ORIGINAL ARTICLES

Macro- and Micromorphological Study of The Leaf, Stem, Flower and Root of *Hibiscus rosa-sinensis* L

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ABSTRACT

The macro- and micro morphological study of *Hibiscus rosa-sinensis* L (family *Malvaceae*) was carried out with the aim of finding out the characteristic features of the different organs of the plant in both entire and powdered forms.

**Key words:** Macro- and Micromorphology, leaf, stem, flower, root, *Hibiscus rosa-sinensis*.

Introduction

*Hibiscus rosa-sinensis* L. is ornamental plant cultivated in Egypt. It belongs to family *Malvaceae* that comprise around 82 genera and over 1500 species distributed all over the world in warm temperate and tropical regions (Lawrence, 1969 and Gupta, 1981). Natural products extracted from plants which belong to the *Malvaceae* family are used in the treatment of many diseases worldwide.

Genus *Hibiscus*, with more than 300 species distributed in tropical and subtropical regions, have been widely utilized in several formulae in traditional medicine (Gupta, 1981 and Holser et al., 2004). Previous pharmacological investigations of the genus Hibiscus indicated the presence of some species with useful biological activities as antihypertensive, anti-inflammatory, antipyretic, hepatoprotective, anti-diarrhoeic, anti-spermatogenic, anti-tumour, antidiabetic, anticonvulsivant, antihelminthic immunomodulator, antioxidant and antimutagenic agents (Dafallah and Al-Mustafa, 1996; Sachdeva and Khemani, 2003; Pale et al., 2004; Hui et al., 2007; Deyanira, 2010; Chang et al., 2005; Mishra et al., 1999; Tzu et al., 2007 and Gilani et al., 2005).

*Hibiscus rosa-sinensis* extract exerted potential protective effect against tumour promotion stage of cancer development (Sharma et al., 2004b and Sharma and Sultana, 2004a) and the anthocyanins extract of this plant grown in Egypt proved pronounced cytotoxic activities against hepatoma and breast cancer cell lines (Abdel-Monem et al., 2011). Thus *Hibiscus rosa-sinensis* may be a great natural source for the development of new drugs and may provide a cost-effective mean of treating cancers and other diseases in the developing world.

Certainly, no previous literature report concerning the macro- and micro-morphological characters of *Hibiscus rosa-sinensis* L. grown in Egypt, which encouraged us to undertake full descriptive macro and micro morphological study of this plant. In order to facilitate the plant could be identified in both entire and powdered forms. This study is of utmost important not only in finding out genuity but also, in detection of adulterants in marketed drugs.

Materials And Methods

Plant material:

The plant material of *Hibiscus rosa-sinensis* L was collected in July 2010 from the private garden of Faculty of Pharmacy, Zagazig University. The identify of this plant was kindly verified by Dr. A. Abd-Elmagly, Agriculture researches centre, Land Reclamation and Agriculture Ministry, Egypt. A voucher sample of the plant is kept in the Department of Pharmacognosy, Faculty of Pharmacy, Zagazig University, Zagazig, Egypt. Fresh samples were used throughout the study.

Results And Discussion

I. Macromorphology:

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Hibiscus rosa-sinensis L. (Fig. 1) is a glabrous, evergreen, annual shrub, showing a monopodially branched stem, attaining 1-4 m in height. The plant carries red auxiliary or in terminal solitary flowers around the year.

**The leaves** (Fig. 2A & B) are simple, alternate, cauline, petiolate, stipulate. Lamina is simple, ovate to oblong-lanceolate in shape having acuminate apex, symmetric base and hairy surface, having entire margin in the lower half part and being dentate in the upper half one, green in colour and the upper surface is darker than lower one. It measures 2 - 7 cm long and 2 - 4 cm broad. The venation is pinnately reticulate and the midrib and big veins are prominent on the lower surface than the upper one. The stipules (Fig. 2C) are linear, acute, green in colour and measuring 0.7 - 1.5 cm long and 0.2 - 0.4 cm broad.

**The petiole** (Fig. 2B) is reddish brown in colour, pubescent, cylindrical having light groove on the ventral surface. It measures 0.5 - 2.5 cm in length

**The stem** (Fig. 2A) is erect and cylindrical. It is freely and monopodially branching, bearing both flowering and foliage alternate branches. The internodes measuring 1-5 cm in length, being shorter near the apex. The stem measures 70 - 400 cm in height and 0.3 - 3 cm in diameter. The young stem is pubescent and flexible while the older one is woody, covered by reddish brown cork, hard to break, showing fibrous fracture and yellowish white interior. It is reddish brown in colour.

**The root** (Fig. 2D) is cylindrical, fusiform, solid tap-root. It bearing several lateral branches and forming a well developed root system measuring 40 - 60 cm in length and 0.2 - 3 cm in diameter. Externally, it is whitish brown in colour with striated surface bearing many fine rootlets. It is flexible when fresh and breaks with fibrous fracture exposing yellowish-white wood when dry.

**The flowers** (Fig. 3A & B) are red in colour, pedicellate and occur solitary, terminal or in the axils of the upper leaves. They measure 7 - 10 cm in length and 8 - 10 cm in diameter. They are hermaphrodite, actinomorphic and having an outer whorl of bracts called epicalyx.

**The pedicle** (Fig. 3B) is erect, cylindrical, hairy, and green in colour with reddish brown colour near the base. It is measure 3 - 6 cm in length and 0.2 - 0.4 cm in diameter.

**The epicalyx** (Fig. 3C) is represented by an aggregation of green bracts forming a whorl outside the calyx. It consists of 6-8 linear-lanceolate segments, hispid, persistent, connate below with the base of the calyx. It is green in colour and measures 0.8 - 1.2 cm in length and 0.1 - 0.2 mm in diameter.

**The calyx** (Fig. 3B & D) is hypogenous, persistent, consisting of five sepals, united near to its half length. They are oblong-lanceolate in shape, green in colour with yellow tinge at the base having acute apices. Each sepal has three nerves, fleshy with spiny outer surface and hairy inner one measuring 1.2 - 2 cm in length and 0.8 - 1 cm in diameter.

**The corolla** (Fig. 3A, B & E) is hypogenous, formed of five free, thin, convoluted petals. They are red in colour with dark red or brownish spot at the base of ventral surface and faint yellow tinge at the dorsal surface. It is spathulate with obtuse apex, entire margin, measuring 5 - 7 cm in length and 3 - 4 cm in width.

**The androecium** (Fig. 3F & G) is gynostemium, measuring 3 - 4 cm in length. It consists of indefinite number of hypogenous stamens. The filaments are very short, red in colour measuring 0.3 - 0.5 mm in length. It bearing red with yellow spots, globose to reniform anthers, one-celled or spuriously divided into two cells by a thin and incomplete longitudinal septum forming two-anther lobes, Measuring 0.5 - 0.8 mm in diameter.

**The gynoecium** (Fig. 3G) is syncarpous formed of five united carpels. The ovary is superior showing five locules. Each locule contains two ovules arranged on axial placenta. The surface of the ovary is hairy. It is ovoid, yellowish white in colour and measures 1 - 2 cm in length and 0.5 - 1 cm in width. The style is long, emerges from the staminal tube and ends with five dark reddish brown capitate stigmas. The style and stigma measure 7 - 9 cm in length.

The plant has characteristic odour and mucilaginous taste.

