

MACRO- AND MICROMORPHOLOGICAL STUDY OF *DAUCUS CAPILLIFOLIUS* GILLI CULTIVATED IN EGYPT¹Wafaa H. B. Hassan, ^{1*}Sahar Abdelaziz, ¹Samih I. Eldahmy and ¹Entesar El Senosy¹Department of Pharmacognosy, Faculty of Pharmacy, Zagazig University, Zagazig 44519, Egypt.**Corresponding Author: Dr. Sahar Abdelaziz**

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ABSTRACT

Macro- and micromorphological study of the leaf, stem, root, fruit and inflorescence of *Daucus capillifolius* Gilli was carried out with the aim of finding the characteristic features of these plant organs in both entire and powdered forms.

KEY WORDS: *Daucus capillifolius* Gilli, leaf, stem, root, fruit and the inflorescence macro- and micromorphological study.

INTRODUCTION

Umbelliferae (Apiaceae) is a large and widely distributed family throughout the world, especially in the North Hemisphere ^[1]. From an economical and medicinal point of view the family is of great interest. Certain species of the umbelliferae are eaten as vegetables, others are source of gum resins used in perfumery and medicine, and a third group yields other products of medicinal value ^[2]. Some species of the family are well known either because they have medicinal properties, or because of the great amount of essential oils. Genus *Daucus* is a member of this family and represented in Libya and Egypt by ten and eight species respectively ^[3] and it was reported as one of the richest sources in the essential oil content ^[4]. *Daucus capillifolius* Gilli family umbelliferae (Apiaceae) (Fig. 1) is an annual wild herb present in Lybia and now cultivated in Zagazig University farm, faculty of pharmacy, Zagazig, Egypt. It is similar in habit with *Daucus parviflorus* Desf, but tall up to 2 m. Leaf segments are linear and variable in length up to 5 cm long. The literature survey shows no report concerning the macro- and micromorphology of this plant. The present study represents macro- and micromorphological study of the leaf, stem and root of *D. capillifolius* Gilli aiming to find out the diagnostic features by which the plant can be easily identified in both entire and powdered forms

**EXPERIMENTAL
PLANT MATERIAL**

The fresh plant material of *Daucus capillifolius* Gilli (wild), family Apiaceae was collected during the flowering and fruiting stages from the plant cultivated in the farm of faculty of Pharmacy Zagazig University, Zagazig, Egypt and the identification was verified by Prof. Dr. Al Seddiki, Faculty of pharmacy, Tripoli

University, Tripoli, Libya and was confirmed by DNA fingerprinting using RAPD technique. Voucher specimens are deposited in the Herbarium of the Department of Pharmacognosy, it was preserved in water: ethanol: glycerin (1: 1: 1) mixture for botanical study.

I. MACROMORPHOLOGY**THE LEAF**

The leaves of *D. Capillifolius* Gilli (Fig. 1 B) are smooth green, alternate, compound and petiolated. They are imparipinnatisect with 9 to 13 leaflets. Each leaflet is formed of several segments. The segment is lobed and measures 1 to 3 cm in length. The lobe is linear with one main midrib, entire margin and acute apex.

The rachis is green in color, angular in shape and measuring 6.5 to 17.5 cm in length. The petiole is also green and grooved in the upper part and measuring 16 to 23 cm in length.

The leaf base is green, broad ensheathing the node and shows two lateral wings. The outer surface of the leaf base shows 11 to 15 raised ridges indicating the position of veins.

THE STEM

The stem of *D. capillifolius* Gilli plant figure (Fig. 1 C) is herbaceous, glabrous, erect, cylindrical and monopodially branched. It shows nodes ensheathed by the leaf base and internode measuring from 4.5 to 6.5 cm in length. The whole aerial parts reach up to 2 m in height.

THE ROOT

The fresh root of *D. capillifolius* (Fig. 1 D) is flexible and cylindrical in shape, whitish in color and shows some rootlets. It measures from 30 to 40 cm in length.

THE INFLORESCENCE

The plant has several compound inflorescences (compound umbel) each compound umbel is formed of 11-28 simple umbel. The outer rays are longer than the inner ones. The flowers or the fruits in the umbel (Fig. 1 F) are yellow in color. The flowers are hermaphrodite. The calyx formed of five green elongated sepals. Corolla is yellow. The androecium formed of free five stamens, each is formed of cylindrical smooth surface filament with two lobes anther. The gynoecium consists of

bilcarpillary, bilocular with hairy surface ovary, style and stigma.

THE FRUITS

The fruit of *D. capillifolius* (Fig. 1 E) is a true, simple, schizocarpic cremocarp. Each cremocarp is oblong in shape measuring up to 5 mm in length and 2 mm in width. The mericarp is indehiscent shows flat commissural surface and convex dorsal surface. The dorsal surface shows five primary ridges and four more prominent secondary ridges. The secondary ridges bear several prickles measuring up to 3 mm long and ended by 3 to 4 hairs arranged as a hook. The primary ridges show non glandular trichomes.

