radially arranged, tangentially elongated thin walled, cellulose rectangular cells (Fig. 8). The xylem is formed of lignified vessels, tracheids, tracheidal vessels, wood fibers and wood parenchyma. The vessels have spiral, pitted, bordered pitted, reticulate and scalariform thickenings (Fig. 10). The tracheids are narrow with pitted and lignified walls (Fig. 10 & 11K). The wood fibers are spindle-shaped showing thick lignified walls with narrow lumina and tapering ends and are shorter than the pericyclic fibers (Fig. 10 & 11G). The wood parenchyma is polygonal cells with lignified and pitted walls (Fig. 10 & 11K). The medullary rays are

formed of uni to biseriolate elongated cells with lignified and pitted walls (Fig. 10 & 11L). The pith consists of large, thin walled, more or less rounded parenchymatous cells showing clusters of calcium oxalate, mucilage cells and mucilage cavity (Fig. 9 & 9D).

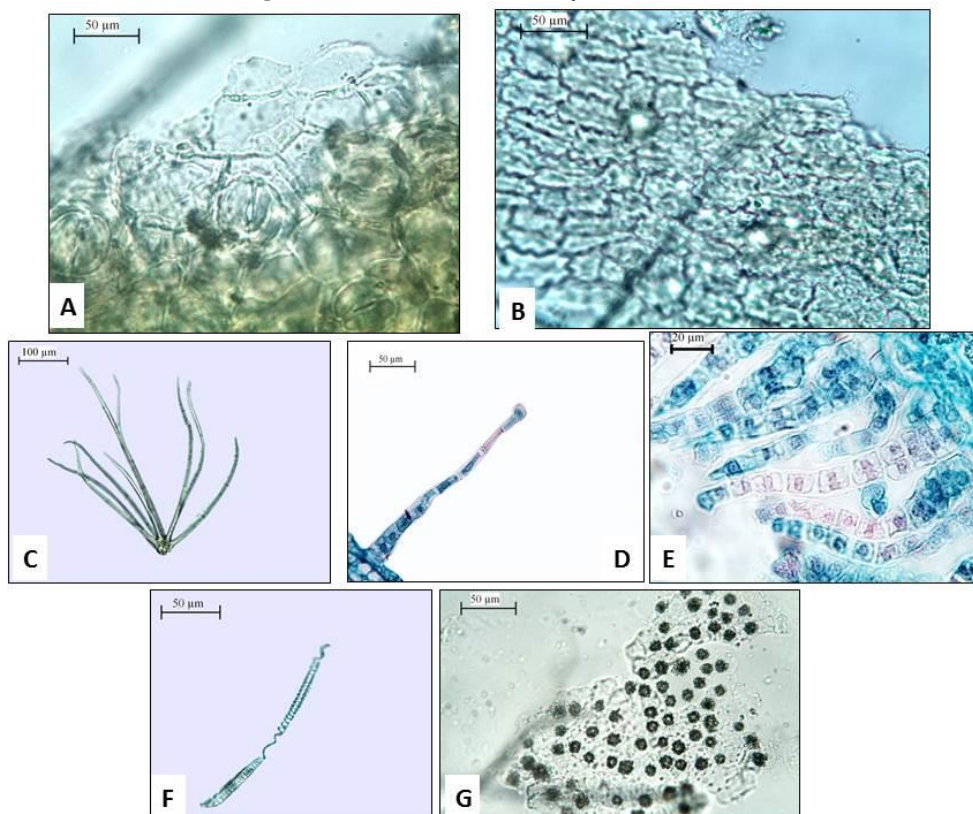
**The powder of the stem** is pale green in colour with a characteristic odour and a mucilaginous taste. The elements of the powdered stem are shown in Fig. 11.

*The root*

A transverse section in the root is nearly circular in outline, showing a layer of brownish cork surrounding the cortex, followed by the vascular tissue consisting of phloem zone and a very wide zone of xylem extending to



**Fig. 16:** Detailed T.S of the calyx.



**Fig. 17:** **A:** Outer epidermis (x 200), **B:** Inner epidermis (x 200), **C:** Stellate hair (x 100), **D:** Glandular hairs with multicellular uniseriate stalk (8-10 cells) and unicellular globular head (x 200), **E:** Glandular hairs with a multicellular biseriate stalk (8-10 cells) with unicellular globular head (x 400), **F:** Spiral xylem vessel(x 200), **G:** Clusters of calcium oxalate (x 200).

the center. The clusters of calcium oxalate are scattered in the cortex (Fig. 12).