II. Micromorphology:

**The Leaf:**

A transverse section of the leaf (Fig. 4A, B & C) is biconvex in outline. It shows upper and lower epidermis carrying glandular and non-glandular trichomes. The lamina has dorsiventral structure with one row of upper palisade being discontinuous in the midrib region. The midrib is prominent on the both surfaces showing sub-epidermal collenchymas, cortical tissues and large central collateral vascular bundle. Cluster crystals of calcium oxalate are scattered in the cortical tissue as well as in the mesophyll and phloem. Secretory glands and mucilage cells are also, present in the parenchymatous tissues.

The upper epidermis (Fig. 5A) consists of polygonal, slightly elongated cells with straight, thin cellulosic anticlinal walls. They measuring 40-45-50 µ L, 33-35-40 µ B and 10-12-15 µ H.
The lower epidermis (Fig. 5B) consists of polygonal cells with slightly wavy, thin cellulotic anticlinal walls. They measuring 40-45-50 µ L, 33-35-37 µ B and 10-11-12 µ H. Both upper and lower epidermises are covered with smooth cuticle and sometimes, having mucilaginous inner walls and appear as transparent dots.

The upper and lower neural epidermal cells (Fig. 5C&D) are polygonal axially elongated with straight anticlinal walls and covered with smooth cuticle. They measure 32-60-80 µ L, 35-37-42 µ B and 10-12-15 µ H and 50-65-84 µ L, 25-27-30 µ B and 10-12-15 µ H, respectively.
Fig. 3: The morphology of flower of *Hibiscus rosa-sinensis* L.
A- The flower (top view)(X 0.5);  
B- The flower (side view)(X 0.5)  
C- The epicalyx (X 0.8);  
D- The calyx(X 0.45)  
E- The corolla (X 0.3);  
F- The anther and stigma(X 20.5)  
G- The androecium and gynoeium(X 0.5)

A., anther; An.L., anther lobe; C., corolla; Epi., epicalyx; Flm., filament; k., calyx; Ov., ovary; Ped., pedicel; 
St., stigma; St.t., stamina tube.

Fig. 4: The Leaf of *Hibiscus rosa-sinensis* L.
A- Transverse section of the leaf (X 13.3).  
B- Transverse section of the midrib (X 73.1).  
C- Transverse section of the lamina (X 199.7).  
ca.ox., cluster crystal; col., collenchymas; end., endodermis;  
l.ep., lower epidermis; m.c., mucilage cell; pal., palisade; par., par., parenchyma; p.f., pericyclic fibers;  
ph.,phloem; sp.t., spongy tissues; s.g., secretory gland; tr., trichome; u.ep., upper epidermis; xy., xylem.
The powdered Leaf of *Hibiscus rosa-sinensis* L.
A- Upper epidermal cells of the lamina(X 134)
B- Lower epidermal cells of the lamina(X 177).
C- Upper epidermal cells of the midrib (200.1).
D- Lower epidermal cells of the midrib(X 180).
E- Glandular and non glandular trichomes (X 62.4).
F- Pericyclic fibers(X 59).
G- Secretory gland(X 143.3).
H- Cluster crystals of calcium oxalate(X 147.5).

The stomata (Fig. 5A&B) are almost of anisocytic type, oval in outline, being more numerous on the lower surface and absent in the neural region. They contain some chloroplast and measuring 22-28-30µ L and 16-18-20µ B.

Both glandular and non-glandular trichomes are present on both surfaces of the leaf (Figs. 4 & 5E). Covering trichomes are either unicellar or stellate ones. Stellate trichomes are more abundant and formed of 2-4 radiating unicellar arms arising from 1-3 epidermal cells with acute apices, wide lumen, thick lignified walls and covered with smooth cuticle. Each arm measuring 135-180-300µ L and 15-20-25 D while the unicellar trichomes having thick lignified walls and covered with striated cuticle and measuring 100-150-180µ L and 18-30-33µ D. The glandular ones are fewer in number and formed of globular multicellular head measuring 20-22-30µ L and 18-20-22µ D and short unicellar stalk measuring 10-12-15µ L and 8-10-12µ D.

The mesophyll (Fig. 4A& C) is dorsiventral, with an upper palisade formed of one row of radially elongated columnar cells with almost straight anticlinal walls. They measuring 145-150-155µ L and 10-15µ D. It is interrupted by collenchyma in the midrib region. The spongy tissues (Fig. 4A& C) is formed of 5-6 rows of thin-walled, more or less rounded chlorenchymatous cells with wide intercellular spaces. They measuring 45-47-50µ D.

The cortex of the leaf (Fig. 4A& B) is parenchymatous with subepidermal collenchyma abutting both upper and lower epidermises. They are with thick cellulosic walls and measuring 35-45-75µ D. The parenchyma is formed of 8-10 rows of thin-walled, more or less rounded cells with wide intercellular spaces and measuring 50-100-140µ D.

The endodermis (Fig. 4A& B) is well differentiated, formed of thin-walled parenchymatous cells measuring 40-55-75µ D. Endodermal cells containing few starch granules.

The pericycle (Figs. 4A,B & 5F) is formed of intermittent groups of lignified fibers separated by parenchymatous cells. Each group consists of 3-20 fusiform fibers with moderately thick lignified pitted walls, wide or uneven lumen and acuminate, rounded apices. Some of them showing wavy wall. They measure 600-750-900µ L and 10-15 - 20µ B.
The vascular bundle (Fig. 4A & B) is represented by a large strand with the xylem to the adaxial side and the phloem to the abaxial side. A little cambi-form tissue between the xylem and phloem.

The xylem (Figs. 4A, B & 5E) is formed of lignified vessels and thin-walled wood parenchyma, separated by 1-2 rows medullary rays. The vessels possess spiral and scalariform thickening and measure 10-20-30µ D. The phloem is formed of small, thin-walled shining cellulosic elements.

Oval shaped secretory glands measuring 150-170-200 µ D and cluster crystals of calcium oxalate measuring 10-30-50µ D are present in the parenchymatous cortex, spongy tissue and phloem parenchyma. Also, few mucilage cells are present in the parenchymatous cortex measuring 150-160-180µ D.

**Numerical Values of The Leaf:**

Stomatal index, vein-islet number, veinlet-termination number and palisade ratio are summarized in Table (1).

**Table 1:** Numerical Values of the leaves of *Hibiscus rosa-sinensis* L.

<table>
<thead>
<tr>
<th>The numerical value</th>
<th>Recorded value</th>
</tr>
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<tbody>
<tr>
<td>2- Stomatal index:</td>
<td></td>
</tr>
<tr>
<td>a- Upper</td>
<td>18-20</td>
</tr>
<tr>
<td>b- Lower</td>
<td>30-33</td>
</tr>
<tr>
<td>3- Vein-islet number</td>
<td>2-3</td>
</tr>
<tr>
<td>4- Veinlet-termination number</td>
<td>3-4</td>
</tr>
<tr>
<td>5- Palisade ratio</td>
<td>20-24</td>
</tr>
</tbody>
</table>

The petiole:

A transverse section of the petiole (Fig. 6A&B) is more or less rounded in outline. It shows an epidermis followed by the cortex which is formed of 1-3 hypodermal rows of chlorenchymatous cells, 2-3 rows of collenchyma, 3-6 rows of parenchymatous cells. The pericycle is represented by intermittent groups of lignified fibers. The vascular tissue is formed of continuous ring of open collateral vascular bundle enclosing wide parenchymatous pith. Cluster crystals of calcium oxalate, secretory glands and mucilage cells are present in the parenchymatous tissues.