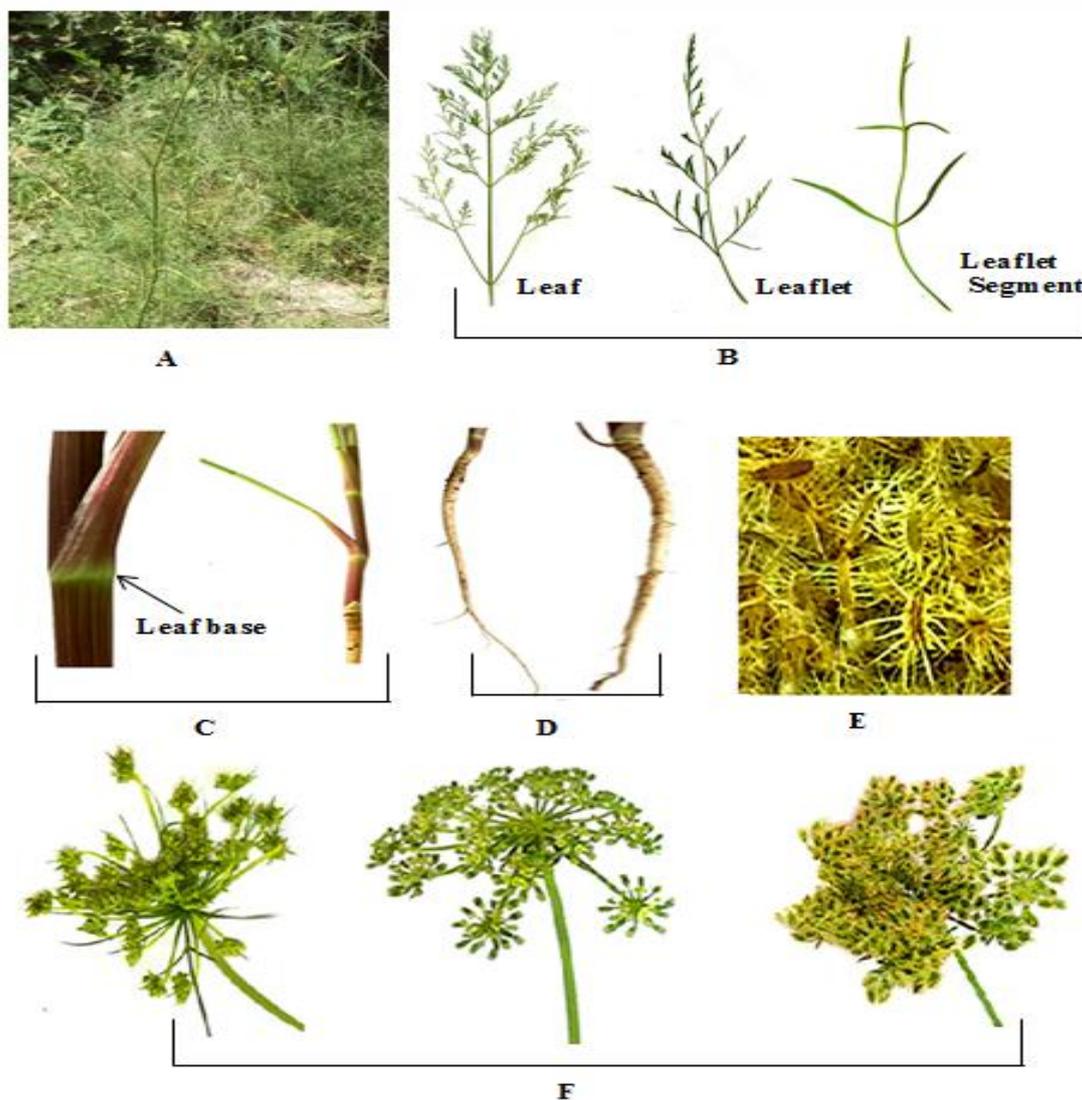


Fig. 1: Macromorphology of *D. capillifolius*. A photograph of.

A: The aerial parts (x 0.03)

B: The compound leaf (x 0.6)

C: The stem showing node and internode (x 0.44) and leaf base (x 0.67)

D: The root (x 0.3)

E: The dried ripe fruit(x 2.2)

F: The umbel in the flowering and fruiting stages (x 3.3)

II. MICROMORPHOLOGICAL STUDY OF *D. CAPILLIFOLIUS* GILLI

1- THE LEAF

a-The leaflet. b- The rachis of leaflet.
c- The petiole. d- Leaf base.

a. The Leaflet

Transverse sections of *D. capillifolius* leaflet (Fig. 2 A, B, C) shows isobilateral structure with two or three rows of palisade abutting both surfaces. The palisade of the upper and the lower surface is discontinuous in the midrib region. The midrib is prominent on lower surface. It shows a parenchymatous cortical tissue with collenchymatous bands below the upper and the lower epidermis in midrib region. It is traversed by one main collateral vascular bundle and some vascular strands in the lamina. The vascular bundle is formed of radiating xylem and phloem.

Detailed transverse section in the leaf (Fig.2 B) shows square or rectangular upper and lower epidermal cells with straight anticlinal walls and covered with thick striated cuticle. The stomata (Fig. 2 D) are diacytic present on both surfaces and being more in lower one. The trichomes (Fig. 2 A, D) are very rare, non-glandular and present on the margin of the leaflet. They are short unicellular, conical shape with pointed apices and covered with warty cuticle. The mesophyll (Fig. 2 C) is isobilateral. It shows three or four layers of columnar palisade cells on the upper epidermis and two to three on the lower one. It is interrupted by 2 to 3 layers of collenchymatous cells under the upper and the lower epidermis. The lamina shows vascular strand and narrow spongy tissue. The cortical tissue is parenchymatous and shows collateral vascular bundle consists of thin walled cellulosic phloem with few non lignified fibers and radiating xylem. The xylem shows lignified spiral, pitted and annular vessels. The fibers (Fig. 2 D) having thin wall, wide lumen and pointed apices. Below the vascular bundle and sometimes in the lamina, there are large oval or rounded schizogenous ducts.

b. The rachis of the leaflet

The transverse section in the rachis (Fig. 3 A) is nearly pentagonal in outline showing raised ridges. It is formed of epidermal cells surrounding a parenchymatous cortical tissue and several layers of chlorenchyma under the epidermal cells. It is interrupted in the ridges by 5-9 rows of collenchyma. One or two rows of collenchyma are present as subepidermal layer in the remaining part of the transverse section. Large oval mostly rounded schizogenous ducts are present under the collenchymatous layers in the raised ridges and sometimes non glandular covering trichomes. The vascular system consists of several collateral vascular bundles scattered mainly in raised ridges and in the parenchymatous cortical tissue. Detailed transverse section (Fig. 3 B) shows polygonal to rectangular epidermal cells, covered with striated cuticle and having diacytic stomata (Fig. 3 D). Unicellular non-glandular trichomes (Fig. 3 C) are occasionally observed

on the epidermis of the leaflet rachis especially on the raised ridges. They have thin walls, pointed apices and covered with warty cuticle. The transverse section shows subepidermal 3- 4 rows of palisade-like chlorenchyma. In the raised ridges it shows subepidermal collenchymatous layer formed of 5 to 9 rows of rounded shiny cells. The cortical tissue (Fig. 3 B) is formed of more or less rounded thin-walled parenchymatous cells with narrow intercellular spaces. It shows an oval or rounded schizogenous ducts above the peripheral vascular bundle which present below the raised ridges. The vascular tissue consists of several collateral vascular bundles. The large ones are below the ridges and each one formed of thin walled cellulosic phloem with few non lignified, elongated, fusiform, thin-walled phloem fibers. The xylem consists of lignified spiral, annular and pitted vessels. The pith is wide, formed of thin-walled cellulosic parenchyma with narrow intercellular spaces.

c. The leaf petiole

The transverse section in the leaf petiole (Fig. 4 A) is nearly similar to that of the rachis of the leaflet. It is sub-rounded in outline with concave upper part and showing several slightly raised ridges. Detailed transverse section of the leaf petiole has the same histological characters as the rachis (Fig.4 B, 4 C).

d- Leaf base

A transverse section in the leaf base (Fig. 5 A, B) appears as crescent-shape with two lateral wings bent inward. The outer epidermis shows raised ridges due to the position of the veins. Detailed transverse section of the leaf base (Fig. 5 B) shows the presence of single layer of square or rectangular epidermal cells covered with thick striated cuticle. Diacytic stomata and few unicellular, non-glandular covering trichomes with pointed apices are also present. The cortical tissue is formed of parenchymatous cells with narrow intercellular spaces. It shows 2 to 3 layers of elongated chlorenchyma directly below the lower epidermis and interrupted with sub epidermal collenchymatous patches in the ridges. The vascular system resembles that of the petiole and rachis. The pericycle is represented by group of several rows of collenchymatous cells. In addition large schizogenous ducts are distributed in the cortical tissue above the collenchyma and below the vascular bundles.