*The cork*

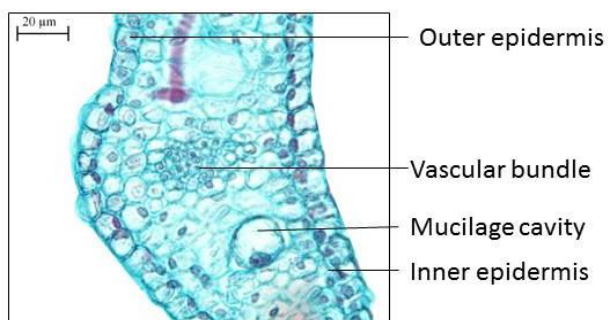
It is formed of 3-4 rows of tangentially elongated tubular cells with thin walls as seen in the transverse section, while in surface view they appear as polygonal cells with isodiametric to slightly elongated thin walls, these cells are brown in colour (Fig. 12& 14 A).

*The secondary cortex*

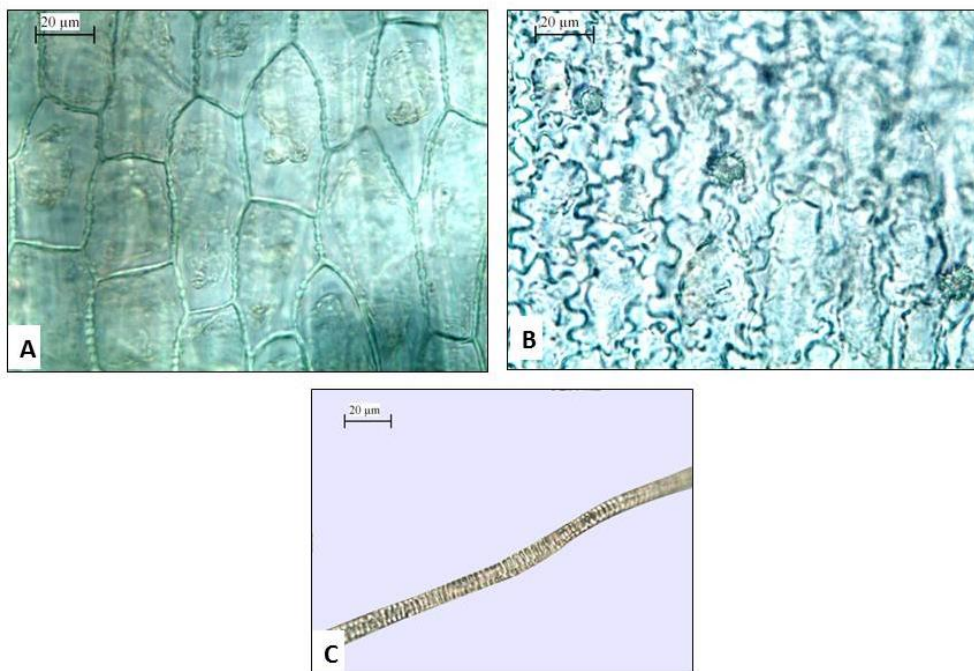
It is formed of 3-4 rows of polygonal parenchymatous cells with thick walls, narrow intercellular spaces; some of them contain clusters of calcium oxalate and starch granules (Fig. 12).