The epidermal cells and stomata (Fig. 7A) are similar to that present in the leaf, they measure 30-40-50µ L, 20-23-25µ B, 12-16-18µ H and 32-35-37µ L, 23-25-27µ B, respectively.

**Fig. 6:** The Petiole of *Hibiscus rosa-sinensis* L.
Transverse section of the petiole(A X 13.3 & B X 60).
ca.o.x., cluster crystal; col., collenchyma; end., endodermis; ep., epidermis; hyp., hypodermis; s.g., secretory gland; m.c., mucilage cell; p., pith; par., parenchyma; p.f., pericyclic fibers; ph., phloem; tr., trichome; xy., xylem.
Both glandular and covering trichomes (Figs. 6A,B & 7B) are similar to that present in the leaf. Stellate trichomes are more abundant. They measure 135-150-170 µ L and 20-25-30 µ D. The unicellar trichomes are twisted at the end like cottony hair. They measure 180-200-250 µ L and 18-20 -22 µ D. The glandular ones are fewer in number. The head measure 45-47-50 µ L and 25-27-30 µ D. The stalk measure 10-14-16 µ L and 8-10-12 µ D.

The cortex (Fig. 6A & B) is formed of 1-3 rows of rounded to oval chlorenchymatous cells measuring 18-20-21 µ D followed by 2-3 rows of moderately thick cellulosic rounded collenchymatous cells measuring 30-40-50 µ D. The rest of cortex is formed of 3-6 rows of parenchymatous cells with thin-cellulosic walls and wide intercellular spaces. They measure 60-80-120 µ D.

The endodermis (Fig. 6A & B) is distinct, consist of axially elongated parenchymatous cells surrounding the pericycle, the endodermal cells measuring 50-70-100 µ D and contain few starch granules.

The pericycle (Figs. 6B & 7G) is formed of intermittent groups of lignified fibers. Each group consist of 6-15 fusiform fibers similar to that present in the leaf. They measure 800-900 -950 µ L and 10-12-15 µ B.

The vascular tissue (Fig. 6B) is formed of continuous ring of collateral vascular bundle.

The phloem (Fig. 6A & B) is formed of thin-walled, cellulosic elements followed by 1-3 rows of tangentially elongated thin-walled meristematic cells forming the cambium.

The xylem (Figs. 6 and 7D & E) is formed of lignified vessels with spiral, scalariform and reticulate thickening and measure 15-20-25 µ D. It also, shows some trachides with pitted lignified walls, measuring 200-250-300 µ L and 10-11-12 µ B. The wood fibers are spindle-shaped, having lignified pitted walls, uneven lumen and blunt or tapering ends. They measure 450-500-550 µ L and 6-8-10 µ B. The wood parenchyma is paratracheal consists of elongated cells with pitted lignified walls measuring 150-180-200 µ L and 17-18-20 µ B. The medullary rays are uni- or biseriate and formed of radially elongated thin-walled cellulosic cells in the phloem and moderately thin lignified in the xylem region.

The pith (Fig. 6) is formed of wide parenchymatous cells with thin-cellulosic walls and wide intercellular spaces. They measure 50-100-140 µ D.

The parenchymatous tissues of the petiole contain cluster crystals of calcium oxalate measuring 20-50-100 µ D, mucilage cells measuring 100-140 µ D and secretory gland measuring 16 - 25 µ D.
The power of the leaf:

The powder (Figs. 5 & 7) is yellowish-green in colour, with characteristic odour and mucilaginous taste. It is characterized microscopically by the following features:

1. Fragments of upper and lower epidermal covering with smooth cuticle and carrying anisocytic stomata.
2. The covering trichome which are either singles or stellate of 2-4 unicellular hairs. The glandular trichome are few and formed of unicellular stalk and multicellular (4-6), biseriate, globular head.
3. Numerous cluster crystals of calcium oxalate which are free or in the cells.
4. Fragment of the lamina in sectional view showing dorsiventral structure and palisade formed of one row of radially elongated columnar cells.
5. Fragments of lignified vessels mostly with spiral and scalariform thickening.
6. Fragments of lignified pericytic fibers with lignified pitted walls, wide or uneven lumen and acuminate apices.

The Young stem:

A transverse section of the young stem (Fig. 8A& B) is oval to circular in outline. It shows an epidermis carrying anisocytic stomata and trichomes followed by the cortex. The vascular tissues are formed of intermittent groups of 6-10 vascular bundles arranged in ring surrounding wide parenchymatous pith. Cluster crystals of calcium oxalate, mucilage cavities as well as secretory glands are scattered in parenchymatous tissues of the cortex, pith and sometimes in the chlorenchymatous cells.

The epidermis (Fig. 8C1) is formed of polygonal, axially elongated cells with straight anticlinal walls and covered with smooth cuticle. They measure 30-32-35µ L, 25-27-30µ B and 25-27-30µ H. The stomata (Fig. 8C1) are similar to that present in the leaf and they measure 30-35-40µ L and 25-27-30µ B.

The trichomes (Fig. 8C 3) are of glandular and non-glandular types. Covering trichomes are similar to that present in the leaf. They measure 85-120-200µ L and 10-11-12µ D. The glandular ones are fewer in number and are similar to that present in the leaf. The head measure 50-55-60 µ L and 30-35-40 µ D. The stalk measure 11-15-22µ L and 8-10-12µ D.

The cortex (Fig. 8C) is formed of glandular and non-glandular types. Covering trichomes are similar to that present in the leaf. They measure 50-60-70µ L, 25-27-30µ B and 10-11-12 µ H. The endodermal cells (Fig. 8A & B) are distinct and similar to that present in the petiole measuring 30-40-50µ D.

The pericycle (Fig. 8A, B& C) is consist of batches of lignified fibers. They are strap-shaped fibers with lignified pitted walls, uneven lumen and acute or blunt apices measuring 50-60-70µ L and 8-9-10µ B.

The vascular tissue (Fig. 8A & B) is formed of a ring of 6-10 separated vascular bundles. Each is composed of an outer phloem of thin-walled cellulosic elements and inner xylem showing a narrow lignified spiral and scalariform vessels measuring 8-15-22 µ D. The medullary rays (Fig. 8A & B) are wide parenchymatous and formed of oval cells with thin cellulosic walls.

The pith (Fig. 8A & B) is wide formed of large polyhedral parenchymatous cells with thin-cellulosic walls and wide intercellular spaces. They measure 40-80-150 µ D.

Cluster crystals of calcium oxalate measuring 10-25-40 µD, Mucilage cells measuring 100-120-140 µ D and secretory gland measuring 150-180-200 µ D are present in the young stem and similar to that present in the leaf.

Old stem and Root:

The transverse section of the old stem and root (Figs. 9 & 10) are more or less circular in outline. They are showing an outer layer of cork followed by the phellogem which is formed of 4-6 rows of parenchymatous cells. The pericycle in the old stem is represented by several tangentially arranged batches of lignified fibers forming triangular shape with the base inward. The vascular tissue is formed of continuous ring of collateral vascular bundle with an outer phloem and inner xylem traversed by procumbent medullary rays forming triangular shape with the base outward in the pericycle region. The pith is wide and parenchymatous having batches of preimedullary phloem. The vascular system of the root is formed of outer wide secondary phloem showing narrow groups of fibers and inner wide cylinder of radiating xylem with central primary penta-arch proto-xylem in the center. Both phloem and xylem are traversed by five nearly funnel-shaped primary medullary rays and numerous narrow secondary ones.