Powdered leaf

The powdered leaves (Fig. 2, 3, 4 and 5) are light green in color with characteristic aromatic odor. It is characterized microscopically by the following.

- 1- Fragments of epidermis of different parts of the leaf showing polygonal or elongated cells having straight anticlinal walls covered with striated cuticle and shows diacytic stomata.
- 2- Abundant non-glandular trichomes being unicellular, straight or curved and covered with thick warty cuticle.
- 3- Fragment of palisade cells.
- 4- Fragment of non-lignified fibers.

5- Fragment of chlorenchyma of the cortical tissues of rachis, petiole and leaf base

6- Fragments of vascular tissue showing lignified xylem vessels, fibres and tracheids.

2- THE STEM

A transverse section of the stem (Fig. 6 A) is nearly rounded in outline. It is formed of epidermis surrounding a narrow cortex with alternating patches of subepidermal chlorenchyma and collenchyma. The cortex shows schizogenous ducts. The vascular tissue is formed of narrow phloem and wide xylem surrounding wide central parenchymatous pith. Detailed transverse section of the stem (Fig. 6 B) shows epidermis formed of single layer of square or rectangular cells covered with thick striated cuticle and shows diacytic stomata rarely anomocytic. Non glandular covering trichomes are very rare but were detected in the powdered stem. The cortex is narrow and formed of an outer zone consists of patches of 7 to 9 rows of rounded collenchyma in the raised ridge alternating with 4 to 5 rows of slightly elongated chlorenchyma as subepidermal layer. Above the chlorenchyma there is a single row of subepidermal collenchyma. The inner zone consists of oval or tangentially elongated parenchyma cells with narrow intercellular space. The parenchymatous layer of the cortex shows large oval or rounded schizogenous ducts below the collenchymatous layer in the ridges. The pericycle is parenchymatous. The vascular tissue is formed of non-continuous ring of phloem with sieve tube, companion cells and phloem parenchyma. Xylem is represented by groups of lignified spiral, pitted, annular vessels, pitted lignified tracheids, lignified wood fibers. All are connected by wood parenchyma to form continuous ring. The pith is two-third of the stem diameter. It consists of large rounded or polygonal parenchymatous cells with narrow intercellular spaces and sometimes shows small rounded schizogenous duct.

The powdered stem

The powdered stem (Fig. 6 D) is light green in color with aromatic odor and characterized microscopically by the presence of:

- 1- Fragment of epidermis showing polygonal sometimes tangentially elongated cells with straight anticlinal wall and covered with striated cuticle and showing diacytic sometimes anomocytic stomata.
- 2- Fragment of unicellular non glandular covering trichomes with pointed apices and covered with warty cuticle
- 3- Fragments of lignified spiral, pitted and annular vessels.
- 4- Fragments of chlorenchyma appearing oval or sometimes rounded, having thin walls and narrow intercellular spaces.

3. THE ROOT

A transverse section in the root (Fig. 7 A) is circular in shape. It consists of an outer narrow cork, secondary cortex, phloem and secondary xylem that is formed of

wide region surrounds a tetra arch primary xylem in the center. Funnel-shaped medullary rays traverse the xylem and the phloem. The detailed transverse section in the root (Fig. 7 B) shows the following layer: The cork is narrow zone formed of 2 to 3 rows of dark brownish rectangular lignified cells. The cortex is formed of several rows of thin-walled tangentially elongated parenchyma cells and shows air cavities. The vascular tissues is formed of the phloem which consists mainly of thick-walled soft cellulosic elements, companion cells and phloem parenchyma with some collapsed cells. The cambium is formed of 1-2 layers of thin walled rectangular cells. Wide xylem consists mainly of the lignified spiral, annular and pitted vessels, pitted tracheids, elongated fusiform fibres with thin wall and narrow lumen and wood parenchyma. The medullary rays are funnel shaped uni-to triseriate and more wide in phloem region.

Powdered root

Powdered root: (Fig. 7 C) is yellowish white in color and shows the following.

- 1- Fragments of cork cells which appear as thin walls polygonal or rectangular in shape sometimes showing brown contents.
- 2- Fragments of cork cells in sectional view appear as rectangular thin walled cells.
- 3- Fragments of lignified spiral, pitted and annular xylem vessels.
- 4- Fragments of elongated f thin wall fusiform fibers with wide lumen and pointed apices.
- 5- Fragments of pitted walled tracheids and wood parenchyma.
- 6- Fragments of the medullary rays cells.

II. MICROMORPHOLOGICAL STUDY OF *D. CAPILLIFOLIUS*GILLI

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c- The petiole. d- Leaf base.

a. The Leaflet

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b. The rachis of the leaflet

The transverse section in the rachis (Fig. 3 A) is nearly pentagonal in outline showing raised ridges. It is formed of epidermal cells surrounding a parenchymatous cortical tissue and several layers of chlorenchyma under the epidermal cells. It is interrupted in the ridges by 5-9 rows of collenchyma. One or two rows of collenchyma are present as subepidermal layer in the remaining part of the transverse section. Large oval mostly rounded schizogenous ducts are present under the collenchymatous layers in the raised ridges and sometimes non glandular covering trichomes. The vascular system consists of several collateral vascular bundles scattered mainly in raised ridges and in the parenchymatous cortical tissue. Detailed transverse section (Fig. 3 B) shows polygonal to rectangular epidermal cells, covered with striated cuticle and having diacytic stomata (Fig. 3 D). Unicellular non-glandular trichomes (Fig. 3 C) are occasionally observed on the epidermis of the leaflet rachis especially on the raised ridges. They have thin walls, pointed apices and covered with warty cuticle. The transverse section shows subepidermal 3- 4 rows of palisade-like chlorenchyma. In the raised ridges it shows subepidermal collenchymatous layer formed of 5 to 9 rows of rounded shiny cells. The cortical tissue (Fig. 3 B) is formed of more or less rounded thin-walled parenchymatous cells with narrow intercellular spaces. It shows an oval or rounded schizogenous ducts above the peripheral vascular bundle which present below the raised ridges. The vascular tissue consists of several collateral vascular bundles. The large ones are below the ridges and each one formed of thin walled cellulosic phloem with few non lignified, elongated, fusiform, thin-walled phloem fibers. The xylem consists of lignified spiral, annular and pitted vessels. The pith is wide, formed of thin-walled cellulosic parenchyma with narrow intercellular spaces.

c. The leaf petiole

The transverse section in the leaf petiole (Fig. 4 A) is nearly similar to that of the rachis of the leaflet. It is sub-rounded in outline with concave upper part and showing several slightly raised ridges. Detailed transverse section

of the leaf petiole has the same histological characters as the rachis (Fig.4 B, 4 C).

d- Leaf base

A transverse section in the leaf base (Fig. 5 A, B) appears as crescent-shape with two lateral wings bent inward. The outer epidermis shows raised ridges due to the position of the veins. Detailed transverse section of the leaf base (Fig. 5 B) shows the presence of single layer of square or rectangular epidermal cells covered with thick striated cuticle. Diacytic stomata and few unicellular, non-glandular covering trichomes with pointed apices are also present. The cortical tissue is formed of parenchymatous cells with narrow intercellular spaces. It shows 2 to 3 layers of elongated chlorenchyma directly below the lower epidermis and interrupted with sub epidermal collenchymatous patches in the ridges. The vascular system resembles that of the petiole and rachis. The pericycle is represented by group of several rows of collenchymatous cells. In addition large schizogenous ducts are distributed in the cortical tissue above the collenchyma and below the vascular bundles.

