



MACRO-AND MICROMORPHOLOGY OF THE LEAVES, STEM BARK AND FLOWERS OF *PUNICA GRANATUM* L. VAR. *NANA* CULTIVATED IN EGYPT

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Punica granatum L. var. *nana* (ornamental pomegranate) belongs to family Punicaceae. It is popularly planted in gardens for ornament. The root, stem bark and to a lesser extent fruit rind of the edible pomegranate had been commonly used as a vermifugal or taenicidal agent on tapeworms. By reviewing the literature, no botanical studies were done on *Punica granatum* L. var. *nana*, so this study aims for characterization and identification of this plant in both entire and powdered forms.

INTRODUCTION

The family Punicaceae contains the single genus *Punica*, which is composed of 2 species, the common one being the cultivated pomegranate (*P. granatum*) and the other species is *P. protopunica* Balf. S.^{1&2}. There are different varieties of *P. granatum* L. (edible pomegranate), some are grown for their fruits, others grown for ornamental purpose. *P. granatum* L. var. *nana* (ornamental pomegranate) is a dwarf ornamental variety of pomegranate popularly planted in gardens for ornament³. Pomegranate is native to Persia, cultivated in Greece, Italy and Egypt. Later, it spreads into Asian countries like (Turkmenistan, Afghanistan, India and China). It can also be found in North Africa and Mediterranean Europe^{4&5}. Pomegranate is one of the oldest known edible fruits, its history dates to very ancient times. This tree is one of the species mentioned in the Holy Quran in the sora of "Al Rahman". (فيهما فاكهة ونخل ورمان)

The root, stem bark and to a lesser extent the fruit rind of pomegranate have been commonly used as a vermifugal or taenicidal agent on tapeworms⁶. Pomegranate was also found to have astringent effect. It was used in the form of an aqueous decoction for dysentery, diarrhea, rectal and uterine prolapse.

Also, the fruit juice with honey is good for stomach and mouth ulcers, while the fruit rind extract is useful in stopping women's bleeding^{6&7}. Pomegranate flowers served as a remedy for diabetes mellitus⁸. By reviewing the literature, few reports were traced dealing with phytochemical investigation of *P. granatum* L. var. *nana*. Estrone, 1-galloyl- β -D-glucose, cyanidin-3,5-O-diglucoside and 2-methylpyran-4-one-3-O- β -D-glucopyranoside were isolated from *P. granatum* L. var. *nana*^{9&10}. Concerning macro- and micro-morphology of this plant, nothing could be traced. This encouraged us to undergo a macro- and micro-morphological study of the leaves, stem bark and flowers of *P. granatum* L. var. *nana*.

Habitat

Punica granatum L. var. *nana* is an ornamental deciduous shrub about 3-4 m height. The leaves are simple, exstipulate, petiolate and opposite decussate. The flowers of pomegranate are actinomorphic and sessile (Figs. 1, 2A&2B). The flowering habit of pomegranate depends on climatic conditions. It flowers from the middle of April up to the end of May. It prefers rich, well watered and well drained soil in sunny locations. It bears small spherical, red to brown fruits of berry type.



Fig. 1 : A photo of the plant x 0.05

Material

Fresh samples of *Punica granatum* L. var. *nana* leaves, stem bark and flowers were collected during the flowering stage in the period from April to July 2011 from the Experimental Station of Agriculture, Faculty of Agriculture, Assiut University, Assiut, Egypt.

The plant was identified and authenticated by Dr. Naem E. Keltawy, Professor of Ornamental Horticulture and Floriculture, Faculty of Agriculture, Assiut University, Assiut, Egypt. Voucher specimens (No 45) were kept in the herbarium of Pharmacognosy Department, Faculty of Pharmacy, Assiut University. Different organ samples were preserved in mixture of alcohol (70%): glycerin: water (1:1:1) and stored in a tightly closed container. For microscopical study of the powder, each organ of the plant was separately air-dried and reduced to fine powder.

THE LEAF

A- Macromorphology

The leaves are simple, exstipulate, petiolate, opposite decussate with upper green surface and lower paler one (Fig. 2A&2B). The lamina is ovate to lanceolate in shape with entire margin, symmetric base and acute slightly recurved apex. It measures about 1.8-4.2 cm in length and about 1-2 cm in width. The venation is pinnate-reticulate and the texture is coriaceous. The petiole is short being cylindrical to subcylindrical in shape, measures about 0.2-0.4 cm in length and 0.2-0.5 cm in diameter. The leaf has faint odour with bitter and astringent taste.

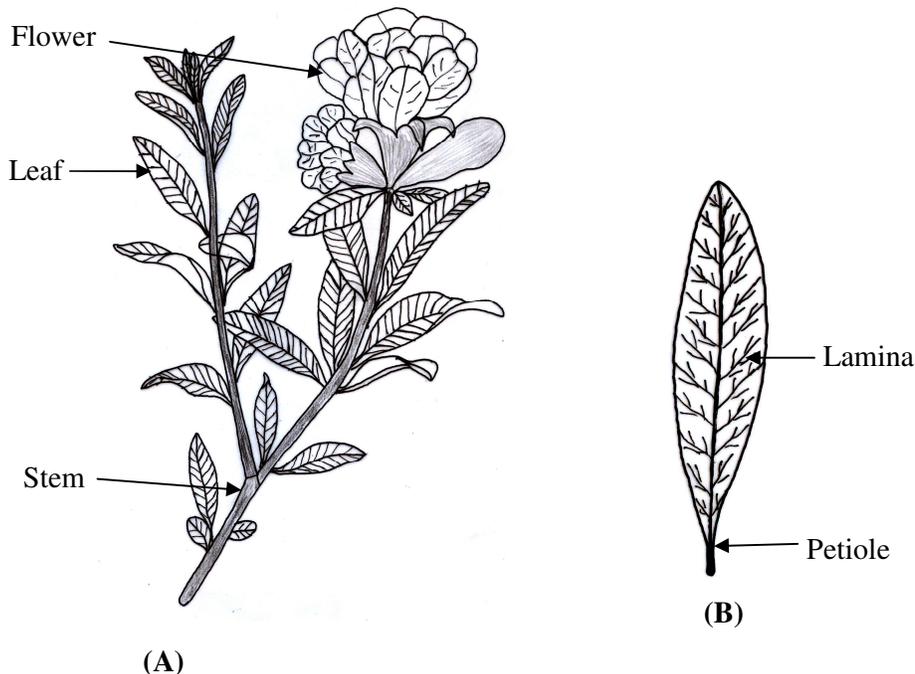


Fig. 2: A) Macromorphology of the flowering branch.
B) Macromorphology of the leaf.

X 0.175
X 1.47

B- Micromorphology

1- The lamina

The transverse section of the lamina is concavoconvex in outline (Fig. 3A). It shows a dorsiventral structure¹¹, the palisade is interrupted in the midrib region by a small mass of collenchyma. The midrib shows collateral crescent shaped vascular bundle having lower arc of pericycle, which is mainly parenchymatous with scattered pericyclic fibres. The endodermis is indistinguishable. Large groups of intraxylary phloem are present above the bundle.

The epidermis

Upper epidermis: It consists of one row of square to subrectangular cells (Figs. 3B&4). In surface view (Fig. 3C), the cells appear polygonal usually isodiametric with nearly straight beaded anticlinal walls, covered with smooth moderately thick cuticle, sometimes showing short papilli. Stomata and hairs are absent.

Lower epidermis: It consists of one row of square to subrectangular cells (Figs. 3B&4). In surface view (Fig. 3D), the cells appear polygonal usually isodiametric with slightly wavy beaded anticlinal walls, covered with smooth moderately thick cuticle and sometimes showing short papilli. Numerous oval to rounded stomata of anomocytic type are present and hairs are absent.

Neural epidermis: In surface view (Fig. 3E), the neural epidermal cells appear as elongated rectangular cells with beaded and slightly wavy walls.

The mesophyll

The leaf (Fig. 3B) shows a dorsiventral structure with a mesophyll differentiated into a palisade and spongy tissue. The palisade is formed of one row of cylindrical columnar radially elongated cells containing chloroplasts. The spongy tissue is formed of thin walled rounded to oval parenchymatous cells showing very large solitary prisms of calcium oxalate along the boundary between the palisade and the spongy tissue and sometimes clusters of calcium oxalate.

The midrib

The cortical tissue

The cortical tissue (Fig. 4) consists of cellulosic rounded to oval parenchymatous cells containing starch granules, prisms and clusters of calcium oxalate mainly in the lower part. The starch is mainly simple sometimes compound, spherical to oval in shape with centric point hilum appearing in large ones. A hypodermal zone of collenchymatous cells is abutting on both epidermises.

The pericycle

The pericycle consists of lower arc of parenchymatous cells containing starch granules and interrupted with groups of non lignified fibres. The fibres are thin walled, with wide lumina and sometimes showing wavy dentate margin (Fig. 7).

The vascular tissue

The vascular tissue (Fig. 4) shows a collateral vascular bundle consisting of radiating xylem and phloem.

a- The xylem

The xylem (Fig. 4) consists mainly of lignified vessels regularly arranged in radial rows of 7-8 vessels usually with pitted, scalariform and spiral thickenings (Fig. 7). Wood fibres are straight in outline with thin lignified walls, with wide lumina and some are septate divided by numerous septa into chambers each containing one or two prisms of calcium oxalate (crystalliferous fibre). Tracheids are pitted with lignified walls. (Fig. 7).

Medullary rays are uniseriate rarely biseriate, consisting of radially elongated lignified cells containing starch granules. (Fig. 4).

b- The phloem

The phloem (Fig. 4) is formed of small thin walled cellulosic elements consisting of sieve tubes, companion cells and phloem parenchyma containing starch granules and numerous small cluster crystals of calcium oxalate.

c- Intraxylary phloem

Intraxylary phloem (Fig. 4) is formed of large groups of small soft elements above the xylem containing numerous small clusters crystals of calcium oxalate and starch granules.