*The vascular tissue*

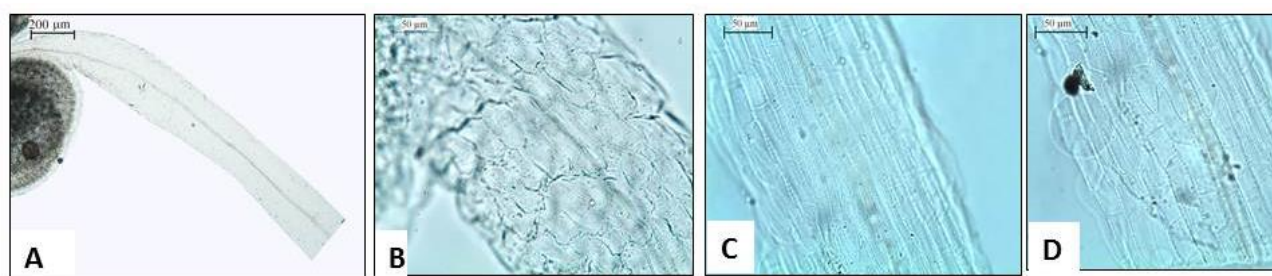
The phloem consists of soft cellulosic elements of phloem parenchyma, sieve tube, companion cells and successive groups of phloem fibers. The fibers are fusiform with thick lignified walls, narrow lumina and acute ends as shown in Fig. 14B. Clusters of calcium oxalate are scattered in the phloem parenchyma. The cambium is represented by a continuous ring of 4-6 rows of tangentially elongated, radially arranged thin walled cells (Fig. 12). The xylem consists of lignified vessels, wood parenchyma, wood fibers, tracheids and tracheidal vessels as shown in Fig. 13. The wood parenchyma is polygonal cells with thick lignified and pitted walls (Fig. 13 & 14D). The vessels have bordered pitted, spiral and scalariform thickenings (Fig. 14F, G & H). The wood fibers have lignified walls,



**Fig. 18:** Detailed T.S. of the corolla (x 400).



**Fig. 19:** A: Outer epidermis (x400), B: Inner epidermis (x 400), C: Spiral xylem vessel (x 400).



**Fig. 20:** A: The filament (x40), B: Upper part of the filament (x 200), C & D: Middle & basal part of the filament (x 200).

narrow and wide lumena with acute ends (Fig. 13 & 14C). The tracheids have lignified walls with simple pits (Fig. 13). The medullary rays are uni to triseriate consisting of radially elongated cells with thick lignified pitted walls (Fig. 13 & 14E). Starch granules are present in the medullary rays which are small, simple or compound (2-3 components) polygonal to rounded with centric cleft hilum and faint striation (Fig. 14 J& K).

#### *The powder of the root*

The powdered root is pale brownish –yellow in colour, odourless and mucilaginous in taste. The elements of the powdered roots are shown in Fig. 14.

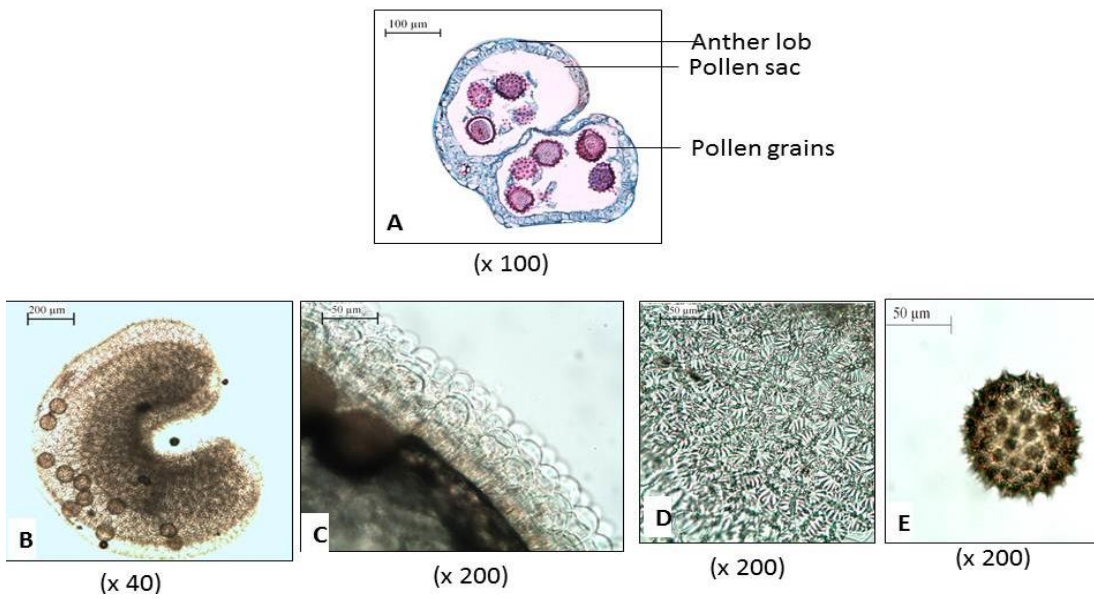
#### *The flower*

A transverse section in the flower (Fig. 15) shows a hairy calyx, followed by a corolla, an androecium of many stamens and each anther lobe consists of one pollen sac containing numerous spiny pollen grains and a gynoecium.