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- 3- Fragment of palisade cells.
- 4- Fragment of non-lignified fibers.
- 5- Fragment of chlorenchyma of the cortical tissues of rachis, petiole and leaf base
- 6- Fragments of vascular tissue showing lignified xylem vessels, fibres and trachieds.

2- THE STEM

A transverse section of the stem (Fig. 6 A) is nearly rounded in outline. It is formed of epidermis surrounding a narrow cortex with alternating patches of subepidermal chlorenchyma and collenchyma. The cortex shows schizogenous ducts. The vascular tissue is formed of narrow phloem and wide xylem surrounding wide central parenchymatous pith. Detailed transverse section of the stem (Fig. 6 B) shows epidermis formed of single layer of square or rectangular cells covered with thick striated cuticle and shows diacytic stomata rarely anomocytic. Non glandular covering trichomes are very rare but were detected in the powdered stem. The cortex is narrow and formed of an outer zone consists of patches of 7 to 9 rows of rounded collenchyma in the raised ridge alternating with 4 to 5 rows of slightly elongated chlorenchyma as subepidermal layer. Above the chlorenchyma there is a single row of subepidermal collenchyma. The inner zone consists of oval or

tangentially elongated parenchyma cells with narrow intercellular space. The parenchymatous layer of the cortex shows large oval or rounded schizogenous ducts below the collenchymatous layer in the ridges. The pericycle is parenchymatous. The vascular tissue is formed of non-continuous ring of phloem with sieve tube, companion cells and phloem parenchyma. Xylem is represented by groups of lignified spiral, pitted, annular vessels, pitted lignified tracheids, lignified wood fibers. All are connected by wood parenchyma to form continuous ring. The pith is two-third of the stem diameter. It consists of large rounded or polygonal parenchymatous cells with narrow intercellular spaces and sometimes shows small rounded schizogenous duct.

The powdered stem

The powdered stem (Fig. 6 D) is light green in color with aromatic odor and characterized microscopically by the presence of:

- 5- Fragment of epidermis showing polygonal sometimes tangentially elongated cells with straight anticlinal wall and covered with striated cuticle and showing diacytic sometimes anomocytic stomata.
- 6- Fragment of unicellular non glandular covering trichomes with pointed apices and covered with warty cuticle
- 7- Fragments of lignified spiral, pitted and annular vessels.
- 8- Fragments of chlorenchyma appearing oval or sometimes rounded, having thin walls and narrow intercellular spaces.

4- THE ROOT

A transverse section in the root (Fig. 7 A) is circular in shape. It consists of an outer narrow cork, secondary

cortex, phloem and secondary xylem that is formed of wide region surrounds a tetra arch primary xylem in the center. Funnel-shaped medullary rays traverse the xylem and the phloem. The detailed transverse section in the root (Fig. 7 B) shows the following layer: The cork is narrow zone formed of 2 to 3 rows of dark brownish rectangular lignified cells. The cortex is formed of several rows of thin-walled tangentially elongated parenchyma cells and shows air cavities. The vascular tissues is formed of the phloem which consists mainly of thick-walled soft cellulosic elements, companion cells and phloem parenchyma with some collapsed cells. The cambium is formed of 1-2 layers of thin walled rectangular cells. Wide xylem consists mainly of the lignified spiral, annular and pitted vessels, pitted tracheids, elongated fusiform fibres with thin wall and narrow lumen and wood parenchyma. The medullary rays are funnel shaped uni-to triseriate and more wide in phloem region.

Powdered root

Powdered root: (Fig. 7 C) is yellowish white in color and shows the following:

- 1- Fragments of cork cells which appear as thin walls polygonal or rectangular in shape sometimes showing brown contents.
- 2- Fragments of cork cells in sectional view appear as rectangular thin walled cells.
- 3- Fragments of lignified spiral, pitted and annular xylem vessels.
- 4- Fragments of elongated f thin wall fusiform fibers with wide lumen and pointed apices.
- 5- Fragments of pitted walled tracheids and wood parenchyma.
- 6- Fragments of the medullary rays cells.

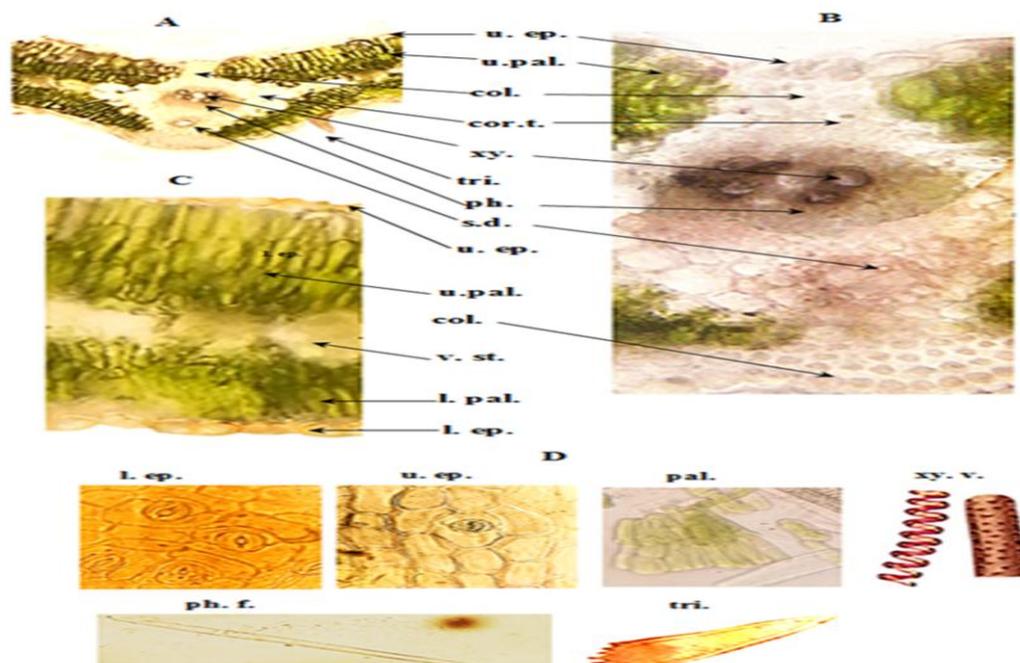


Fig. 2: The leaflet of *D. capillifolius* Gilli, a photograph of.