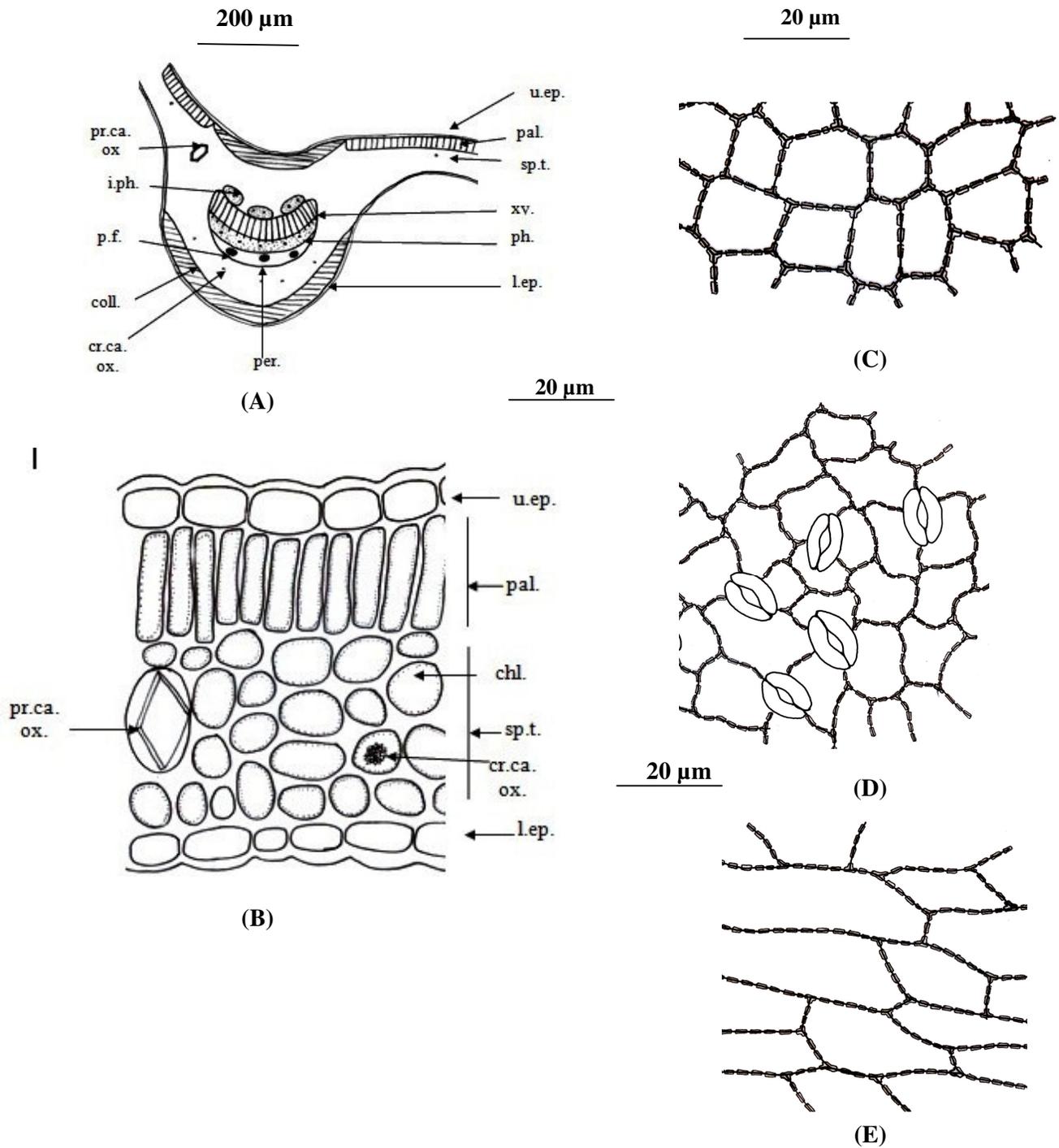


Fig. 3: A) The diagrammatic T.S of the leaf.
 B) The detailed T.S. in the lamina.
 C) The upper epidermis of the leaf.
 D) The lower epidermis of the leaf
 E)The neural epidermal cells of the leaf.

chl., chlorenchyma; coll., collenchyma; cr.ca.ox., cluster of calcium oxalate; i.ph., intraxylary phloem; l.ep., lower epidermis; per., pericycle; p.f., pericyclic fibres; pal., palisade cells; ph., phloem; pr.ca.ox., prism of calcium oxalate; sp.t., spongy tissue; u.epi., upper epidermis; xy., xylem.

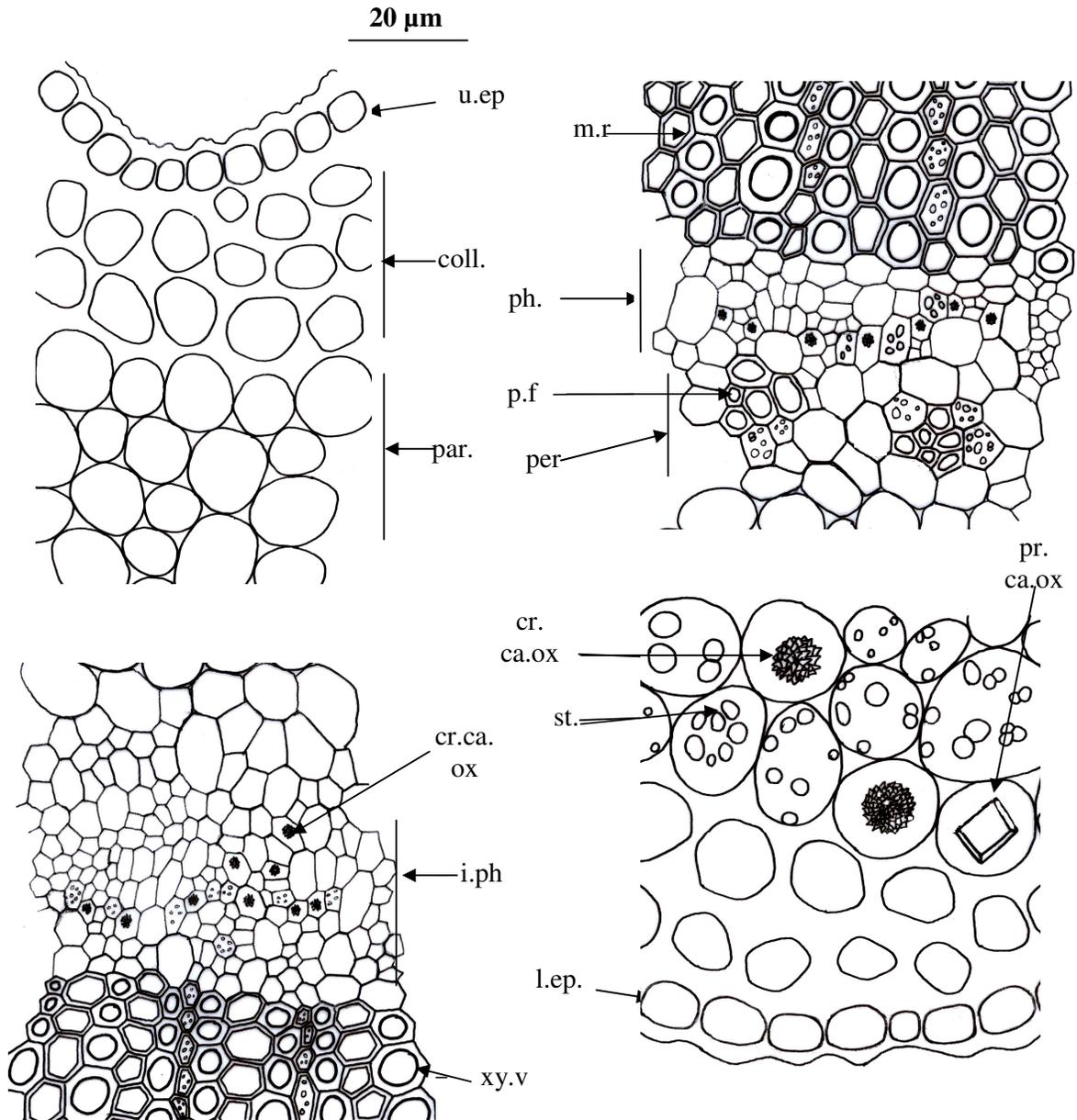


Fig. 4: The detailed T.S. in the midrib region.

coll., collenchyma; cr.ca.ox, cluster of calcium oxalate; i.ph., intraxylary phloem; l.ep., lower epidermis; m.r., medullary rays; par., parenchyma; per, pericycle; p.f., pericyclic fibres; ph., phloem; pr.ca.ox, prism of calcium oxalate; st., starch; u.ep., upper epidermis; xy.v., xylem vessels.

2- The petiole

The transverse section in the petiole (Fig. 5A) is mainly concavo-convex in outline with two external loops. It has an outer epidermis followed by wide parenchymatous cortex with small outer zone of collenchyma. The endodermis is indistinguishable. The vascular tissue is represented by crescent shape collateral vascular bundle having lower arc of parenchymatous pericycle. Groups of intraxylary phloem are present above the vascular bundle.

The epidermis: The epidermis (Fig. 6) consists of one row of square to subrectangular cells. In surface view (Fig. 5B), the cells appear polygonal usually isodiametric with straight beaded anticlinal walls covered with smooth moderately thick cuticle. Stomata and hairs are absent.

The cortical tissue: The cortical tissue (Fig. 6) consists of cellulosic rounded to oval parenchymatous cells containing oval to rounded starch granules. Numerous prisms and cluster crystals of calcium oxalate are present. A hypodermal zone of collenchyma of two to three rows of rounded to oval cells is abutting on epidermal surfaces.

The pericycle: The pericycle consists of lower arc of parenchymatous cells containing starch granules and interrupted with groups of non lignified fibres.

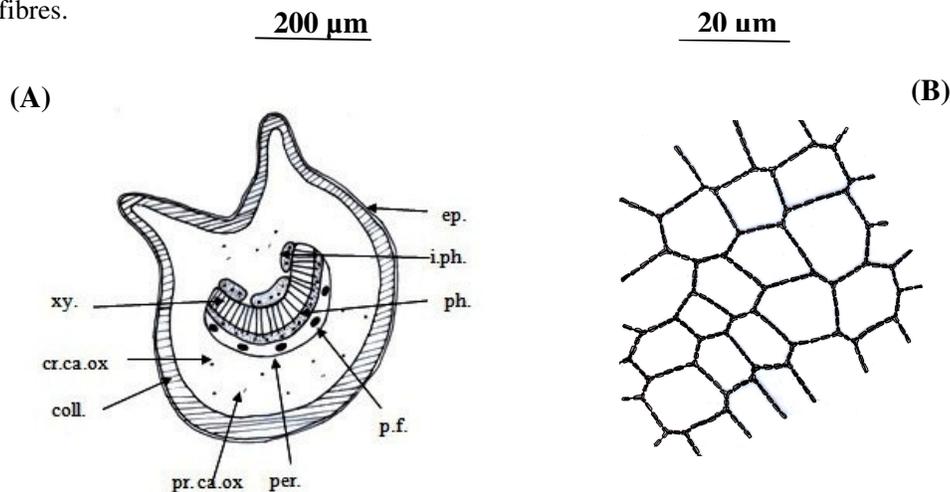


Fig. 5: A) The diagrammatic T.S. of the petiole.
B) The epidermis of the petiole.

coll., collenchyma; cr.ca.ox, cluster of calcium oxalate; ep., epidermis; i.ph., intraxylary phloem; p.f., pericyclic fibres; per., pericycle; ph., phloem; xy., xylem.

The vascular tissue

The vascular tissue (Fig. 6) shows a collateral vascular bundle consisting of radiating xylem and phloem.

a- The xylem

The xylem (Fig. 6) consists mainly of lignified vessels regularly arranged in radial rows of 7-8 vessels with spiral, scalariform and pitted thickenings. The wood fibre (Fig. 7) is elongated, with thin lignified wall and has wide lumen. The medullary rays are mainly uniseriate rarely biseriate, showing radially elongated lignified cells and containing starch granules (Fig. 6). Tracheids are pitted with lignified walls.

b- The phloem

The phloem (Fig. 6) consists of soft elements which are formed of sieve tubes, companion cells and phloem parenchyma containing starch granules and small clusters of calcium oxalate.

c- Intraxylary phloem

Intraxylary phloem (Fig. 6) consists of large groups of small soft elements present above the vascular bundle, containing starch granules and numerous small clusters of calcium oxalate.