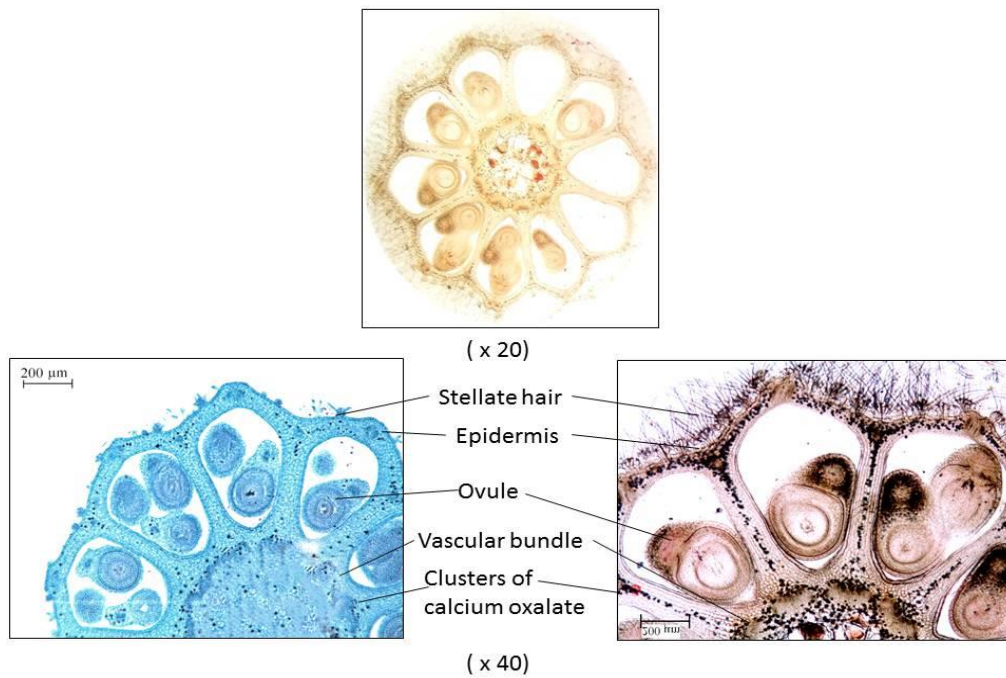
#### *The calyx*

A transverse section in the calyx shows hairy lower and upper epidermises enclosing a wide parenchymatous cortex, and several vascular bundles. Clusters of calcium oxalate are present in the cortex (Fig. 16).

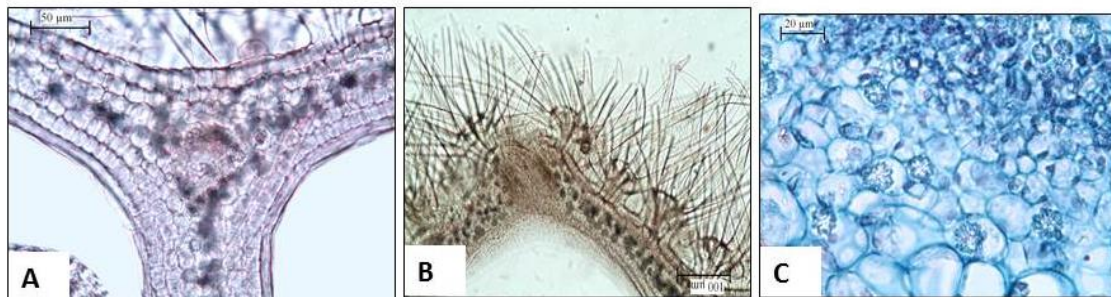
The upper (inner) epidermis is formed of one row of rectangular cells covered with a thin cuticle (Fig. 16)