A: Diagrammatic transverse section in the leaflet segment (x 100)

B: Detailed transverse section in the midrib (x 361)

C: Detailed transverse section in the lamina (x 400)

D: Epidermal cells and some elements of leaflet of *D. capillifolius* Gilli

col., collenchyma; l. epi., lower epidermis; l. pal., lower palisade; ph., phloem; ph. f., phloem fibre; u. epi., upper epidermis; u. pal., upper palisade; s. d. schizogenous duct; v. st. vascular strand; xy.v., xylem vessel.

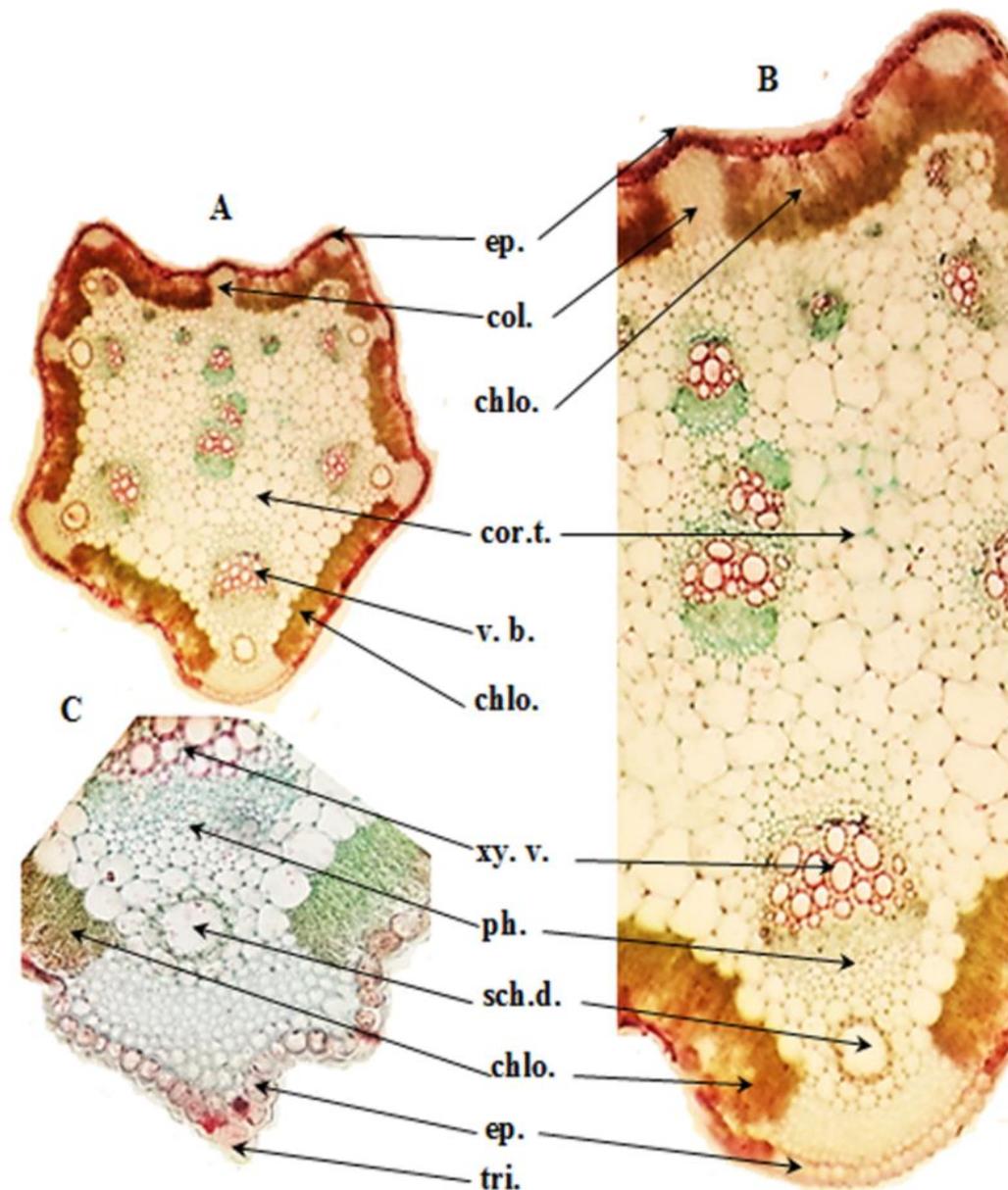


Fig. 3: A photograph of the leaflet rachis of *D. capillifolius* Gilli.

A: Diagrammatic transverse section in the leaflet rachis. (x 416)

B: Detailed transverse section in leaflet rachis. (x 433)

C: Fragment shows the lower raised ridge of the leaflet rachis (x 166)

col., collenchyma; chlo., chlorenchyma; epi., epidermis; ph., phloem; ph. f., phloem fibre; s. d. schizogenous duct; tri., trichome; v. b., vascular bundle; xy.v., xylem vessel