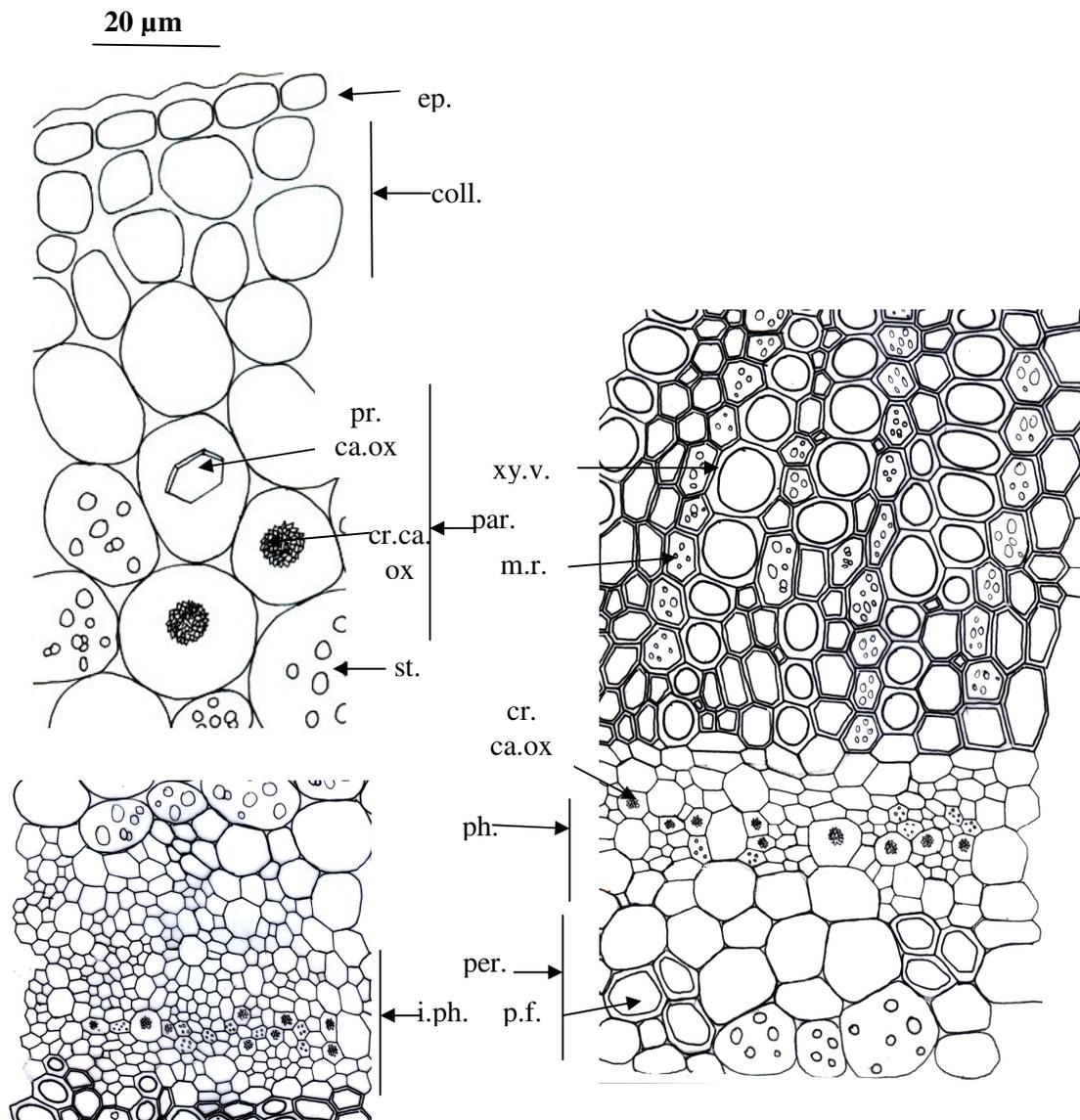


Fig. 6: The detailed T.S. in the petiole.

coll., collenchyma; cr.ca.ox, cluster of calcium oxalate; i.ph., intraxylary phloem; ep., epidermis; m.r., medullary rays; par., parenchyma; per., pericycle; p.f., pericyclic fibres; ph., phloem; pr.ca.ox, prism of calcium oxalate; st., starch granules; xy.v., xylem vessels.

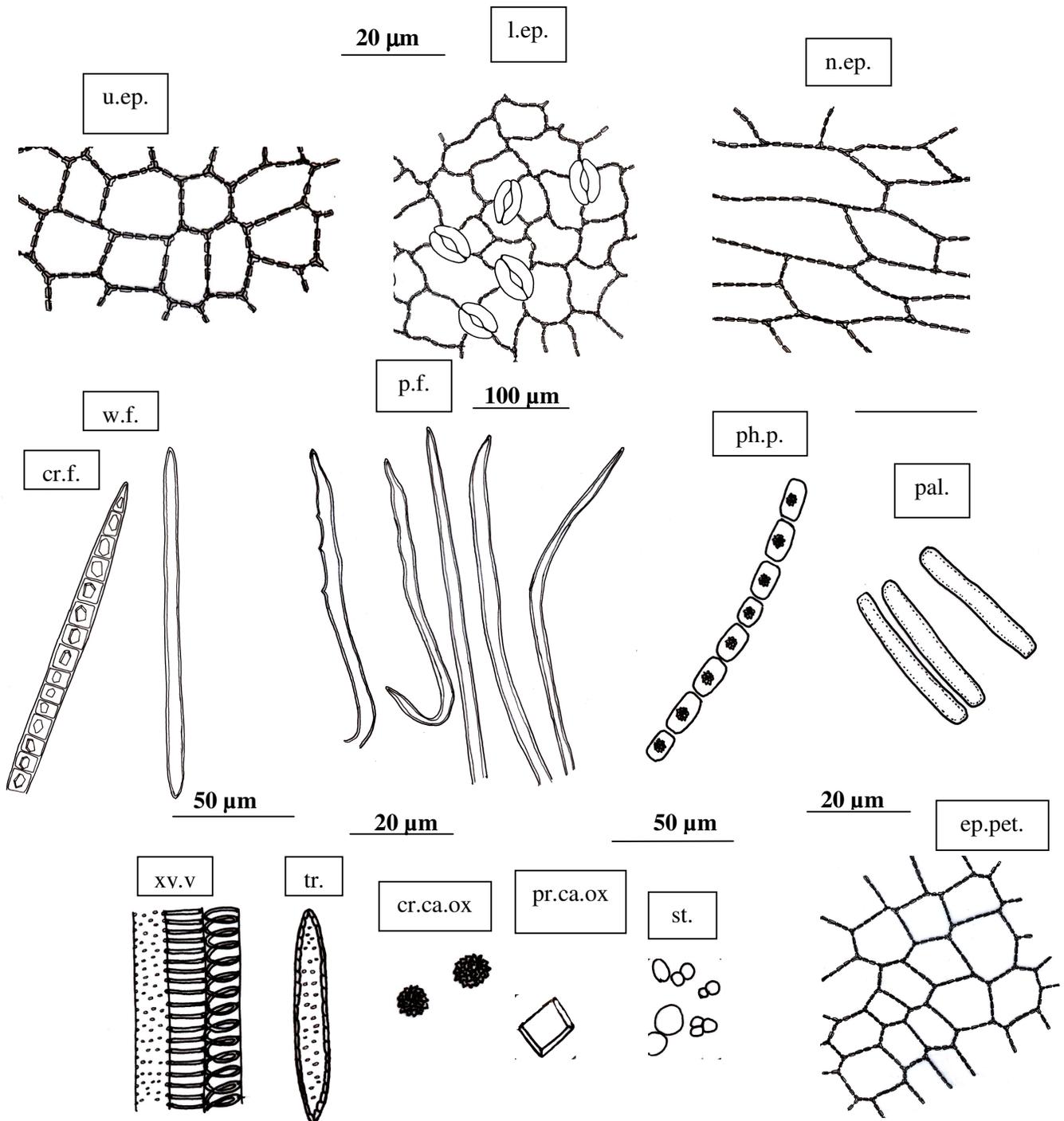


Fig. 7: Powdered leaf.

cr.ca.ox, cluster of calcium oxalate; cr.f., crystalliferous fibre; ep.pet., epidermis of petiole; l.ep., lower epidermis; n.ep., neural epidermis; pal., palisade cells; p.f., pericyclic fibres; ph.p., phloem parenchyma containing clusters of calcium oxalate; pr.ca.ox, prism of calcium oxalate; st., starch granules; tr., tracheid; u.ep., upper epidermis; xy.v, xylem vessels; w.f., wood fibres.

Powdered leaf

The powdered leaf is green in colour, possessing faint odour, bitter and astringent taste.

It is characterized by the following features (Fig. 7):

- 1- Fragments of upper epidermal cells being polygonal usually isodiametric with straight beaded anticlinal walls, covered with smooth moderately thick cuticle; stomata and hairs are absent.
- 2- Fragments of lower epidermal cells being polygonal usually isodiametric with wavy slightly beaded anticlinal walls, covered with smooth moderately thick cuticle, numerous oval to rounded stomata of anomocytic type are present and hairs are absent.
- 3- Fragments of rectangular neural epidermal cells with beaded and slightly wavy walls.
- 4- Fragments of epidermal cells of the petiole which appear as polygonal usually isodiametric cells, with straight beaded anticlinal walls covered with smooth moderately thick cuticle; stomata and hairs are absent.
- 5- Fragments of palisade cells, which are columnar radially elongated cells containing chloroplast.
- 6- Scattered prisms and clusters of calcium oxalate.
- 7- Fragments of pericyclic fibres with non lignified thin walls, wide lumina and sometimes showing wavy dentate margin.
- 8- Fragments of phloem parenchyma containing numerous small cluster crystals of calcium oxalate.
- 9- Fragments of lignified pitted, scalariform and spiral xylem vessels.
- 10- Fragments of tracheids with lignified pitted wall.
- 11- Fragments of wood fibres with lignified walls, wide lumina, some are septate, divided by numerous septa into chambers each containing one or two prisms of calcium oxalate (crystalliferous fibre).
- 12- Scattered oval to rounded starch granules with centric point hilum appearing in large ones.

The stem bark

Macromorphology of stem bark

The stem bark (Fig. 8A&8B) occurs in the form curved pieces or quills (single or double). It is brown in colour with occasional greyish patches of lichens and longitudinal wrinkles. The inner surface of the bark is yellowish brown in colour with fine striations and the fracture is short granular. The bark has faint odour and astringent bitter taste¹².

Micromorphology of stem bark

The transverse section (Fig. 8C) in the stem bark shows cork arranged in radial and tangential rows followed by phellogen and wide parenchymatous phelloderm with few groups of lignified sclereids, the phloem is wide occupying the major part of the bark traversed by medullary rays.

The cork

The cork (Fig. 9) consists of alternating layers of radially arranged tangentially elongated thin walled suberized cells in 2-3 rows followed by lignified ones with thick inner tangential walls in 4-6 rows.

Cork cells are filled with amorphous masses of tannins giving blue colour with ferric chloride and dark brown pigments.

The cork cells in surface view (Fig. 10) appear polygonal in shape showing straight anticlinal walls.

Phelloderm

The phelloderm (Fig. 9) is formed of several rows of tangentially elongated parenchymatous cells containing small starch granules which are simple or compound with 2-4 components, oval to rounded in shape with centric hilum appearing in large granules. Prisms and cluster crystals of calcium oxalate are also present. Few groups of sclereids present in the phelloderm, each group of 2-3 sclereids oval to rounded in shape with very thick striated lignified walls and narrow lumen.

Phloem

The phloem zone is formed of tangential alternating bands of sieve areas and phloem parenchyma traversed by pyramidal shape medullary rays appearing cone shape towards outside. The sieve areas are formed of sieve tubes and companion cells. The phloem parenchyma contain starch granules and small clusters of calcium oxalate in tangential rows.

Medullary rays are mainly uniseriate rarely biseriate formed of tangentially elongated to square cells in upper part, the cells become radially elongated towards the end of phloem, containing starch granules and small clusters of calcium oxalate. (Fig. 9)

The powdered stem bark is characterized by the following features

- 1- Fragments of cork cells which are brown polygonal cells with straight anticlinal walls and some cells appear lignified.
- 2- Fragments of large oval to rounded sclereids with very thick striated lignified walls and narrow lumena.
- 3- Scattered starch granules, which are simple or compound with 2-4 components, oval to rounded in shape with centric hilum appearing in large granules.
- 4- Prisms and abundant clusters of calcium oxalate, which are scattered either singly or inside parenchyma cells.

Powdered stem bark

The powdered stem bark (Fig. 10) is yellowish brown in colour and possesses faint odour and bitter astringent taste.