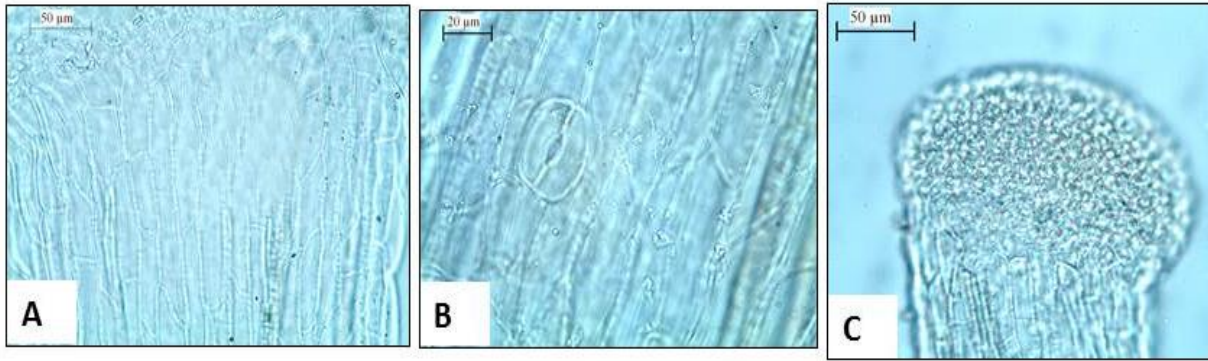
**Fig. 21:** A: The anther (x 100), B & C: Epidermis of the anther showing papillae, D: Fibrous layer of anther (x 200), E: pollen grain (x 200).



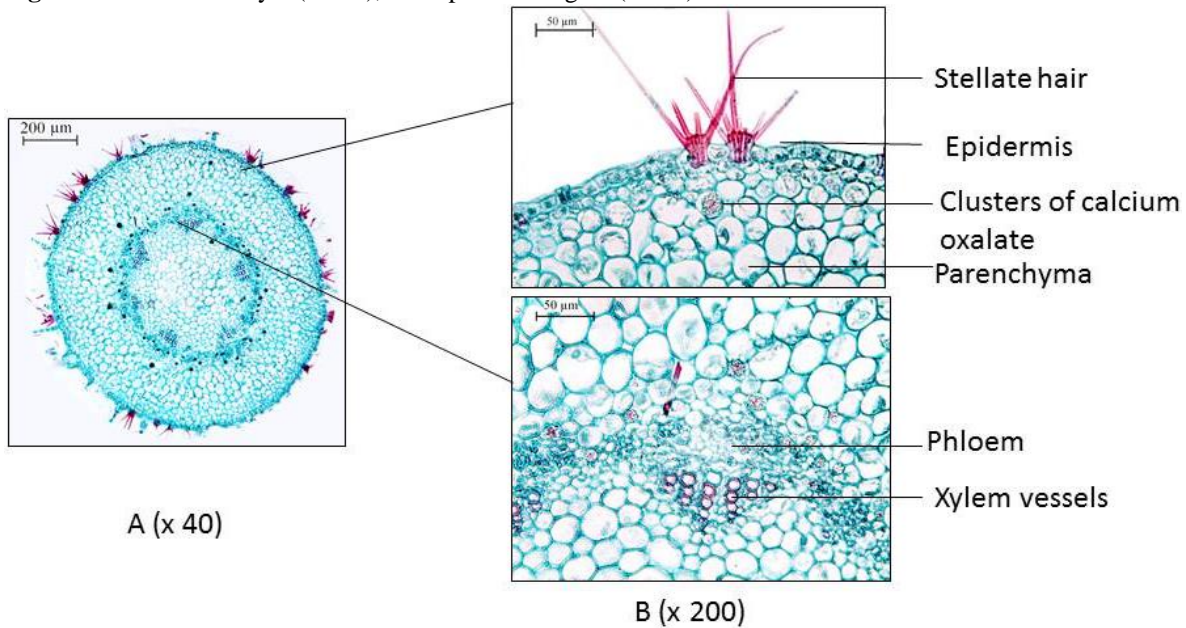
**Fig. 22:** Detailed T.S. in the ovary.



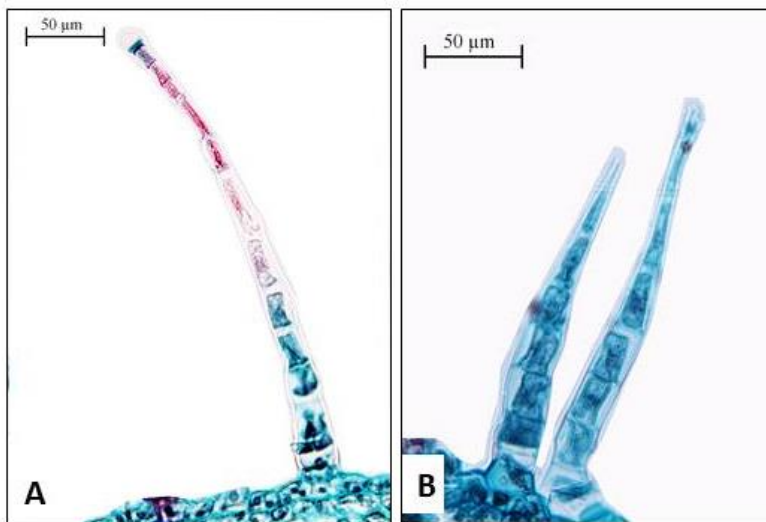
**Fig. 23:** A: Epidermis of the ovary (x 200), B: Stellate hairs of the ovary (x 100) , C: Pith of the ovary (x 400).