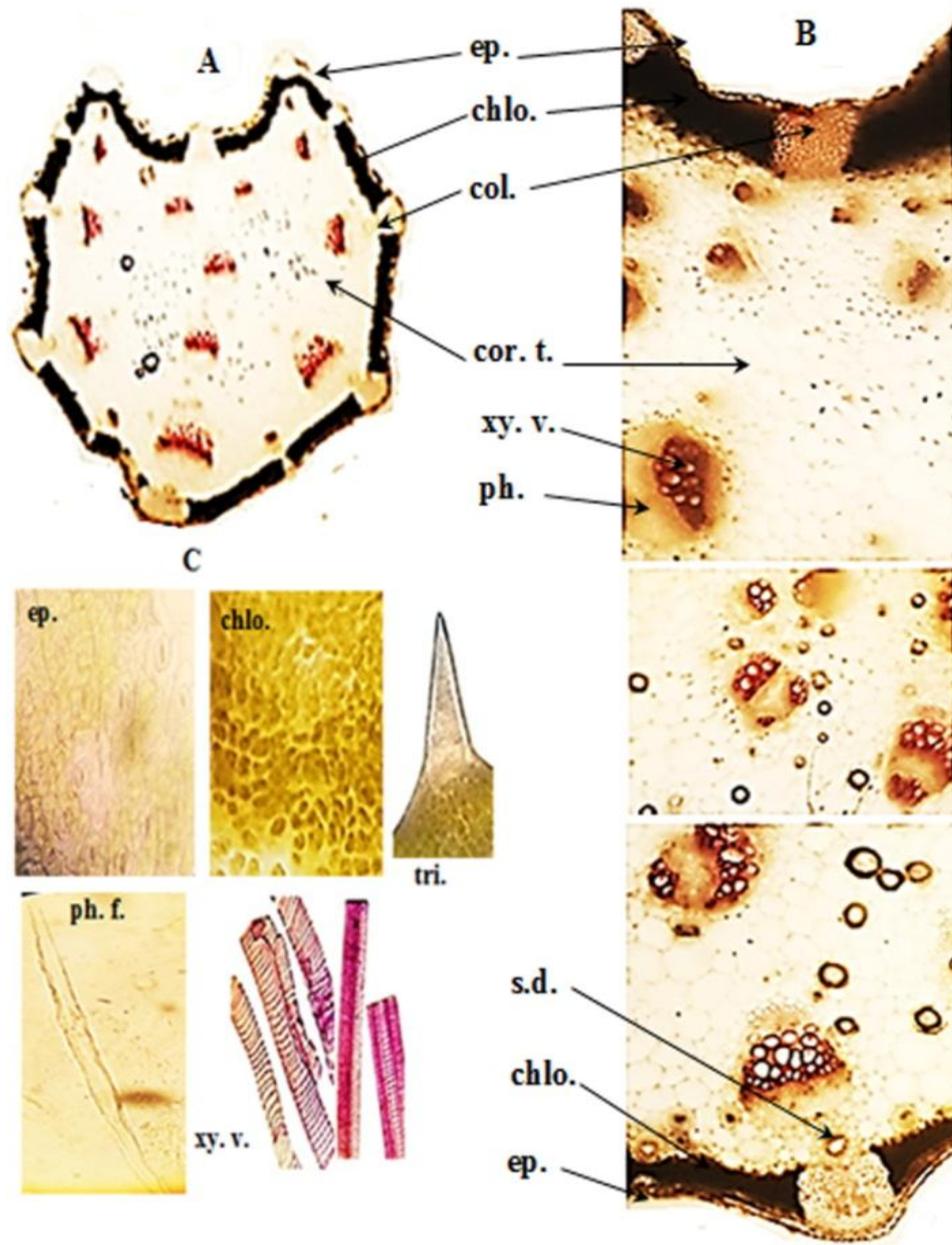


Fig. 4: A photograph of the leaf petiole of *D. capillifolius* Gilli

A: Diagrammatic transverse section in the leaflet petiole. (x 25.6)

B: Detailed transverse section in leaflet petiole. (x 67.4)

C: Isolated elements of the leaflet petiole.

col., collenchyma; chlo., chlorenchyma; epi., epidermis; par., parenchyma cells; ph., phloem; ph. f., phloem fibre; s. d. schizogenous duct; tri., trichome ; v. b., vascular bundle; xy.v., xylem vessel.

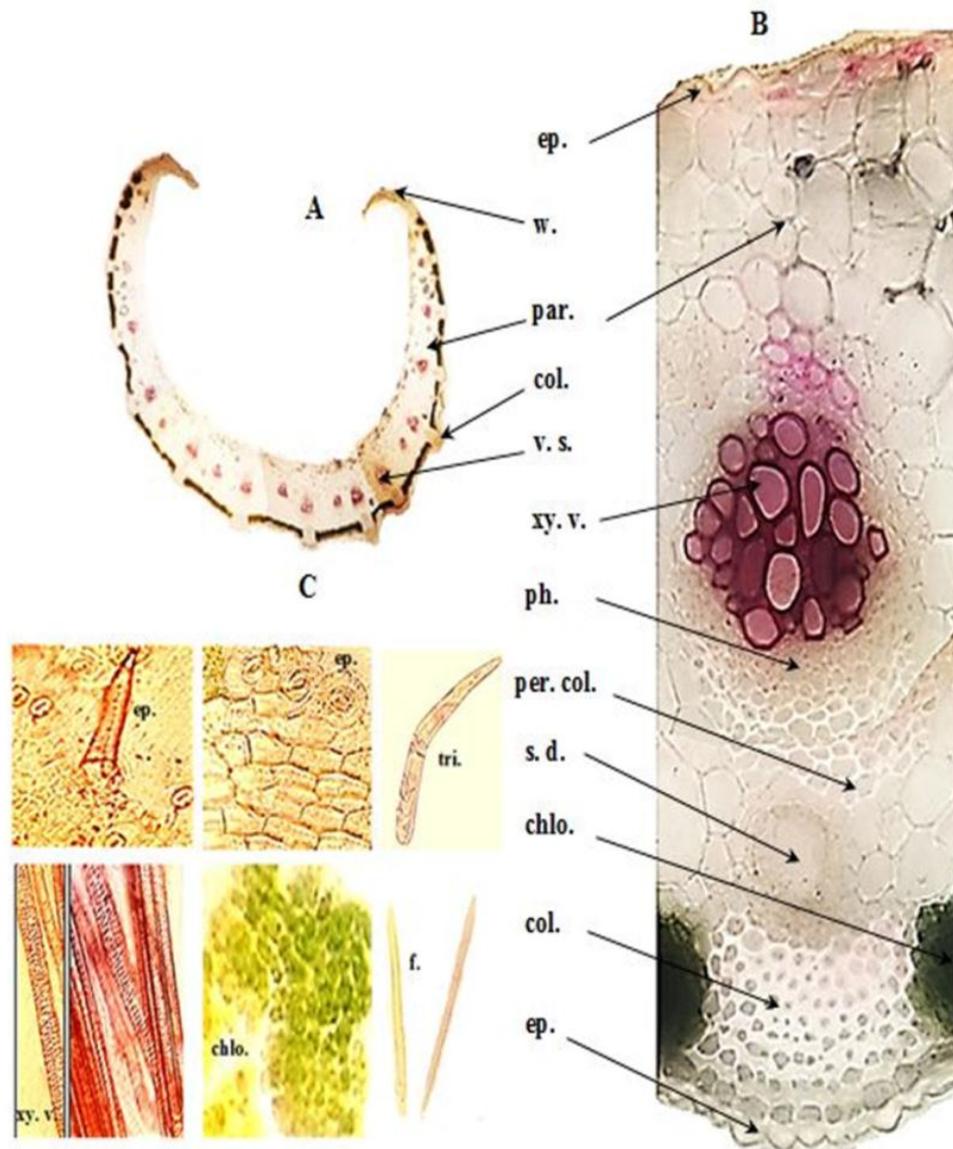


Fig. 5: A photograph of the leaf base of *D. capillifolius* Gilli.

A: Diagrammatic transverse section in the entire leaf base. (x 81)

B: Detailed and diagrammatic transverse section of leaf base. (x 290)

C: Epidermal cells and some elements of leaf base.

col., collenchyma; chlo., chlorenchyma; epi., epidermis; par., parenchyma cells; ph., phloem; ph. f., phloem fibre; s. d. schizogenous duct; tri., trichome ; v. b., vascular bundle; w., wing; xy.v., xylem vessel.