The cork (Figs. 9, 10, 11A, 12A), is formed of 6-8 layers of tangentially elongated, radially arranged tabular, polygonal subrectangular cells with thin suberized walls and brownish contents. They measure 50-60-75 µ L, 30-35-37µ B and 10-11-12 µ H in the old stem, while that of the root measuring 100-120-150µ L, 55-60-70µ B and 20-25-30µ H.
Fig. 8: The Young Stem of *Hibiscus rosa-sinensis* L.
Transverse section of young stem (A X 13 & B X 47)
C1 - The epidermal cells (X 147.5).
C2 - Glandular and non glandular trichomes (X 65.5).
C3 - Secretory gland (X 171.2).
C4 - Cluster crystals of calcium oxalate (X 360.5).
C5 - Xylem vessels (X 321.8).
C6 - Pericyclic fibers (X 262.2).
ca.ox., cluster crystal; end., endodermis; ep., epidermis; hyp., hypodermis; m.c., mucilage cavity; p., p.f., pericyclic fibers; pith; par., parenchyma; ph., phloem; s.g., secretory gland; tr., trichome; xy., xylem.

Fig. 9: T.S of old stem of *Hibiscus rosa-sinensis* L. (X 24).
Cb., cambium; ck., cork; s.g., secretory gland; (1ry, 2nd) mr., primary and secondary medullary ray; p., pith; pd., phelloderm; ph.f., phloem fibers; p.f., pericyclic fibers; pre.ph., premedullary phloem; v., vessel; w.f., wood fibers; w.p., wood parenchyma; 1ry xy., primary xylem.

Fig. 10: T.S of root of *Hibiscus rosa-sinensis* (X 36).
The phelloderm (Figs. 9 & 10) is formed of 4-6 rows of tangentially elongated parenchymatous cells with thin cellulosic walls and narrow intercellular spaces. They measure 40-45-50µ L and 20-22-25 µ B in the old stem, but that of the root measuring 50-140-140µ L and 30-35-40µ B.

The pericycle of old stem (Figs. 9 & 11H) is formed of successive groups of lignified fibers which are tangentially arranged forming triangular shape with the base inward. The groups and rows of the fibers are separated by parenchymatous cells. Each group consists of 2-35 strap-shaped fibers with moderately thick lignified pitted walls, wide or uneven lumen and acute, acuminate, rounded or blunt apices. Some of them showing wavy wall. They measure 100-1200-1500µ L and 5-10-15µ B. The parenchymatous cells are 3-4 cells wide measuring 40-42-45µ D.

The vascular tissue (Figs. 9 & 10) are formed of continuous ring of an outer phloem and inner xylem with cambium in between enclosing wide parenchymatous pith in the old stem and primary proto-xylem in the center of the root.

The phloem (Figs. 9, 10, 11 & 12) is formed of phloem parenchyma, phloem fibers and phloem elements. The phloem fibers are present in groups of 3-15 of spindle- shaped fibers having lignified pitted walls, narrow lumen, tapering apices and measure 900-950-1100µ L and 10-15-22µ B in the old stem and 1000-1100-1200µ L and 15-20-30µ B in the root, respectively.

The xylem (Figs. 9 & 10) is much wider and consist mainly of secondary xylem which is formed of lignified thick walled elements, included abundant fibers, vessels, few tracheids, tracheidal vessels and wood parenchyma, found in radial rows.

The vessels (Figs. 9, 10, 11F & 12F) with spiral, scalariform and pitted with bordered pits thickening either single or in group of 2-4 vessels and measure 10-50-75µ B in the old stem and 30-50-80µ Bin the root.

The tracheids (Figs. 11E & 12E) appearing more or less polygonal in transverse section and varying in shape and length. They have bluntly pointed ends with lignified walls and show bordered pits. They measure 300-400-450µ L, 10-20-30µ B in the old stem and that of the root measuring 400-500-550µ L and 10-15-18µ B.

Tracheidal vessels (Figs. 11D & 12D) are very few with thick lignified pitted walls, showing numerous oval bordered pits, large rounded lateral perforations and blunt ends. They measure 250-300-400µ L, 10-20-25 µ B in the old stem and that of the root measuring 200-350-450µ L and 10-15-18µ B.

The wood fibers (Figs. 11G & 12G) are abundant, spindle-shaped, having lignified straight or dentate walls, wide lumen and blunt or tapering ends. They measure 750-800-900µ L, 8-9-10µ B and 900-950-1050µL, 8-18-25µ B in the old stem and the root, respectively.

The wood parenchyma (Figs. 11C & 12C) are Para tracheal consists of elongated cells with pitted lignified walls measuring 80-90-100µ L, 10-11-12µ B and 60-110µ L, 10-20-30µ B in the old stem and the root, respectively. The cells contain some starch granules. The primary xylem in the old stem (Fig. 9) consists of spiral vessels measuring 10-15-18µ D together with un lignified wood parenchyma.

The medullary rays (Figs. 9 & 10) are multiseriate of 4-9 procumbent cells wide between the groups of pericyclic fibers forming triangular shape have the base outward. They measure 70-90-100µ L and 10-25-35 µ B in the old stem but in the root measure 50-60-75µ L and 35-40-55µ B. In the phloem region, the medullary rays are uni- biseriate and formed of tangentially elongated cells with moderately thick cellulosic walls and measure 30-40-50µ L, 12-15-18µ B and 30-40-50µ L, 20-25-30µ B in the old stem and the root, respectively. In the xylem region, the medullary rays are uni- biseriate and formed of polygonal radially elongated cells with moderately thick pitted and lignified wall. They measure 20-22-25µ L, 10-18-22 µ B, 20-40-50µ L and 10-15-22µ B in the old stem and the root, respectively.

The pith in the old stem (Fig. 9) is wide formed of large polyhedral parenchymatous cells with thin-cellulosic walls and wide intercellular spaces. They measure 40-100-160µ D. Also, intermittent groups of premedullay phloem are present.

Cluster crystals of calcium oxalate measuring 10-50µ D in the old stem and measuring 10-25-40µ D in the root. Mucilage cells are scattered in the parenchymatous tissues and phloem of the root measuring 70-85-100µ D, but mucilage cells are absent in the old stem.

Oval secretory gland is present in the parenchymatous tissues measuring 50-55-60 µ D in the old stem and 30-50-80µ D in the root.

The powdered Stem and Root:

Powdered stem and root (Figs. 8, 11 & 12) are yellowish- brown in colour, with characteristic odour and mucilaginous taste. They are characterized microscopically by the following features:

1. Fragments of epidermal cells with anisocytic stomata.
2. Stellate trichomes formed of 2-8 radiating unicellar arms arising from 1-6 epidermal cells with acute apices, wide lumen, thick lignified walls and covered with smooth cuticle. The glandular ones are formed of globular multicellular head and short unicellar stalk.

3. Fragments of cork cells showing sub rectangular cells with thin suberized walls and brownish contents.

4. Fragments of lignified vessels with spiral, pitted and scalariform thickening.

5. Fragments of tracheids and tracheidal vessels with pitted lignified walls showing bordered pits.

6. Fragments of lignified pericyclic fibers, wood fibers and phloem fibers with lignified pitted walls, wide or uneven lumen and acute, blunt or tapering ends. They differ in size and wall thickness.