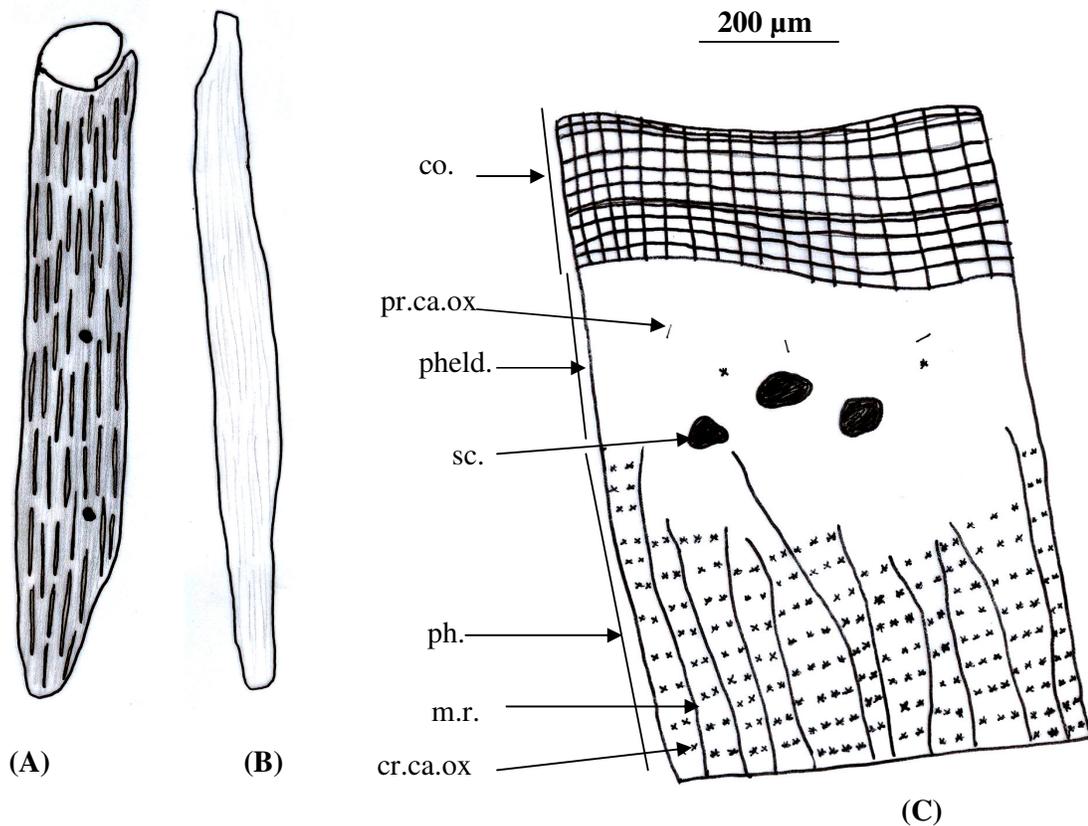


Fig. 8: A) Macromorphology of the outer surface of the stem bark X 0.8
 B) Macromorphology of the the inner surface of the stem bark X 0.8
 C) The diagrammatic T.S of the stem bark

co., cork cells; cr.ca.ox, cluster of calcium oxalate; m.r., medullary rays; pheld., phelloderm; ph., phloem; pr.ca.ox, prisms of calcium oxalate; sc., sclereids.

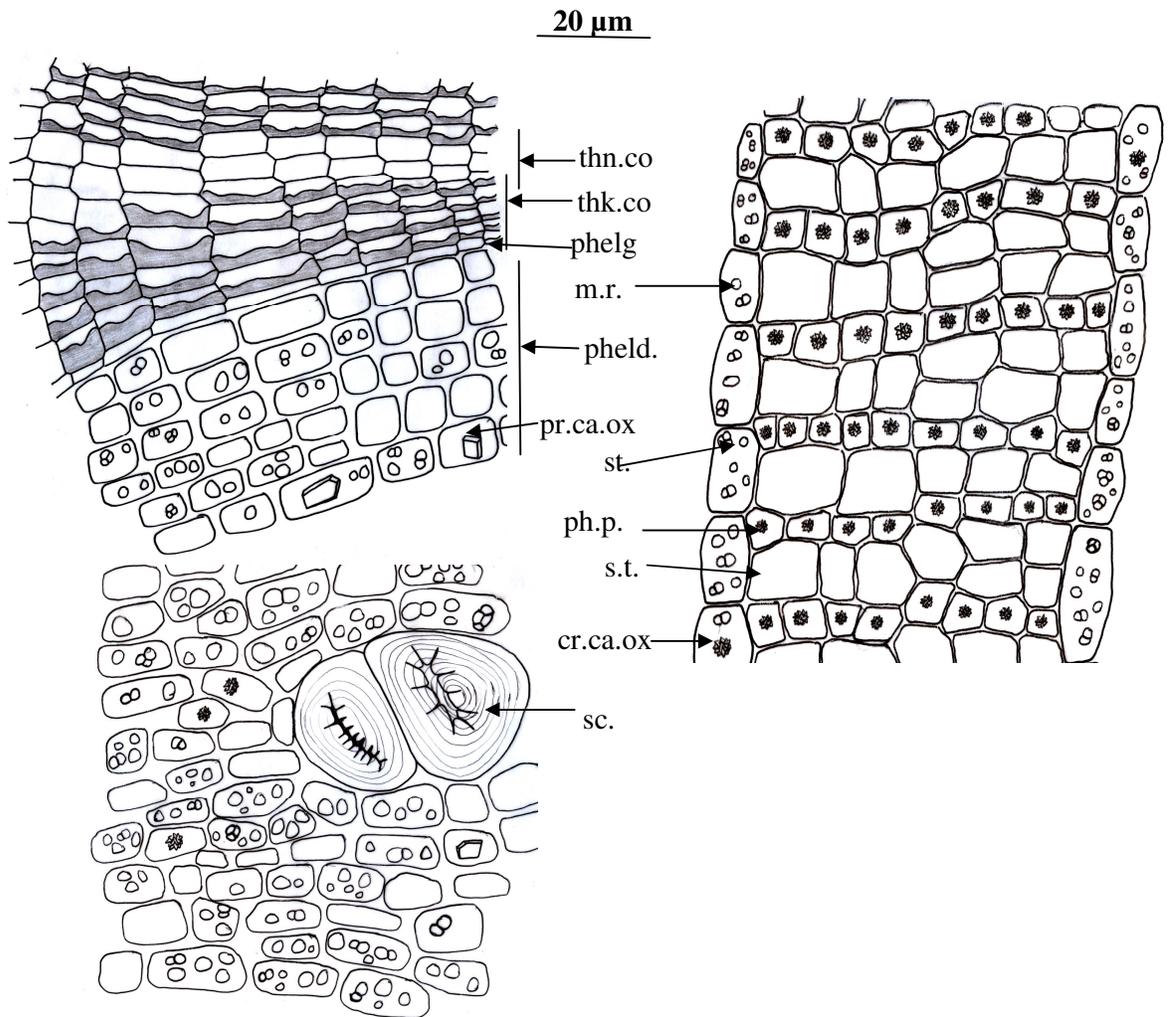


Fig. 9: The detailed T.S. in the stem bark.

cr.ca.ox, cluster of calcium oxalate; m.r., medullary rays; phelg., phellogen; pheld., phelloderm; ph.p., phloem parenchyma; pr.ca.ox, prisms of calcium oxalate; sc., sclereids; st., starch granules; s.t., sieve tube; thn.co., thin walled cork; thk.c., thick walled cork.

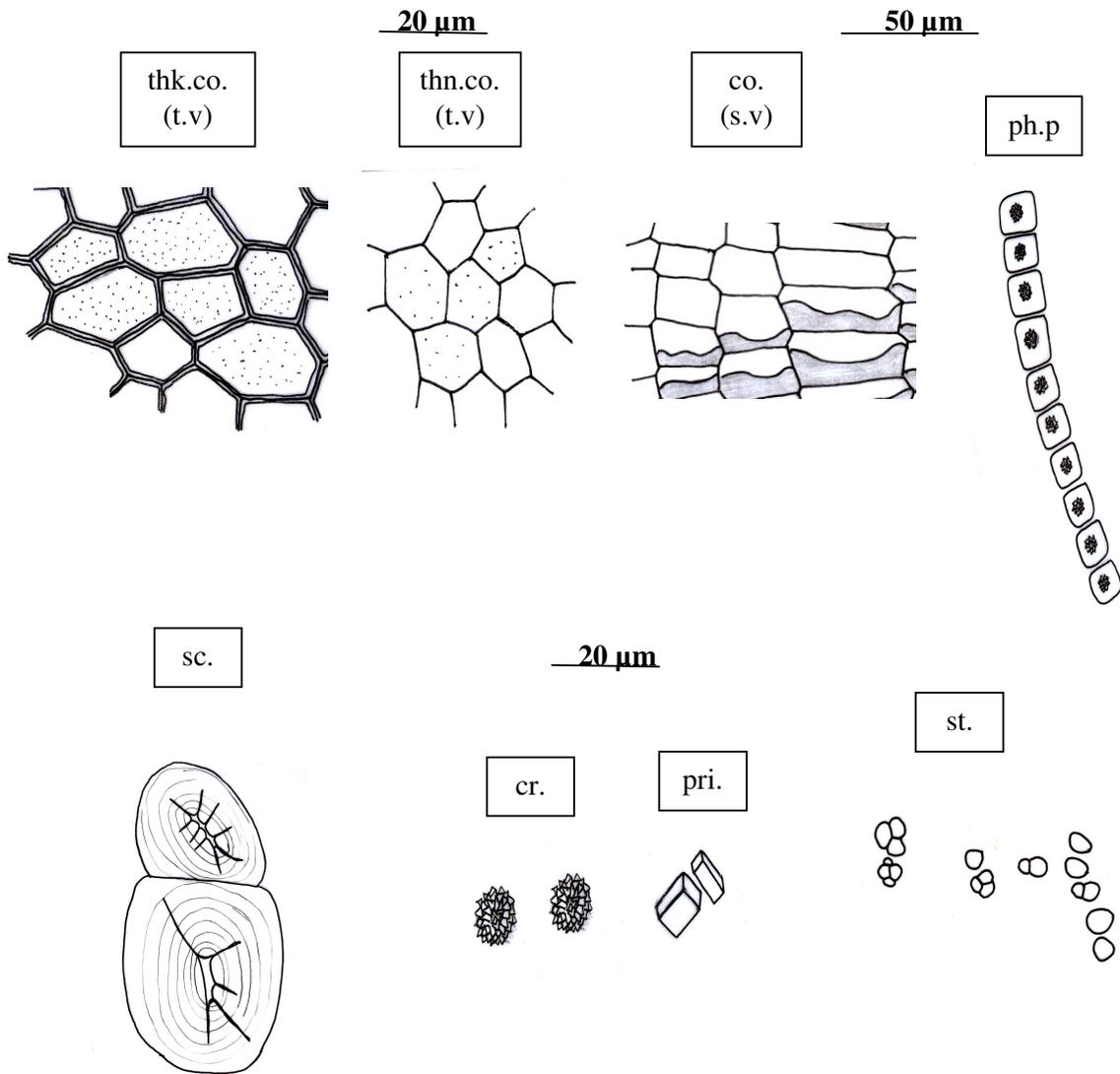


Fig. 10: Powdered stem bark.

co.(s.v); cork cells in surface view; cr.ca.ox, clusters of calcium oxalate; ph.p., phloem parenchyma; pr.ca.ox, prisms of calcium oxalate; sc., sclereids; st., starch granules; thk.co.(t.v), thick walled cork cells in top view; thn.co.(t.v); thin walled cork cells in top view;

The flower

Flowers (Fig. 11A) appear solitary or in pairs or arranged in few-flowered clusters. In most cases, the solitary flowers will appear on spurs along the branches while the clusters are terminal. They are orange in colour and sessile. Flowers are actinomorphic, bisexual, epigenous, terminal or axillary, with brightly coloured receptacle at the middle part. The flower measures 5-5.5 cm in length and 4-4.5 in width.