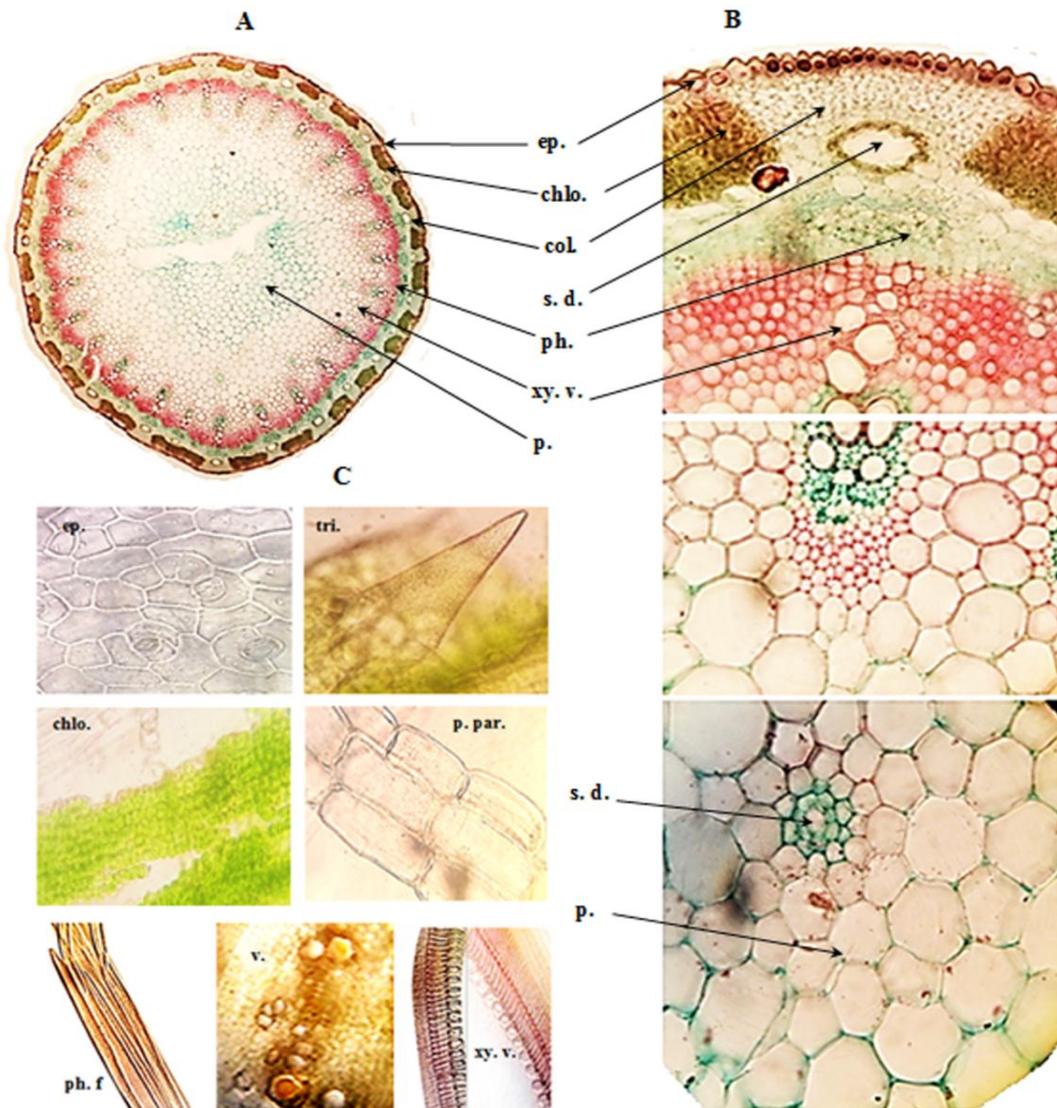


Fig. 6: A photograph of the stem of *D. capillifolius* Gilli.

A: Diagrammatic transverse section in the entire leaf base (x 23.9)

B: Detailed and diagrammatic transverse section of leaf base (x 215.4)

C: Epidermal cells and some elements of the stem

col., collenchyma; chlo., chlorenchyma; ep., epidermis; par., cortical parenchyma; par. o. p., parenchyma of pith; ph., phloem; ph. f., phloem fibre; s. d. schizogenous duct; tri., trichome; v. st., vascular strand; v., xylem vessels containing orange contents; xy.v., xylem vessel.

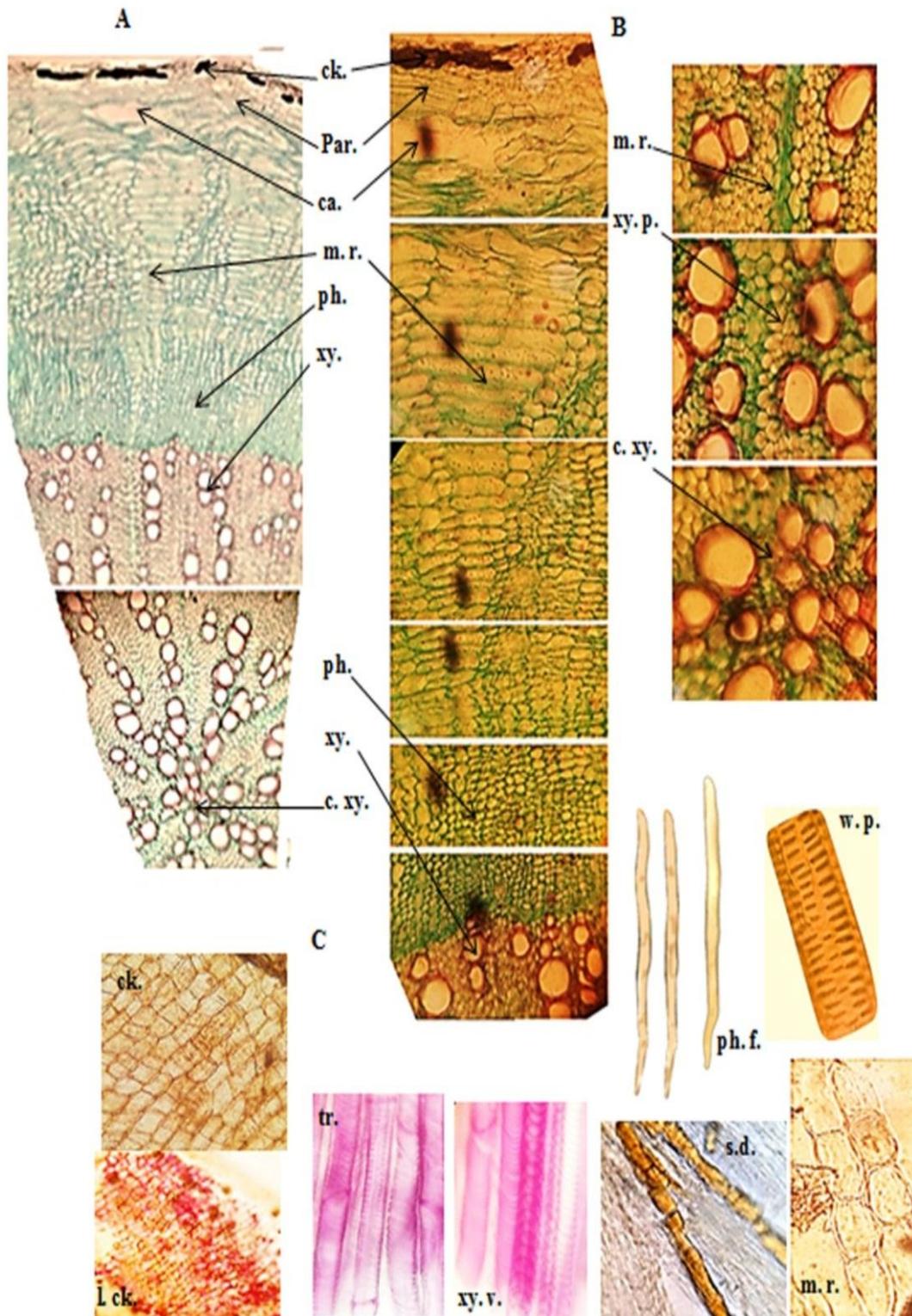


Fig. 7: A photograph of the root of *D. capillifolius* Gilli.