**Fig. 24:** A & B: The style (x 200), C: Papillosed stigma (x 200).



**Fig. 25:** A: T.S. of the pedicle (x 40), B: Detailed T.S. of the pedicle (x 200).



**Fig. 26:** A: Glandular hair with multicellular (5-11 cells) uniseriate stalk and unicellular globular head (x 200), B: Non-glandular multicellular (7-9 cells) uniseriate stalk (x 200).  
 carrying glandular hairs with a multicellular biseriate stalk (8-10 cells) with unicellular globular head (Fig. 17E) as seen in the transverse section, while in surface view the cells appear polygonal with straight beaded anticlinal walls covered with smooth cuticle and showing anomocytic stomata (Fig. 17 A). The lower (outer) epidermis is formed of one row of rectangular cells covered with a thin cuticle as seen in the transverse section (Fig. 16), while in surface view the cells appear polygonal, elongated cells with wavy anticlinal walls covered with a smooth cuticle (Fig. 17 B)

and carrying numerous stellate hairs (Fig. 17C) and few glandular hairs of multicellular uniseriate stalk (8-10 cells) and unicellular globular head (some of these hairs have collapsed cells) (Fig. 17D). The cortex is formed of several layers of rounded to oval thin-walled parenchymatous cells. Mucilage cavities are observed in the cortical tissue and clusters of calcium oxalate are more scattered in the parenchyma cells under the inner epidermis. The vascular tissue is formed of several collateral vascular bundles with lignified spiral xylem vessels towards the upper epidermis and phloem towards the lower one (Fig. 16).

*The corolla*

A transverse section through the petals consists of upper epidermis and lower epidermis enclosing in between a wide parenchymatous cortex followed by small vascular bundles alternating with the mucilage cavities. The clusters of calcium oxalate are scattered in the cortex (Fig. 18). The

upper (inner) and lower (outer) epidermis are formed of one row of rectangular cells covered with a thin cuticle as appearing in the transverse section (Fig. 18), while in surface view the inner epidermis has polygonal, elongated cells with striated beaded anticlinal walls covered with a smooth cuticle but the outer epidermis has polygonal elongated cells with wavy anticlinal walls covered with a smooth cuticle (Fig. 19 A&B). Trichomes are absent. The cortex consists of polygonal, thin walled parenchymatous cells with small intercellular. Large mucilage cavities are present in the cortex alternating with small vascular bundles. Clusters of calcium oxalate are scattered in the cortical tissue (Fig. 18). The vascular tissue is formed of small collateral vascular bundles with lignified spiral xylem vessels towards the upper epidermis and phloem towards the lower one (Fig. 19C).