7. Fragments of lignified wood parenchyma.

8. Numerous cluster crystals of calcium oxalate.

The flower:

1. The pedicel:

A transverse section of the pedicel (Fig. 13) is more or less rounded in outline. It shows an outer, hairy epidermis followed by the cortex which is formed of 1-2 rows of hypodermal chlorenchymatous cells, 1-2 rows of collenchymatous cells and 3-4 rows of parenchymatous cells. The pericycle is represented by intermittent groups of lignified fibers. The vascular tissue is formed of continuous ring of collateral vascular bundle enclosing wide parenchymatous pith with small groups of perimedullary phloem. Cluster crystals of calcium oxalate, secretory glands and mucilage cells are present in parenchymatous cells.

The epidermal cells (Fig. 14A) are similar to that of the young stem but they are covered with striated cuticle. They measure 33-45-60 µm L, 25-28-30 µm B and 10-15-25 µm H.

Stomata (Fig. 14A) are similar to that of the leaf; they measure 22-25-28 µm L and 20-22-25 µm B.

Covering trichomes (Fig. 14B) are similar to that of the leaf, they measure 75-100-150 µm L and 10-15-18 µm D.

The cortex (Fig. 13) is formed of 1-2 rows of hypodermal of rounded chlorenchymatous cells measuring 10-20-30 µm D followed by 1-2 rows of rounded thick cellulosic collenchymatous cells measuring 20-40-75 µm D. The rest of cortex is formed of 3-4 rows of parenchymatous cells with thin-cellulosic walls and wide intercellular spaces. They measure 75-90-100 µm D.

The endodermis (Fig. 13) is distinct; their cells measure 25-40-60 µm D and contain few starch granules.

The pericycle (Figs. 13 & 14E) is formed of intermittent groups of lignified fibers separated by parenchymatous cells. Each group consists of 2-20 fibres similar to that of the stem and root. They measure 450-500-550 µm L and 8-15-25 µm B. The parenchymatous cells between the groups of fibers measuring 20-30-40 µm D.

The vascular tissue (Fig. 13) is formed of continuous ring of vascular bundle with an outer phloem and inner xylem and cambium in between. Groups of pre medullary phloem are present in the peripheral zone of the pith.

The phloem (Fig. 13) is formed of thin-walled, cellulosic elements.

The cambium (Fig. 13) is continuous ring represented by 1-3 rows of tangentially elongated thin-walled meristematic cells measuring 8 - 16 µm L and 5 - 6 µm B.

The xylem elements are similar to that present in stem and root. The vessels (Fig. 14F) with spiral, pitted and scalariform thickening and measuring 8-25-35 µm D. Trachides (Fig. 14G) are few and measuring 170-200-250 µm L and 10-12-20 µm B, while tracheidal vessels (Fig. 14F) measuring 150-175-200 µm L and 10-20-25 µm B and wood parenchyma (Fig. 14H) measuring 100-120-150 µm L and 12-15-20 µm B they contain some starch granules.

The medullary rays (Fig. 13B) are uniseriate and formed of radially elongated thin-walled cellulosic cells in the phloem region and measure 120-150-180 µm L and 8-10-12 µm B. In the xylem, they are moderately thick lignified and measure 60-80-100 µm L and 5-8-10 µm B.

The pith (Fig. 13B) is formed of wide parenchymatous cells with thin-cellulosic walls and wide intercellular spaces. They measure 40-80-150 µm D. Groups of premedullary phloem are present in the peripheral zone of the pith.

The parenchymatous cells of the pedicel showing scattered cluster crystals of calcium oxalate (Fig. 12D) measuring 10-20-30 µm D, mucilage cells measuring 100-120-150 µm D and secretory gland (Fig. 14 C) measuring 150-160-180 µm D.
Fig. 11: The powdered Old stem of *Hibiscus rosa-sinensis* L.
A- Cork Cells(X 177). B- Medullary rays(X 118).
C- Wood parenchyma(X 151.7). D- Trachedial vessels(X 167.2).
E- Trachedies(X 157.3). F- Xylem vessels(X 144).
G- Different types of fibers(X 177).
H- Secretory gland(X 186.3)
I- Cluster crystals of calcium oxalate(X 283.2).

Fig. 12: The powdered Root of Hibiscus rosa-sinensis L:
A- Cork Cells(X 177). B- Medullary rays(X 113.4).
C- Wood parenchyma(X 136.1). D- Trachedial vessels(X 148.4).
E- Trachedies(X 187.5). F- Xylem vessels(X 136).
G- Different types of fibers(X 167).
H- Secretory gland(X 354)
I- Cluster crystals of calcium oxalate(X 324.5).
p.f., pericyclic fibers; ph.f., phloem fibers; w.f., wood fibers
2. The epicalyx:

A transverse section of the bract (Fig. 15A) shows an inner and outer epidermis carrying abundant of non glandular trichomes and few glandular ones and enclosing homogenous mesophyll. The mesophyll shows a parenchymatous cortex traversed by numerous small collateral vascular bundles, mucilage cells and cluster crystals of calcium oxalate.

The inner epidermis of bract at the apex and middle (Fig. 15B₁ & B₂) consist of polygonal, axially elongated cells with straight anticlinal wall and covered with striated cuticle. Some mucilage cells are present in the middle epidermal cells which are measure 67 - 145µ D. At the base (Fig. 15B₃) the epidermal cells are polygonal, isodimetric or rectangular with straight anticlinal walls.

The outer epidermis of the bract at the apex (Fig. 15C₁) and the middle (Fig. 15C₂) are consist of polygonal, axially elongated, rectangular cells covered with striated cuticle and show anisocytic stomata, while that at the base (Fig. 15C₃) are isodimetric to rectangular have wavy anticlinal walls.

Table 2: Dimensions of the epidermal cells of the epicalyx of Hibiscus rosa-sinensis L.

<table>
<thead>
<tr>
<th>Epidermis</th>
<th>Length (µ)</th>
<th>Breadth (µ)</th>
<th>Height (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outer epidermis:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the apex</td>
<td>30-50-64</td>
<td>25-32-40</td>
<td>15-20-25</td>
</tr>
<tr>
<td>At the middle</td>
<td>30-60-75</td>
<td>25-32-40</td>
<td>15-20-25</td>
</tr>
<tr>
<td>At the base</td>
<td>30-45-55</td>
<td>25-32-40</td>
<td>15-20-25</td>
</tr>
<tr>
<td><strong>Inner epidermis:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the apex</td>
<td>23-32-50</td>
<td>30-40-50</td>
<td>20-25-30</td>
</tr>
<tr>
<td>At the middle</td>
<td>42-55-65</td>
<td>30-40-50</td>
<td>20-25-30</td>
</tr>
<tr>
<td>At the base</td>
<td>30-45-55</td>
<td>30-40-50</td>
<td>20-25-30</td>
</tr>
</tbody>
</table>

Stomata (Fig. 15C₁ & C₂) are present in the outer surface, being more numerous on the upper and central parts but absent on the basal part. They are similar to that present in the pedicel measuring 50-55-60µ L and 25-27-30µ B.