The floral formula (Fig. 11E):



The calyx

The calyx (Fig. 11A&11B) is persistent, tubular in shape with 5-7 sepals united at the base, pale green to orange colour. Sepals are thick, leathery, valvate, and triangular in shape with entire margin and acute apex. The surface is glabrous on outer and inner surface while hairy on the edges. It measures 1-1.2 cm in length and 0.8-0.9 cm in width.

The corolla

The flower is polypetalous, imbricate, episepalous, inserted on calyx lobes. The petals (Fig. 11A&11C) are indefinite in number, very delicate, slightly wrinkled, having pale to dark orange colour, obovate in shape, with rounded apex, and entire margin. The venation is reticulate pinnate. The petals measure 2.2-2.4 cm in length and 2.4-2.6 cm in width.

The androecium

The androecium (Fig. 11D) is polyandrous with more than 300 stamens, episepalous, inserted on calyx tube. The filament is strap like and orange red in colour.

The anther is dorsifixed, yellow in colour, bilobed and elliptical to oblong in shape.

The filament measures 0.7-0.9 cm in length, while the anther measures 0.1-0.2 in length.

The gynaecium

The gynaecium (Fig. 11D) consists of inferior multicarpellary ovary which is

imbedded in the receptacle tube. The carpels vary in number but are usually eight superimposed in two whorls. They form a syncarpic ovary and are arranged in two layers. The ovary is multilocular with several locules in two series, one above the other, There are 4-15 loculi, where often (5-9) are found in the upper layer and lesser number in the lower layer, the lower with axile placenta, while the upper is parietal. Numerous ovules can be found on each placenta and the ovules are anatropous.

Style is simple, pale yellow in colour and slender in shape. It measures 1.9-2.1 cm in length and 0.05-0.1 cm in diameter. Stigma is capitate, green in colour and measures 0.2 cm in length and 0.05-0.75 cm in diameter.

The receptacle

The receptacle (Fig. 11D) is usually concave, bearing the floral whorls one within the other and enclosing the ovary.

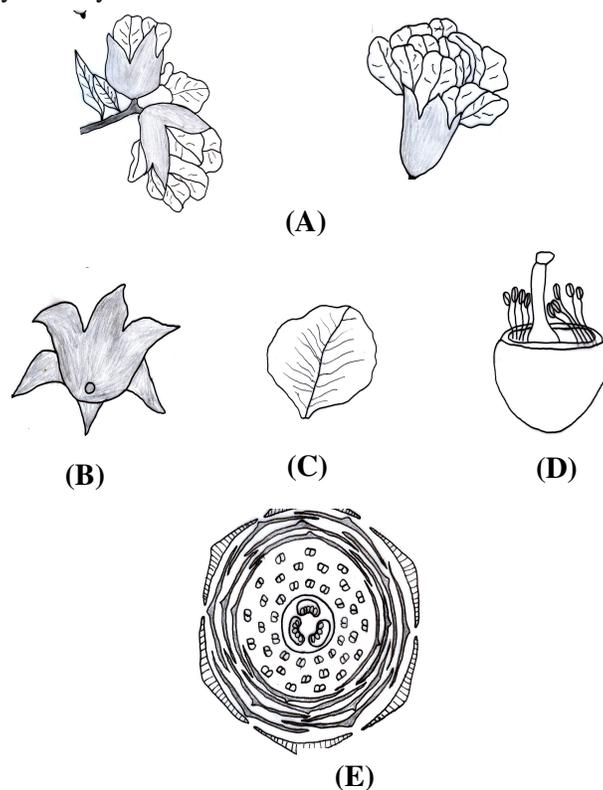


Fig. 11: A) Macromorphology of the flower X 1.0
B) Macromorphology of the calyx X 0.9
C) Macromorphology of the petal X 0.9
D) Macromorphology of the floral parts carried on receptacle X 0.9
E) The floral diagram of the flower.

Micromorphology of flower parts

1-The calyx

The transverse section in the sepals (Fig. 12A) is nearly plane in outline comprising upper and lower epidermises, enclosing in between a wide mesophyll. The upper epidermis carries glandular hairs. The mesophyll shows collenchyma abutting on the lower surface and wide parenchyma cells traversed by vascular system of collateral vascular bundle with groups of intraxylary phloem above the bundle and nonlignified pericyclic fibres below it.

The upper epidermis (inner surface)

It consists of one row of square to subrectangular large cells (Fig. 13). In surface view (Fig. 12B), the cells appear polygonal usually isodiametric with straight anticlinal walls, covered with faintly striated, moderately thickened cuticle and stomata are absent.

The epidermal cells show hairs of glandular type which appear mainly at the margin. They are of short unicellular stalk and unicellular rounded, club shaped head. The cells don't show marked variations in size and shape at different parts of the surface.

The lower epidermis (outer surface)

It consists of one row of square to subrectangular cells (Fig. 13). In surface view (Fig. 12C) they appear polygonal usually isodiametric with nearly straight beaded anticlinal walls, they are covered with smooth moderately thick cuticle and carrying oval to rounded slightly sunken stomata of anomocytic type. The cells don't show marked variations in size and shape at different parts of the surface but at the apical part the cells carries fewer number of stomata compared to cells of the middle and basal parts.

The cortical tissue

The cortical tissue (Fig. 13) is composed of thin walled parenchyma cells above and below the bundle containing starch granules, prisms and clusters of calcium oxalate. Collenchyma is abutting on lower surface and formed of rounded to oval cells in two to three rows.

The pericycle

The pericycle consists of lower arc, which is usually parenchymatous with occasional groups of non lignified pericyclic fibres, which are thin walled with wide lumena.

The vascular tissue

The vascular tissue is represented by main collateral vascular bundle (Fig. 13) accompanied by lower pericyclic arc.

a- The xylem

The xylem zone (Fig. 13) consists of vessels, tracheids, and xylem parenchyma and traversed by uniseriate medullary rays. The xylem vessels are lignified mainly with scalariform and spiral thickenings.

b- The phloem

The phloem (Fig. 13) consists of sieve tubes, companion cells and phloem parenchyma containing starch granules. Cambium is indistinguishable.

c- The intraxylary phloem: The intraxylary phloem (Fig. 13) is a narrow zone of small soft elements above the xylem.

2-The corolla

The transverse section in petals (Fig. 14A) is planoconvex in outline comprising upper and lower epidermises and enclosing in between a fairly wide mesophyll. The mesophyll shows parenchymatous cells and traversed by vascular system formed of collateral vascular bundle with groups of intraxylary phloem above the bundle.

The upper epidermis (inner surface)

It consists of one row of square to subrectangular cells (Fig. 15). In surface view (Fig. 14B), the cells are polygonal, isodiametric, with wavy anticlinal walls, covered with clear striation showing raised portions of cuticle (papilli like).

The lower epidermis (outer surface)

It consists of one row of square to subrectangular cells (Fig. 15C). In surface view (Fig. 14C), the lower epidermal cells of the corolla are similar to the upper ones but they are quite smaller in size. Hairs are absent on each surface.

The cells don't show marked variations in size and shape at different parts of each surface.

The cortical tissue

The cortical tissue (Fig. 15) is composed of thin walled parenchyma cells above and below the bundle containing starch granules.

The pericycle

The pericycle consists of lower arc, which is usually parenchymatous with occasional groups of non lignified pericyclic fibres, which are thin walled with wide lumina.

The vascular system

The vascular system (Fig. 15) is represented by collateral vascular bundle with lower pericyclic arc.

a- The xylem

The xylem zone (Fig. 15) consists of vessels and wood parenchyma and traversed by medullary rays. The xylem vessels are lignified mainly with scalariform and spiral thickenings.

b- The phloem

The phloem (Fig. 15) consists of sieve tubes, companion cells and phloem parenchyma containing starch granules. Cambium is indistinguishable.

c- The intraxylary phloem

The intraxylary phloem (Fig. 15) is a narrow zone of small soft elements above the xylem.

3- The androecium

A transverse section (Fig. 16A) in the anther shows two equal anther lobes which are attached with the connective tissue through which passes a small vascular strand. Each anther lobe is formed of two pollen sacs containing pollen grains. The anther wall consists of one layer of epidermal cells followed by the fibrous layer.

A- The anther

The epidermis: The epidermal cells in surface view (Fig. 17) are polygonal with straight anticlinal walls. They are covered with smooth cuticle; stomata and hairs are absent.

The fibrous layer: The fibrous layer of anther (Fig. 17) consists of a single layer of lignified bar like thickened cells. It is continuous around the anther lobe except where the two pollen sacs meet. Here, the cells are thin walled parenchyma that rupture when the anther dehisces.

In surface view (Fig. 17) the cells are somewhat polygonal, isodiametric with distinctly beaded walls.

The pollen grains: The pollen grains are smooth, fine and minute in size. They are spherical in polar view (Fig. 16C) and elliptical in equatorial view (Fig. 16B) with three germ pores and three germ furrows.

B-The filament: The epidermis of the filament appears in surface view (Fig. 17) as axially elongated cells with straight beaded anticlinal walls, covered with smooth cuticle; stomata and hairs are absent.

4- The gynaecium

A- The ovary

A transverse section in the ovary (Fig. 16D&16E) shows that it is multilocular structure with more or less circular outline. Each locule has many ovules with upper parietal (Fig. 16D) and lower axile placentation (Fig. 16E). The epidermis of ovary in surface view (Fig. 17) is formed of polygonal isodiametric cells with more or less straight anticlinal walls and covered with smooth cuticle. Stomata and hairs are absent.

B- The style

The epidermal cells of the style (Fig. 17) are polygonal cells with straight anticlinal walls and covered with smooth cuticle. Stomata and hairs are absent.

C- The stigma

The epidermal cells of stigma in surface view (Fig. 17) are polygonal with straight anticlinal walls, papillosed and covered with smooth cuticle. Stomata and hairs are absent.

Powdered flower

The powdered flower is green to orange in colour and possesses faint odour and slightly astringent taste.