**Table 1:** Microscopical measurements of different organs of *A. hirtum*. (in micron)

<i>Item</i>	<i>Length</i>	<i>Width</i>	<i>Height</i>	<i>Diameter</i>
<i>Leaf</i>				
Upper epidermis	18-28-38	10-16-22	14-18-22	
Lower epidermis	16-31-45	11-16-21	14-19-23	
Non glandular hairs	144-1072-2000	13-17-22		
Glandular hairs				
stalk	147-326-505(multi)	17-19-22		
head	8-11-14(uni)	10-16-23		14-15-16(uni) 24-27-30(mult)
Stellate hair	145-385-626	7-12-17		
Stomata	18-20-23	16-17-18		
Collenchyma				12-26-41
Parenchyma of the cortex				27-47-68
Pericyclic fibers	187-220-245	7.5-10-13		
Pericyclic fibers of petiole	625-1062-1500	20-25-30		
Wood fibers	340-392-444	12-17-22		
Parenchyma of the pith				21-41-61
Mucilage cells				60-82-104
Coax clusteress				17-25-33
Palisade cells	20-23-28	4-8-12		
Wood parenchyma	39-43-47	18-19-21		
Xylem vessels				15-23-32
<i>Stem</i>				
Epidermal cells	15-24-33	7-10-14	9-12-15	
Non glandular hairs	1560-1720-1880	16-24-32		
glandular hairs				
stalk	150-272-350	8-15-23		
head				10-15-17
Stellate hair	166-264-363	4-8-11		
Collenchyma				6-18-29
Parenchyma of the cortex				26-54-82
Pericyclic fibers	466-1233-2000	11-19-27		
Wood fibers	343-471-600	9-13-17		
Wood parenchyma	30-41-52	32-41-50		
Xylem vessels				26-52-79
Tracheids	94-114-134	10-13-16		
Medullary rays	42-53-65	16-20-25		
Coax clusteress				6-16-27
Mucilage cells				100-109-119

**Table 1:** Microscopical measurements of different organs of *A. hirtum*. (in micron)

<i>Item</i>	<i>Length</i>	<i>Width</i>	<i>Height</i>	<i>Diameter</i>
Parenchyma of the pith				27- <u>66</u> -105
Secretory cavity				180- <u>240</u> -300
<b>Root</b>				
Cork cells	12- <u>27</u> -42	10- <u>16</u> -22	3- <u>6</u> -9	
Parenchyma of the cortex				19- <u>33</u> -47
Phloem fibers	400- <u>937</u> -1150	12- <u>14</u> -17		
Wood fibers	250- <u>529</u> -625	11- <u>13</u> -15		
Xylem vessels				19- <u>34</u> -50
Wood parenchyma	27- <u>36</u> -50	17- <u>19</u> -21		
Medullary rays	52- <u>75</u> -89	10- <u>11</u> -13		
Tracheids	63- <u>82</u> -91	5- <u>8</u> -11		
Starch				5- <u>7</u> -9
Coax clusters				8- <u>22</u> -37
<b>Flower</b>				
<b>Calyx</b>				
Inner(upper ) epidermis	25- <u>41</u> -57	12- <u>17</u> -22	10- <u>13</u> -16	
Outer (lower) epidermis	50- <u>72</u> -95	35- <u>44</u> -54	13- <u>15</u> -18	
Stellate	85- <u>322</u> -559	3- <u>16</u> -29		
Glandular hairs				
Stalk	183- <u>195</u> -207	10- <u>13</u> -17		12- <u>14</u> -15
head	115- <u>120</u> -125(bisriate)	10- <u>13</u> -16		8- <u>10</u> -12(biseriate)
Parenchyma				10- <u>16</u> -23
Mucilage cavities				52- <u>60</u> -68
Coax Clusters				5- <u>10</u> -16
Xylem vessels				3- <u>5</u> -8
<b>Corolla</b>				
Inner(upper ) epidermis	47- <u>64</u> -82	22- <u>32</u> -42	7- <u>9</u> -11	
Outer (lower) epidermis	52- <u>65</u> -79	13- <u>19</u> -26	6- <u>8</u> -10	
Parenchyma				7- <u>11</u> -16
Mucilage cavities				20- <u>23</u> -27
Coax Clusters				13- <u>17</u> -21
<b>Androecium</b>				
Epidermis of filament(upper part)	34- <u>53</u> -73	16- <u>21</u> -27		
Epidermis of filament(middle part)	37- <u>47</u> -58	13- <u>17</u> -21		
Epidermis of filament(lower part)	32- <u>49</u> -67	12- <u>16</u> -20		
Fibrous layer of anther	21- <u>29</u> -37	13- <u>17</u> -21		
Pollen grains				43- <u>61</u> -79
<b>Gynaecium</b>				
Epidermis of ovary			11- <u>15</u> -19	
Non glandular hairs	138- <u>203</u> -269	15- <u>19</u> -23		
Parenchyma of the pith				13- <u>23</u> -33
Coax clusters				8- <u>11</u> -15
Epidermis of style	26- <u>59</u> -92	13- <u>19</u> -26		
Epidermis of stigma	17- <u>35</u> -54	10- <u>14</u> -19		
<b>Pedicel</b>				
Epidermis			10- <u>13</u> -17	
Collenchyma				10- <u>14</u> -19
Parenchyma				19- <u>29</u> -39
Coax clusters				6- <u>12</u> -19
Xylem vessls				4- <u>8</u> -12
Non glandular hairs	166- <u>187</u> -208	18- <u>21</u> -24		
stellate	21- <u>88</u> -156	4- <u>8</u> -12		
Glandular hairs				
Stalk	190- <u>248</u> -306	12- <u>17</u> -23		
head				8- <u>10</u> -11