The trichomes (Fig. 15B₁,C₁ & D) are of glandular and non-glandular types. Stellate trichomes are more abundant being similar to that present in the pedicel. They measure 100-120-150µ L and 10-15-20µ D. The unicellular trichomes (whip-like) with acute or blunt apices, wide lumen, thick lignified walls and covered with striated cuticle and measure 150-180-200µ L and 22-30-37µ D. The glandular ones (Fig. 15D) are fewer in number and similar to that present in the pedicel. The head measure 50-52-55µ L and 25-30-35µ D. The stalk measure 13-15-17µ L and 6-8-12µ D.

Fig. 13: The Pedicel of Hibiscus rosa-sinensis L.
Transverse section of the pedicel (A X 6.6, B X 26.6)
cb., cambium; end., endodermis; ep., epidermis; hyp., hypodermis; p., pith; par., parenchyma; p.f., pericyclic fibers; ph., phloem; pre.ph, premedullary phloem; tr., trichome; xy., xylem
Fig. 14: The powdered Pedicel of *Hibiscus rosa-sinensis* L.
A- The epidermal cells(X 277.6).
B- Trichomes(X 78.6).
C- Wood parenchyma(X 259), D- Trachedial vessels(X 208.6).
E- Trachides(X 226.9). F- Xylem vessels(X 197.5).
G- Pericyclic fibers(X 183). H- Secretory gland(X 181.5).
I- Cluster crystals of calcium oxalate(X 196.6).

The cortex (Fig. 15A) consists of almost rounded, thin cellulosic walled parenchymatous cells with small intercellular spaces. They measure 50-75-90µ D and vascular strands (Fig. 15A) consists of small vascular bundles consisting of few thin cellulosic phloem measuring 5-7-9µ D surrounding few annular vessels measuring 10-12-15µ D.

Mucilage cells are present in the mesophyll and in the inner epidermis measuring 150-180-200µ D. Also, scattered cluster crystals of calcium oxalate are present in parenchymatous cells -measuring 10-30-50µ D.

3. The calyx:

A transverse section of the sepal (Fig. 16A) shows an inner and outer epidermis which are densely hairy, carrying abundant of non glandular trichomes and few glandular ones and enclosing homogenous mesophyll, shows a parenchymatous cortex traversed by 13 – 15 small vascular bundles and 4 -5 large ones under the big veins. Mucilage cells and cluster crystals of calcium oxalate are also, present.

The inner epidermis of sepal consists of polygonal cells covered with striated cuticle and having variation in shape and size.

At the apex (Fig. 16B1) the cells are polygonal, axillary elongated with slightly wavy anticlinal wall. At the middle (Fig. 16B2) the cells are similar to that at the apex and showing some mucilage cells which measure 83 –125µ D. At the base (Fig. 16B3) the cells are similar to that at the apex and axially elongated with moderately thick anticlinal walls.

The outer epidermis of the sepal consists of polygonal cells covered with striated cuticle and showing variation in shape and size.

At the apex (Fig. 16C1) the cells are polygonal, axially elongated to isodimetric with slightly wavy anticlinal. At the middle (Fig. 16C2) the cells are polygonal , isodimetric with wavy anticlinal walls. At the base (Fig. 16C3) the cells are polygonal, axially elongated with slightly wavy, moderately thick anticlinal walls.
Fig. 15: The epicalyx of *Hibiscus rosa-sinensis* L.  
A- Transverse section of the epicalyx (X 43.3).  
B- Inner epidermis of the epicalyx:  
B1- At the apex (X 142.8).  B2- At the middle (X 90.7).  B3- At the base (X 147.5).  
C- Outer epidermis of the epicalyx:  
C1- At the apex (X 81.9).  C2- At the middle (X 118).  C3- At the base (X 125.3).  
D- Glandular and non glandular trichomes (X 78.6).  
E- Cluster crystals of calcium oxalate (X 245.5).  
F- Xylem vessels (X 160.9).  
in.ep., inner epidermis; m.c, mucilage cavity; out.ep., outer epidermis; tr., trichome; v.st., vascular strand.

Table 3: Dimensions of the epidermal cells of the calyx of *Hibiscus rosa-sinensis* L.

<table>
<thead>
<tr>
<th>Epidermis</th>
<th>Length (µ)</th>
<th>Breadth (µ)</th>
<th>Height (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner epidermis:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the apex:</td>
<td>25-30-47</td>
<td>30-35-40</td>
<td>20-22-25</td>
</tr>
<tr>
<td>At the middle:</td>
<td>41-45-47</td>
<td>30-35-40</td>
<td>20-22-25</td>
</tr>
<tr>
<td>At the base:</td>
<td>40-45-48</td>
<td>30-35-40</td>
<td>20-22-25</td>
</tr>
<tr>
<td>Outer epidermis:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the apex:</td>
<td>25-35-50</td>
<td>27-33</td>
<td>15-18-20</td>
</tr>
<tr>
<td>At the middle:</td>
<td>25-35-50</td>
<td>37-42</td>
<td>15-18-20</td>
</tr>
<tr>
<td>At the base:</td>
<td>25-35-50</td>
<td>30-35</td>
<td>15-18-20</td>
</tr>
</tbody>
</table>

Stomata (Fig. 16B2,C1) present in the upper and middle part in both surface and completely wanted in the basal part. They are similar to that present in the pedicel and measure 25-28-32µ L and 22-25-28µ D.

The trichomes (Fig. 16D) are of glandular and non-glandular types. Covering trichomes are either unicellar or stellate ones. Stellate trichomes are more abundant and similar to that present in the epicalyx. They measure 120-150-180µ L and 25-28-30µ D. The unicellular trichomes similar to that present in the epicalyx measuring 45-80-120µ L and 11-15-18µ D. The glandular ones are fewer in number and similar to that present in the epicalyx. The head is multicellular (5-19) and measuring 44-80-100µ L and 27-35-40µ D. The stalk is unicellular and measuring 13-18-22µ L and 5-8-11µ D.

The cortex (Fig. 16A) consists of almost rounded, thin cellulosic walled parenchymatous cells with small intercellular spaces. They measure 75-120-150µ D.
Fig. 16: The calyx of *Hibiscus rosa-sinensis* L.
A- Transverse section of the calyx (X 11.1).
B- Inner epidermis of the calyx:
B1- At the apex(X 124.2). B2- At the middle(X 105.8). B3- At the base(X 118).
C- Outer epidermis of the calyx:
C1- At the apex(X 147.5). C2- At the middle(X 131.1). C3- At the base(X 142.2).
D- Glandular and non glandular trichomes (X 109.5).
E- Cluster crystals of calcium oxalate(X 241.3).
F- Trachides(X 288.4)
G- Xylem vessels(X 238.3).
in.ep., inner epidermis; m.c, mucilage cavity; out.ep., outer epidermis; tr., trichome; v.st., vascular strand.

The vascular tissue (Fig.16A) is formed of small vascular bundles. It is consists of phloem formed of moderately thick-walled cellulosic elements and xylem (Fig. 16G) showing lignified spiral and scalariform vessels measuring 8-9-10µ D. It also, shows some trachides (Fig. 16F) measuring 75-80-90µ L and 5-6-8µ B.

Cluster crystals (Fig. 16E) of calcium oxalate measuring 10-30-40µ D and mucilage cells measuring 100-120-150µ D are also present in the parenchymatous cortex.

4. The corolla:

A transverse section of the petal (Fig. 17A) shows an inner and outer epidermis enclosing homogenous mesophyll. The parenchymatous cortex traversed by small collateral vascular bundles alternating with large mucilage cavities.