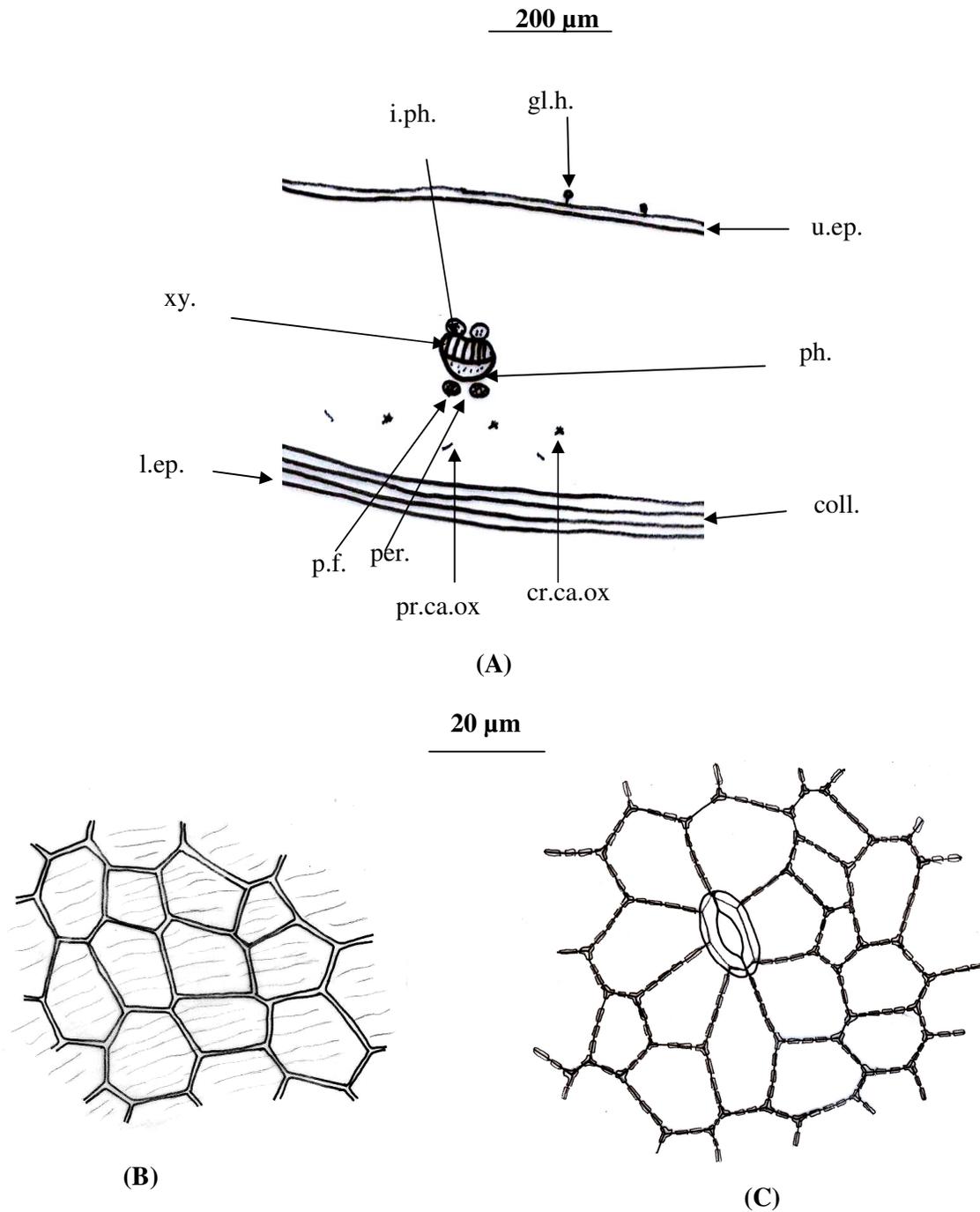


Fig. 12: A) The diagrammatic T.S of the sepal.
 B) The upper epidermis of the sepal.
 C) The lower epidermis of the sepal.

coll., collenchyma; cr.ca.ox, cluster of calcium oxalate; gl.h., glandular hairs; i.ph., intraxylary phloem; l.ep., lower epidermis; per., pericycle, p.f., pericyclic fibres; ph., phloem; pr.ca.ox, prism of calcium oxalate; u.ep., upper epidermis; xy., xylem.

20 μ m

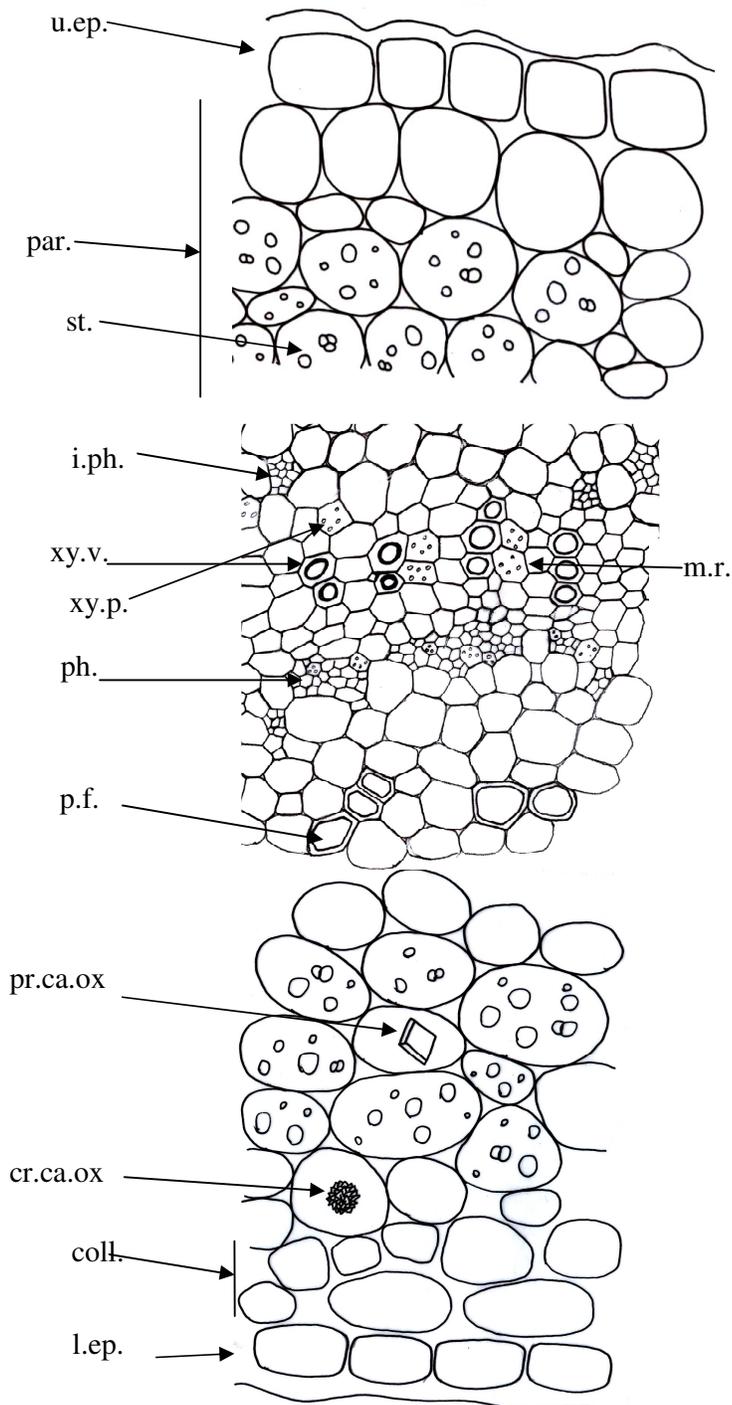


Fig. 13: The detailed T.S. in the sepal.

coll., collenchyma; cr.ca.ox, cluster of calcium oxalate; i.ph., intraxylary phloem; l.ep., lower epidermis; m.r., medullary rays; par., parenchyma; p.f., pericyclic fibres; ph., phloem; pr.ca.ox, prism of calcium oxalate; st., starch; u.ep., upper epidermis; xy.v., xylem vessel, xy.p., xylem parenchyma.

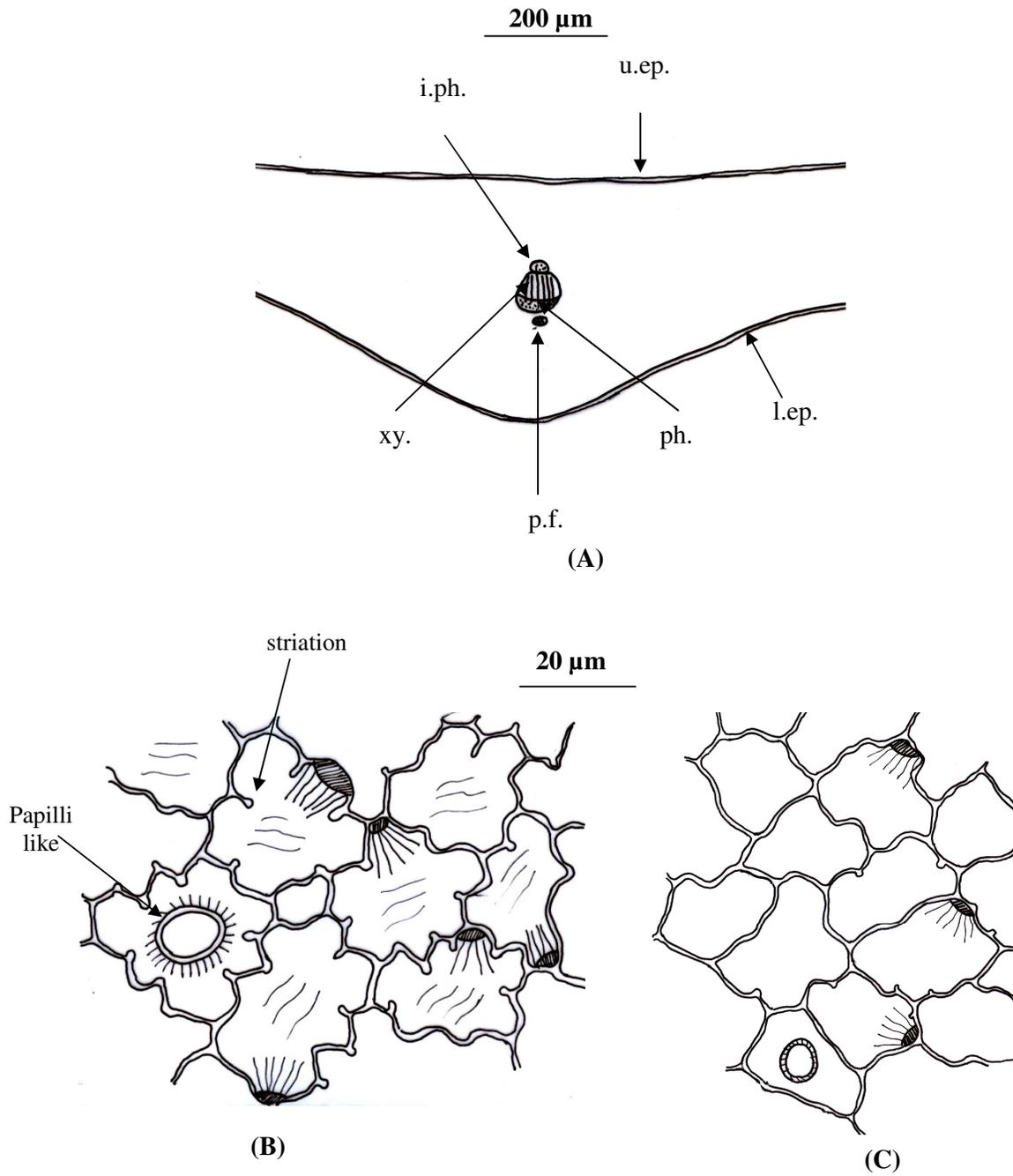


Fig. 14: A): The diagrammatic T.S of the petal.
 B): The upper epidermis of the petal.
 C) The lower epidermis of the petal.

i.ph., intraxylary phloem; l.ep., lower epidermis; p.f., pericyclic fibres; ph., phloem; u.epi., upper epidermis; xy., xylem.