*The androecium**The filament*

The surface view of the epidermal cells of the filament (Fig. 20A) are formed of polygonal, axially elongated cells with sinuous anticlinal walls and covered with a striated cuticle in the middle (Fig. 20C) and upper part of the filament (Fig. 20B), while the basal epidermal cells are elongated having straight beaded anticlinal walls (Fig. 20D). Stomata and trichomes are completely absent on the epidermis of the filament.

*The anther*

A transverse section in the anther shows two anther lobes attached together by connective tissue which is formed of parenchyma. The two anther lobes contain numerous spiny spherical pollen grains (Fig. 21A & E). The anther wall is formed of an epidermis followed by a fibrous layer and the remaining of tapetum. The epidermal cells of the anther are polygonal, isodiametric cells with thin straight anticlinal walls covered with a smooth cuticle showing papillae (Fig. 21B & C). The epidermis of the anther is devoid of stomata and trichomes.

*The fibrous layer of anther*

The fibrous layer of anther is formed of polygonal axially elongated cells, thick lignified walls with bar-like thickening (Fig. 21D).

*The pollen grains:* The pollen grains are spherical in shape, yellow in colour showing a spiny exine (Fig. 21A & E).

*The gynoecium**The ovary*

A transverse section in the ovary is circular in outline showing an epidermis enclosing ten united carpels with ten locules. Each locule contains from one to three ovules (Fig. 22). The ovary shows outer and inner epidermises enclosing a parenchymatous mesophyll in between. The non-glandular unicellular and stellate hairs cover the outer epidermis as shown Fig. 22 & 23 B. The mesophyll is formed of polygonal thin-walled parenchyma with small intercellular spaces traversed by several small vascular bundles. Clusters of calcium oxalate are scattered in the parenchyma cells (Fig. 22 & 23C). The epidermal cells appear rectangular covered with a thin cuticle as seen in the transverse section (Fig. 22 & 23A).

*The style*

The epidermal cells of the style appear polygonal, axially elongated with slightly straight beaded anticlinal walls covered with a thin slightly striated cuticle showing anomocytic stomata as shown in Fig. 24 A & B.

*The stigma*

The epidermis of the stigma consists of polygonal papillosed cells (Fig. 24C).

*The pedice*

A transverse section in the pedicel is nearly circular in outline. It shows hairy epidermis followed by a wide cortex, collateral vascular bundles and wide parenchymatous pith (Fig. 25).

*The epidermis*

The epidermis is formed of one row of rectangular cells covered with a thin cuticle (Fig. 25) carrying numerous

non-glandular stellate and multicellular uniseriate (7-9 cells) stalk (Fig. 25 & 26 B), in addition to a few glandular hairs which have a multicellular (5-11 cells) uniseriate stalk and unicellular globular head covered with a smooth cuticle (Fig. 26).

*The cortex*

The cortex is formed of one row of small rounded collenchyma cells with no intercellular spaces and several rows of large parenchymatous cells with thin cellulose walls and wide intercellular spaces. Mucilage cells and clusters of calcium oxalate are scattered in the cortex. The endodermis is parenchymatous and indistinguishable (Fig. 25B).

The pericycle is formed of a continuous ring of small rounded cellulose thin walled parenchymatous cells with no pericyclic fibers. The clusters of calcium oxalate are scattered in the pericycle (Fig. 25B). The vascular tissue is formed of small collateral vascular bundles. The phloem consists of thin walled, soft, cellulose elements of phloem parenchyma, sieve tubes and companion cells. Some phloem parenchyma contains clusters of calcium oxalate. The xylem is formed of lignified vessels together with wood parenchyma (Fig. 25B). The pith is formed of large rounded parenchymatous cells with thin walls and wide intercellular spaces.

**CONCLUSION**

The present study summarizes macro and micromorphological features of the different organs of *Abutilon hirtum* including leaves, stems, flowers and roots that is helpful in the identification of the plant in the entire and powdered form.

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