The outer and inner epidermises of petal consist of polygonal, isodimetric, rectangular and axially elongated cells covered with striated cuticle. Variation in shape and size of the epidermal cells are observed.

The inner epidermal cells at the marginal apex (Fig. 17B1) are thickened polygonal with slightly wavy anticlinial walls, usually papillosed, but at the apex (Fig. 17B2) the cells have strongly wavy anticlinial walls. At the middle (Fig. 17B3) the cells have straight anticlinial walls, while at the base (Fig. 17B4) the cells are axially elongated with slightly wavy anticlinial walls.
While epidermal cells at the outer marginal apex (Fig. 17C₁) are consist of polygonal, isodimetric, subrectangular with straight anticlinal wall, but at the apex (Fig. 17C₂) the cells have strongly wavy anticlinal walls. At the middle (Fig. 17C₃) the cells are thickened polygonal, subrectangular with straight anticlinal walls and showing some cicatrices and mucilaginous contents, while at the basal part (Fig. 17C₄) the cells are axially elongated with straight anticlinal walls and few stomata are present.

Table 4: Dimensions of the epidermal cells of the corolla of *Hibiscus rosa-sinensis* L.

<table>
<thead>
<tr>
<th>Location</th>
<th>Length (µ)</th>
<th>Breadth (µ)</th>
<th>Height (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outer epidermis:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the marginal apex</td>
<td>37-45-55</td>
<td>20-30-35</td>
<td>25-30-25</td>
</tr>
<tr>
<td>At the apex</td>
<td>55-80-100</td>
<td>20-30-35</td>
<td>25-30-25</td>
</tr>
<tr>
<td>At the middle</td>
<td>27-40-55</td>
<td>20-30-35</td>
<td>25-30-25</td>
</tr>
<tr>
<td>At the base</td>
<td>75-100-135</td>
<td>20-30-35</td>
<td>25-30-25</td>
</tr>
<tr>
<td><strong>Inner epidermis:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the marginal apex</td>
<td>25-35-45</td>
<td>30-40-50</td>
<td>20-25-30</td>
</tr>
<tr>
<td>At the apex</td>
<td>65-70-80</td>
<td>30-40-50</td>
<td>20-25-30</td>
</tr>
<tr>
<td>At the middle</td>
<td>35-50-75</td>
<td>30-40-50</td>
<td>20-25-30</td>
</tr>
<tr>
<td>At the base</td>
<td>50-100-135</td>
<td>30-40-50</td>
<td>20-25-30</td>
</tr>
</tbody>
</table>

Stomata (Fig. 17C₄) are few in number and present only at the basal part of outer epidermis. They are similar to that present in the epicalyx and measure 35-38-40 µ L and 30-33-35 µ D.

The trichomes (Fig. 17D) are of glandular and non-glandular types. Covering trichomes are unicellular or stellate ones. Stellate trichomes are octopus in shape being more abundant and formed of 2-7 radiating unicellular arms arising from 1-4 epidermal cells. Each arm has acute apices, wide lumen, thick lignified walls and covered with striated cuticle. They measure 150-180-200 µ L and 16-20-22 µ D. The unicellular ones are whip-like with acute or blunt apices, wide lumen, thick lignified walls and covered with striated cuticle and measure 175-200-250 µ L and 10-15-22 µ D. The glandular ones are abundant in number and formed of globular head and short stalk. The head is multicellular (18-20) and measuring 100-105-110 µ L and 16-20-22 µ D. The stalk is unicellular and measuring 10-12-14 µ L and 6-8-10 µ D.

The mesophyll (Fig. 17A) is homogenous formed of almost rounded parenchymatous cells with thin wall and narrow intercellular space. They measure 40-50-60 µ D. The parenchymatous cells enclosing closed collateral vascular bundles alternating with large mucilage cavities measuring 750-900-1050 µ D.

The cortex (Fig. 17A) consists of almost rounded, thin walled parenchymatous cells with small intercellular spaces. They measure 50-100-150 µ D.

The vascular tissue (Fig. 17A) is formed of small vascular bundles. It is consists of phloem formed of moderately thick-walled cellulosic elements and xylem showing lignified spiral and scalariform vessels measuring 8-12-15 µ D.

5. The androecium:

1- The filament:

A transverse section of the filament (Fig. 18A) is nearly rounded in outline showing an epiderm surrounded parenchymatous ground tissue which traversed by small vascular strands and mucilage cavities measuring 16-20-25 µ D.

The epidermal cells of the filament (Fig. 19C & D) are slightly papillosed formed of polygonal, tabular, axially elongated cells with slightly straight anticlinal walls and covered with striated cuticle. They measure 20-30-45 µ L, 16-20-22 µ B and 20-25-30 µ H in the middle and upper part of the filament, while the basal epidermal cells having larger dimension which measure 25-30-50 µ L, 37-40-47 µ B and 20-25-30 µ H. Stomata and trichomes are completely absent on the epidermis of the filament.

2- The anther:

A transverse section of the anther (Fig. 18B & C) consists of two lobes attached together by the connective, traversed longitudinally by small vascular strand continuous with that of the filament. This strand is formed of few lignified spiral vessels surrounded by few layers of compact parenchymatous phloem. Each anther lobe consists of one pollen sac containing pollen grains.

The anther wall (Fig. 18B & C) is thin and formed of an outer epidermis followed by a single row of fibrous layer and the remaining of tapetum.

The epidermal cells of the anther-lobes (Fig. 19B) are slightly papilosed, polygonal, isodimetric with straight anticlinal walls and Covered with striated cuticle. They measure 42-45-47 µ L, 22-35-40 µ W and 20-25-30 µ H. The epidermis of the anther is devoid of stomata and trichomes.
**Fig. 17:** The corolla of *Hibiscus rosa-sinensis* L.

A- Transverse section of the corolla (X 33.3).

B- Inner epidermis of the epicalyx:

- B1- At the marginal apex (X 160.4).
- B2- At the apex (X 189).
- B3- At the middle (X 183.5).
- B4- At the base (X 132.8).

C- Outer epidermis of the epicalyx:

- C1- At the marginal apex (X 147.5).
- C2- At the apex (X 110).
- C3- At the middle (X 160.9).
- C4- At the base (X 128.2).

D- Glandular and non glandular trichomes (X 104.1).

E- Xylem vessels (X 147.5).

c.c, cicatric; in.ep., inner epidermis; m.c, mucilage cavity; out.ep., outer epidermis; v.st., vascular strand.

The fibrous layer of the anther (Fig. 19A) is formed of one row of polygonal, isodimetric cells with straight anticlinal walls showing lignified bar-like thickening in the anticlinal plane and beaded in surface view. They measure 30-32-35 µ L, 35-45-60µ B and 6-8-10µ H.

Tapetum (Fig. 18C) is formed of 2 rows of thin walled, polygonal, tangentially elongated parenchymatous cells measuring 18-30-37µ L and 10-14-16µ B.

The pollen grains (Fig. 19G) are yellow in colour, spherical with three rounded germ pores, three germinal furrows and spiny exine. They measure 150-160-175µ D.

The epidermal cells of the connective (Fig. 19I) are polygonal, or nearly rectangular, isodimetric cells with straight anticlinal walls and covered with striated cuticle. They measure 70-73-77µ L and 32-42-52µ B.