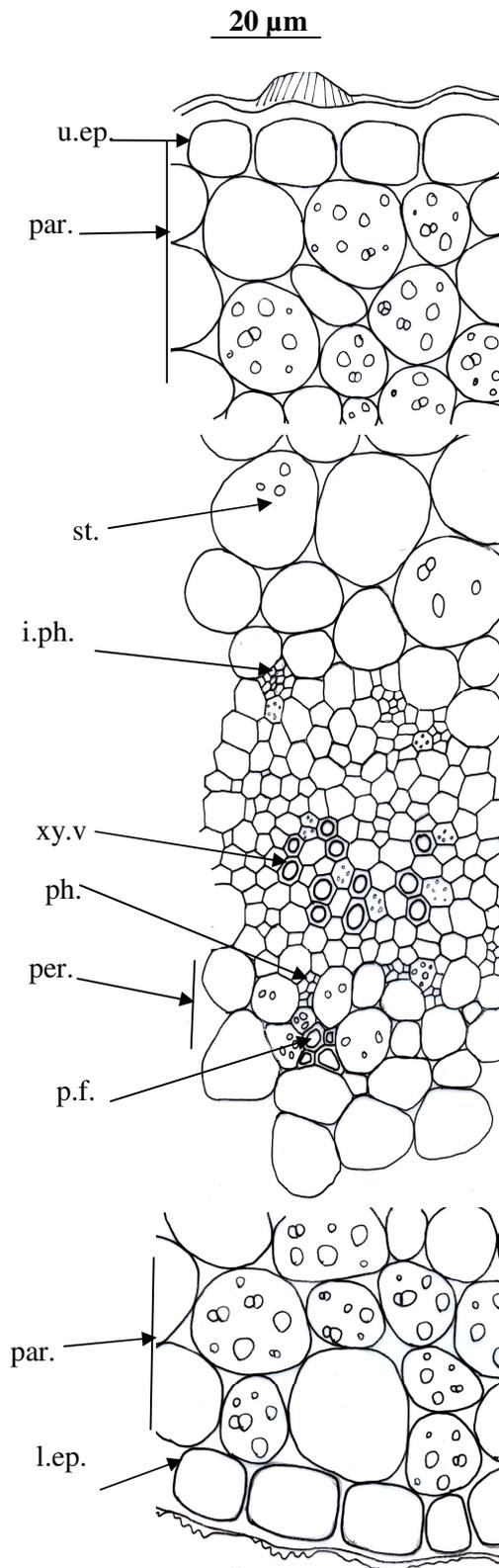


Fig. 15: The detailed T.S. in the petal.

i.ph., intraxylary phloem; l.ep., lower epidermis; par., parenchyma; per.; pericycle, p.f., pericyclic fibres; ph., phloem; st., starch granules; u.ep., upper epidermis; xy.v., xylem vessel.

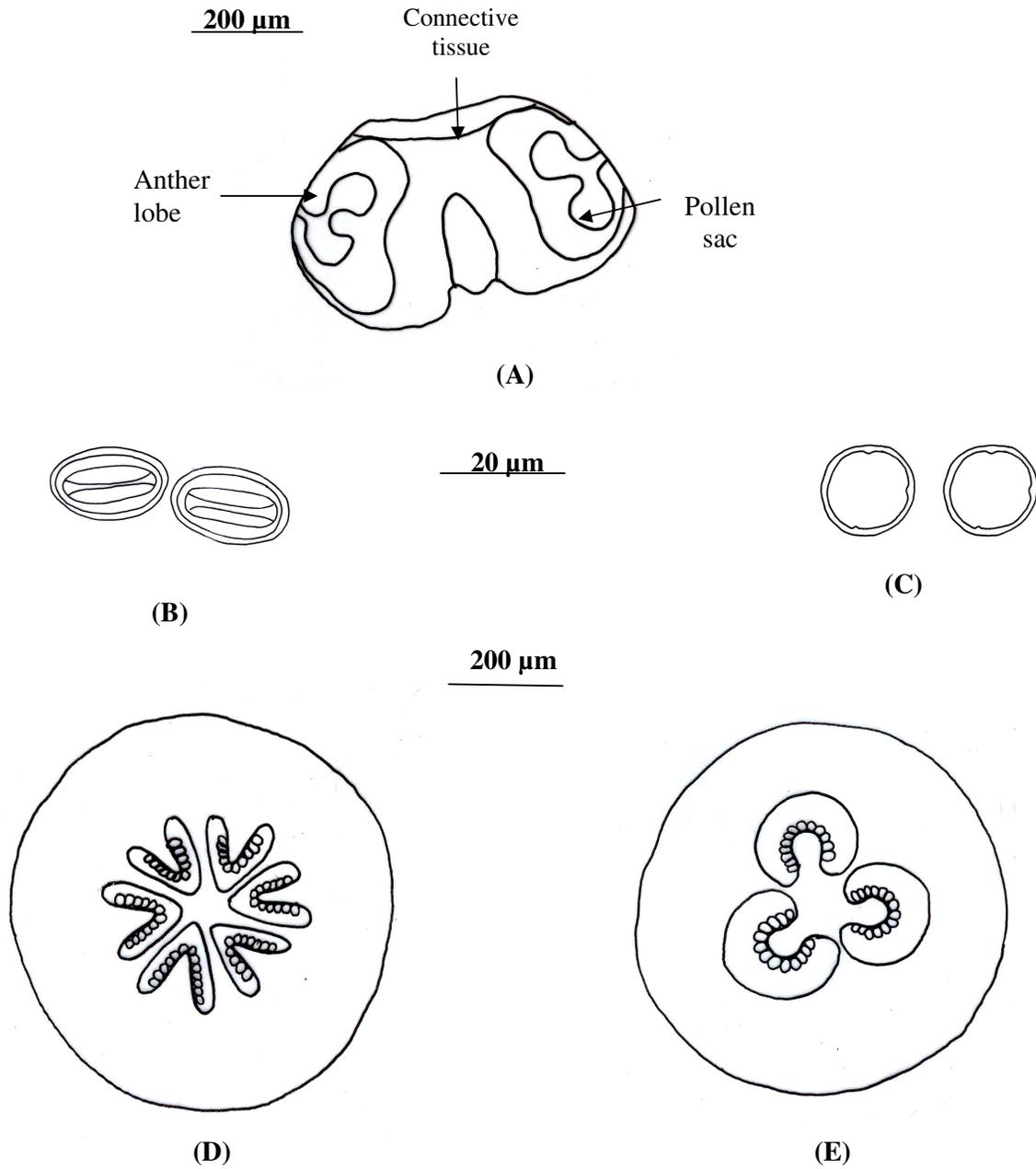


Fig. 16: A) Transverse section in the anther
B) Pollen grain in equatorial view.
C) Pollen grain in polar view.
D) T.S in the ovary in the upper part.
E) T.S in the ovary in the lower part.

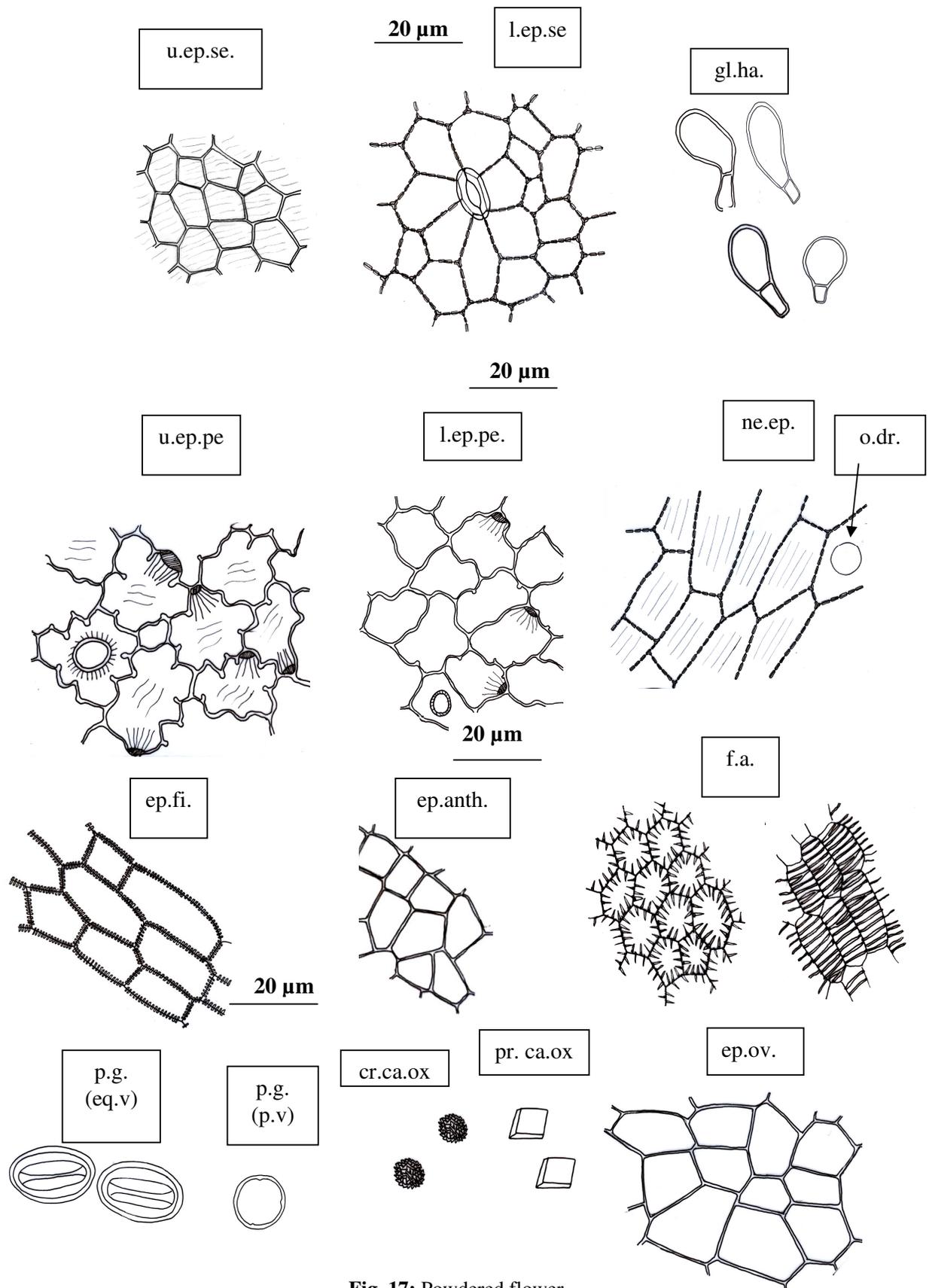


Fig. 17: Powdered flower.

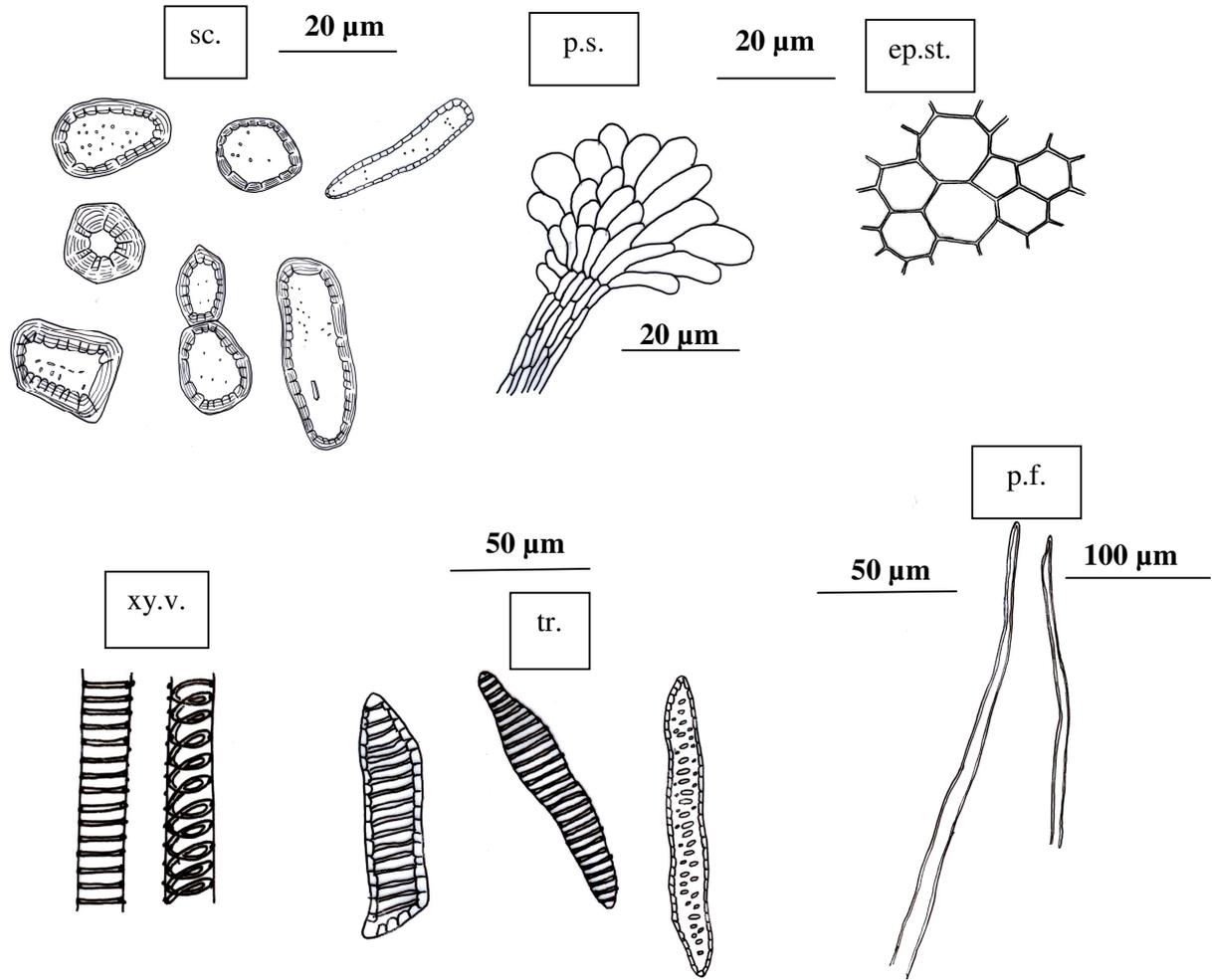


Fig. 17: Powdered flower.(Cont.)