Both outer and inner epidermal cells of staminal tube (Fig. 19E& F) are polygonal isodiametric to rectangular axially elongated cells with straight anticlinal walls, covered with striated cuticle but the outer epidermal cells are with moderately thick wall. The outer epidermal cells measure 20-22-25µ L, 30-40-50µ B, 10-15-20µ H and inner epidermal cells measure 25-28-30µ L, 40-45-60µ B, 20-22-25µ H. Stomata (Fig. 19E&F) are similar to that present in the leaf. They measure 42-45-47µ L and 33-35-42µ D.
Fig. 18: The androecium of *Hibiscus rosa-sinensis* L.
A- Diagrammatic transverse section of the filament (X 36).
B- Diagrammatic transverse section of the anther (X 45).
C- Detailed transverse section of the anther wall (X 214.5)
  Cn. Connective; epi. Epidermis, fl., fibrous layer; m.c, mucilage cavity; t., tapetum; v.st., vascular strand.

Fig. 19: The isolated elements of The androecium of *Hibiscus rosa-sinensis* L.
A- Fibrous layer (X 147.5).
B- Epidermal cells of the anther in surface view (X 387.3).
C- Epidermal cells of the filament at the apex and the middle (X 104.1).
D- Epidermal cells of the filament at the base (X 168.5).
E- Outer epidermal cells of the stamina tube (X 126.4).
F- Inner epidermal cells of the stamina tube (X 94.4).
G- Pollen grain (X 81.1). H- Glandular hair (X 177).
I- Epidermis of connective (X 134.8). J- Xylem vessels (X 98.3).
K- Cluster crystals of calcium oxalate (X 246).
Epidermal cells of stamina tube carrying trichomes of glandular types (Fig. 17H) formed of globular head and short stalk. The head is multicellular (4-6) and measuring 27-30-33µ L and 16-20-22µ D. The stalk is unicellular and measuring 5-8-10µ L and 5-6-8µ D. Cluster crystals of calcium oxalate are present in the ground tissue of stamina tube measuring 10-15-20µ D. Also, large mucilage cells are present in the ground tissue of stamina tube and filament measuring 250-600µ D and 16-20-25µ D, respectively.

6. The gynaecium:

A transverse section of the pentacarpellary ovary (Fig. 20) is almost rounded in outline showing five locules, each locule contain two ovules. The ovary showing an outer and inner epidermis enclosing a parenchymatous mesophyll in between. The mesophyll (Fig. 20) is formed of rounded, moderately thin-walled parenchyma with small intercellular spaces and measure 20-22-25µ D. It is traversed by five vascular strands and mucilage cavities measuring 150-300-600µ D. Each vascular strand is composed of a xylem showing few spiral vessels measuring 5-6-8µ D and a phloem formed of thin-walled cellulosic elements.

![Fig. 20: The gynoecium of Hibiscus rosa-sinensis L.](image)

Transverse section of the ovary (X 8.3).

epi., epidermis; m.c, mucilage cavity; ov., ovule; p., placenta; v.st., vascular strand.

The outer epidermal cells of the ovary (Fig. 21A) are polygonal axially elongated cells with straight anticlinal walls and covered with thin striated cuticle. They measure 25-28-30µ L, 65-90-110µ B and 20-22-25µ H. The inner epidermal cells of the ovary (Fig. 21B) are polygonal isodiametric to axially elongated cells with pitted anticlinal walls. They measure 10-15-25µ L, 50-75-100µ B and 10-12-15µ H.

The outer and inner epidermal cells of the style (Fig. 21C& D) are formed of polygonal, axially elongated cells with straight anticlinal walls and covered with striated cuticle. They measure 10-15-18µ L, 50-75-100 µ B, 8-9-10µ H and 10-15-18 µ L, 65-75-85µ B, 8-9-10µ H, respectively. Outer epidermal cells of style carrying stomata similar to that present in the leaf and measure 36- 40-42µ L and 22-24-28µ D.

The epidermis of the stigma (Fig. 21E) is composed of papillosed cells which are polygonal axially elongated with straight anticlinal walls and covered with striated cuticle. They measure 20-22-25µ L and 10-12-15µ B. The outer periclinal walls of the cells are prolonged into cylindrical or conical-shaped papillae with rounded apices. They measure 350-400-450µ L and 25-30-33µ B.

The epidermal cells of style and stigma carrying glandular trichomes while that of the ovary carrying both glandular and non-glandular types (Fig. 21F). Covering trichomes are unicellar or bicellular (whip-like) with acute or blunt apices, wide lumen, thick lignified walls and covered with striated cuticle and measure 180- 350-500µ L and 22-40-60µ D. The glandular ones are abundant in number and formed of globular head and short stalk. The head is multicellular (8-10) and measuring 50-75-80µ L and 30-40-50µ D. The stalk is unicellular and measuring 25-30-40 µ L and 10-12-15µ D.

The ground tissues of style and ovary showing scattered cluster crystals of calcium oxalate measuring 10-15-20µ D and mucilage cells measuring 100-300-600µ D.
7. The powdered flower:

The flower powder is reddish brown in colour, with characteristic odour and mucilaginous taste. It is characterized microscopically by the following features:

1. Fragments of epidermal cells of pedicle which are polygonal, tabular cells with straight, thin-cellulosic anticlinal walls, covered with striated cuticle.
2. Fragments of epidermal cells of epicalyx and calyx which are polygonal, rectangular, axially elongated cells covered with striated cuticle.
3. Fragments of epidermal cells of corolla which are polygonal, axially elongated with straight anticlinal walls, usually papillose.
4. Fragments of epidermal cells of the anther-lobes and filament which are polygonal, isodimetric with straight anticlinal walls and covered with striated cuticle and devoid of stomata and trichomes.
5. Fragments of epidermal cells of staminal tube which are polygonal isodiametric to rectangular axially elongated cells with straight anticlinal walls and covered with striated cuticle.
6. Fragments of epidermis of the stigma which are papillose, polygonal axially elongated with straight anticlinal walls and covered with striated cuticle, free from stomata. The outer periclinal walls of the cells are prolonged into cylindrical or conical-shaped papillae.
7. Fragments of epidermal cells of the style which are formed of polygonal, axially elongated cells with straight anticlinal walls and covered with striated cuticle.
8. Stomata are of anisocytic type.
9. Fragments of epidermal cells of the ovary which is formed of polygonal, axially elongated cells with pitted anticlinal walls and free from stomata.
10. Fragment of the fibrous layer of the anther which are formed of polygonal, isodimetric cells with straight anticlinal walls showing lignified spiral bar-like thickening in the anticlinal plane and beaded in surface view.

11. The pollen grains which are yellow in colour, spherical with three rounded germ pores, three germinal furrows and spiny exine.

12. Fragments of spiral and annular lignified vessels.

13. Numerous glandular and covering trichomes.

14. Numerous cluster crystal of calcium oxalate are present.

**Conclusion:**

From the fore-mentioned study, the common microscopical characters of *Hibiscus rosa-sinensis* L are in almost in good agreement with the reported microscopical botanical characters on the majority of species of the genus *Hibiscus* as well as family Malvaceae (Metcalfe and Chalk, 1950). These simple but reliable microscopical measurements will be useful to a lay person in using the investigated plants as herbal drug and home remedy. Also, the manufacturers can utilize them for the identification and selection of the raw materials for herbal drug production. Herein, scientific academic research on such crude drugs is essential potential to provide trustful guide in the preparation, safety and efficacy of herbal product.

**References**


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