cr.ca, clusters of calcium oxalate; gl.h., glandular hairs from the calyx; f.a., fibrous layer of anther., ep.anth., epidermis of anther; ep.fi., epidermis of filament; ep.ov., epidermis of ovary; ep.st., epidermis of style; l.ep.se., lower epidermis of sepal; l.ep.pe., lower epidermis of petal; ne.ep., neural epidermis of corolla; o.dr., orange droplets; p.g.(eq.v), pollen grain in equatorial view; p.g.(p.v), pollen grain in polar view; p.f., pericyclic fibres; pri., prisms of calcium oxalate; p.s., papillosed stigma; sc., sclereids; tr., tracheids (pitted and scalariform); xy.v., xylem vessels (spiral and scalariform); u.ep.pe., upper epidermis of petal; u.ep.se, upper epidermis of sepal.

The powdered flower (Fig. 17) is characterized by the following features:

1- Fragments of upper epidermis of calyx showing polygonal usually isodiametric, with straight anticlinal walls, covered with smooth moderately thickened striated cuticle and stomata are absent. The epidermal cells show few hairs of glandular type which are of short unicellular stalk and unicellular rounded, club shaped head.

2- Fragments of lower epidermis of calyx showing polygonal usually isodiametric cells with nearly straight beaded anticlinal walls, covered with smooth moderately thick cuticle and carrying oval to rounded slightly sunken stomata of anomocytic type.

3- Fragments of upper and lower epidermises of corolla showing polygonal cells with sinuated anticlinal walls, clear striations

- and showing raised portions of cuticle (papilli like).
- 4- Fragments of the neural epidermal cells of the corolla, which appear as axially elongated with more or less straight beaded anticlinal walls, covered with faint striated cuticle and contain droplets of orange colouring matter.
 - 5- Fragments of epidermis of filament showing axially elongated cells with straight beaded anticlinal walls, covered with smooth cuticle.
 - 6- Fragments of epidermis of anther showing polygonal cells with straight anticlinal walls, covered with smooth cuticle.
 - 7- Fragments of fibrous layer of anther showing polygonal, isodiametric lignified cells with distinctly beaded walls and bar like thickenings.
 - 8- Numerous minute and smooth pollen grains, which are spherical in polar view and elliptical in equatorial view with three germ pores and two germ furrows.
 - 9- Fragments of epidermis of ovary showing polygonal isodiametric cells with more or less straight anticlinal walls, covered with smooth cuticle.
 - 10- Fragments of sclereids from the ground tissue of the ovary which vary in shape and size, with lignified striated pitted walls and some of them contain small prisms of calcium oxalate.
 - 11- Fragments of epidermis of style showing polygonal cells with straight anticlinal walls and covered with smooth cuticle. Stomata and hairs are absent.
 - 12- Fragment of papillose epidermal cells of stigma.
 - 13- Fragments of lignified xylem vessels with spiral and scalariform thickenings.
 - 14- Fragments of tracheids with pitted or scalariform thickenings.
 - 15- Fragments of pericyclic fibres from the sepal or petal, which are elongated, with tapering ends, wide lumina and non lignified walls.
 - 16- Scattered clusters and prisms crystals of calcium oxalate.
- All microscopical measurements of the different organs (leaf, stem bark and flower) are recorded in tables (2-4)

Comparison showing the main differences between ornamental and edible pomegranate

Table 1: The main differences between ornamental and edible pomegranate.

Item	<i>Punica granatum</i> L. var. <i>nana</i>	<i>Punica granatum</i> L.
Plant	Ornamental plant	Edible plant
Height	Shorter in growth reaching about 3-4 m	Longer in growth reaching about 3.5-6 m
1-Leaf		
Phyllotaxis	Opposite decussate	Opposite to whorled
Shape	Ovate to lanceolate	Oblong or obovate to lanceolate in shape
2-Bark		
Shape	Curved or quill (single or double)	Curved or channelled
3-Flower		
Colour	Orange	Red
A-Calyx		
Colour	Pale green to orange	Red to brick red
B-Corolla		
Colour of petals	Pale to dark orange	Red
Number of petals	Consists of very numerous petals	Consists of 5 – 7 petals
4-Fruit		
Size and edibility	Smaller in size and not edible	Larger in size and edible

Table 2: Microscopical measurements of the tissues of leaf and petiole of *P. granatum* L. var. *nana* (In microns).

Item	Length	Width	Diameter	Height
Leaf				
Upper epidermis	11.2- <u>15.5</u> -21.6	1.8- <u>15.6</u> -19.1		12.5- <u>16.6</u> - 20.4
Lower epidermis	24.6- <u>34.2</u> -48.9	9.9- <u>15.3</u> -20.3		15.5- <u>18.2</u> -22.7
Neural epidermis	33.9- <u>40.3</u> -61.6	14.5- <u>18.1</u> -23.1		
Stomata	22- <u>24.2</u> -26.1	14.4- <u>16.2</u> -19.6		
Palisade cells	42.9- <u>66.4</u> -75.4	6.2- <u>10.7</u> -15.9		
Parenchyma			19.4- <u>30.7</u> -37.4	
Collenchyma			18.1- <u>26.7</u> -31.4	
Chlorenchyma			13.1- <u>16.6</u> -18.3	
Clusters			5.3- <u>16.1</u> -29.8	
Prisms	13.6- <u>29.7</u> -49.1	7.7- <u>15.8</u> -24.1		
Starch			2.7- <u>3.1</u> -4.2	
Pericyclic fibres	203- <u>582</u> -839	9.3- <u>17.4</u> -25.4		
Xylem vessels			7.7- <u>12.4</u> -18	
Xylem fibres	119- <u>142</u> -377	9.7- <u>13.1</u> -16.4		
Tracheids	22.5- <u>45</u> -74.1	10.5- <u>19.4</u> -38.1		
Petiole				
Epidermis	17.3- <u>24.2</u> -31.5	19.8- <u>21.5</u> -30.4		15.3- <u>18.3</u> -20.8
Parenchyma			49.1- <u>56.4</u> -70.2	
Collenchyma			35.1- <u>53.6</u> -66.4	
Clusters			6.1- <u>21.3</u> -36.5	
Prisms	13.9- <u>20</u> -60.1	7- <u>13.3</u> -30.9		
Starch			2.9- <u>4.2</u> -6.7	
Xylem vessels			12.8- <u>16.6</u> -21.9	

Table 3: Microscopical measurements of the tissues of the stem bark of *P. granatum* L. var. *nana* (In microns).

Item	Length	Width	Diameter	Height
Cork cells	12.3- <u>19.9</u> -30.8	11.5- <u>15.2</u> -20.1		18.9- <u>24.9</u> - 27.1
Parenchyma			22.9- <u>38.1</u> -44.7	
Clusters			7.6- <u>12.2</u> -15.1	
Prisms	10.1- <u>12.1</u> -19.3	7.6- <u>10</u> -11.5		
Starch			12.2- <u>4.1</u> - 8.1	
Sclereids	40.5- <u>56</u> -74.5	44.6- <u>50.8</u> -78.9		
Medullary rays	19.9- <u>24.3</u> -34.9	8- <u>12.4</u> -15.3		

Table 4: Microscopical measurements of the tissues of the flower of *P. granatum* L. var. *nana* (In microns).

Item	Length	Width	Diameter	Height
Calyx:				
Upper epidermis	19.2- <u>25.4</u> -33.3	12.9- <u>14.7</u> -19.6		19.3- <u>27.6</u> -32.6
Lower epidermis	14.4- <u>23.5</u> -38.4	9.09, 13.5,17.03		19.7- <u>24.9</u> -27.01
Glandular hairs	17.3- <u>57.2</u> -89.8	11.4-14.8-22.1	23.5- <u>29.5</u> -35.5	
Stomata	16.7- <u>25.5</u> -30.4	10.2- <u>12.5</u> -14.3		
Parenchyma			21.7- <u>43.6</u> -66.1	
Collenchyma			24.3- <u>33.6</u> -44.7	
Clusters			10.1- <u>19.4</u> -29.3	
Prisms	15.4- <u>19.9</u> -21.7	14.4- <u>15.7</u> -18		
Starch			2.3- <u>3.5</u> -4.8	
Xylem vessels			6.7- <u>8</u> -13.5	
Corolla:				
Upper epidermis	5.6- <u>45</u> -56.1	25.9- <u>37.1</u> - 55.1		25.5- <u>32.7</u> -48.7
Lower epidermis	31.7- <u>39.2</u> - 48.4	21.2- <u>27.9</u> - 33.36		24.9- <u>27.6</u> - 35.2
Neural epidermis	65.1- <u>84.1</u> - 115.8	24.6- <u>29.5</u> - 37.4		
Parenchyma			35.7- <u>50.9</u> - 70.1	
Starch			1.4- <u>4.2</u> -5.9	
Xylem vessels			5.6- <u>9.1</u> -13.4	
Androecium:				
Pollen grains			12.9- <u>14.5</u> -17.6	
Fibrous layer of anther	15.4- <u>21.1</u> -29	13.1- <u>18.7</u> -23.5		
Epidermis of anther	13.2- <u>22</u> -30.3	10.4- <u>15.2</u> -20.3		
Epidermis of filament	48.3- <u>67.6</u> -95.3	26.9- <u>35.5</u> -43.9		
Gynoecium:				
Epidermis of style	29.1- <u>35.4</u> -43.7	16.8- <u>27.9</u> -31.1		
Epidermis of ovary	18.6- <u>25.3</u> -28.18	8.3- <u>13.9</u> -20.2		
General elements of flower:				
Pericyclic fibres	568- <u>705</u> -820	7.1- <u>12.8</u> -15.8		
Tracheids	38.5- <u>52.5</u> -82.2	14.9- <u>18.1</u> -22.8		
Sclereids	39.8- <u>83.4</u> -166.5	36.9- <u>43.6</u> -54.2		

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دراسة عيانية ومجهرية لأوراق وقلف السيقان وأزهار نبات رمان الزينة التابع للعائلة الرمانية المنزرع فى مصر

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ينتمى نبات رمان الزينة للعائلة الرمانية ويزرع فى الحدائق بصورة شائعة كنبات للزينة ولقد تم استخدام قلف الساق والجذر وقشرة الثمار للerman كطارد للديدان الشريطية. وحيث انه لا توجد دراسة عقاقيرية على الاوراق وقلف السيقان والأزهار لذا تهدف هذه الدراسة إلي التعرف على هذا النبات سواء فى صورة كاملة أو فى صورة مسحوق.