A: Diagrammatic transverse section in the root (x 76.5)

B: Detailed transverse section in the root (x129.4)

C: Some elements of powdered root.

c.xy., central xylem; ck., cork; l. ck., lignified cork; ca., air cavity; m. r., medullary rays; ph., phloem; w. par., wood parenchyma; xy. v., xylem vessels; xy. par., xylem parenchyma.

5- THE FRUIT

A transverse section in the dried ripe fruit (Fig 8 A) appears convex in outline with flat commissural surface and the dorsal surface shows five primary ridges and four prominent secondary ridges. The primary ridges show non glandular covering trichomes and the secondary ridges show elongated prickles. The mericarp consists of an epicarp, mesocarp traversed by 5 vascular bundles and 6 vittae, four in dorsal surface and two in commissural surface then an endocarp enclosing the seed. Detailed transverse section in the primary and secondary ridges of the dried ripe fruit mericarp (Fig. 8 C, B and D) shows an epicarp formed of a single row of square or rectangular cells having unicellular non glandular covering trichomes covered with warty cuticle. The secondary ridges (Fig. 8 D) are more prominent and show prickles. The prickle consists of a stalk of multicellular multiseriate thick-walled non-lignified cells and terminated by two to four elongated trichome-like cells arranged as a hook. The mesocarp (Fig.8 B, C and D) consists of thin-walled parenchymatous cells except for those lining the vittae which are slightly lignified. The mesocarp is traversed by 5 vascular bundles in the primary ridges three of them are present corresponding to the 3 dorsal primary ridges, the other 2 are present on the commissural surface. Each vascular bundles is formed of phloem bands followed by xylem formed of

few lignified spiral and annular vessels. It also shows 4 triangular vittae present corresponding to the secondary ridges. Two are oval-shaped and present on the commissural surface separated by a cavity and group of reticulate parenchyma cells. The endocarp (Fig. 8 B and C) consists of a single row of narrow tangentially elongated thin-walled cells. It exhibits parallel arrangement in surface view. The seed coat is represented by a single row of square or rectangular brownish cells followed by a collapsed hyaline layer. The endosperm is formed of polygonal cellulosic, thick-walled parenchymatous cells. They contain globules of fixed oil and granules of protein. The embryo consists of thin-walled cells.

Powdered fruits

Powdered fruits (Fig; 8 F) are yellowish brown in color and characterized microscopically by the presence of:

1. Fragments of elongated fusiform brownish vittae.
2. Unicellular non glandular covering trichomes with pointed apices and covered with warty cuticle.
3. Fragment shows lignified reticulate parenchyma.
4. Fragment of epicarp showing small polygonal cells, covered with striated cuticle and showing diacytic stomata.
5. Fragments of lignified spiral and annular vessels.
6. Fragments of parallel endocarp.

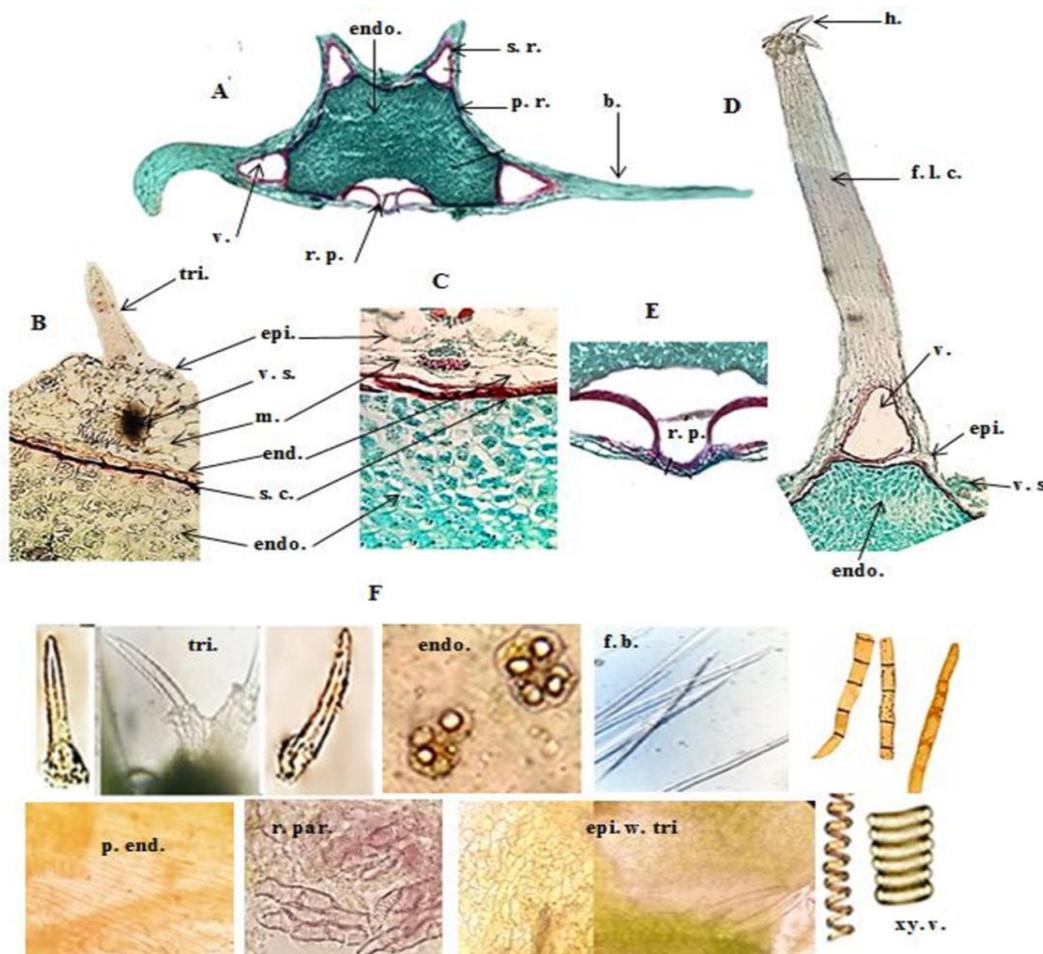


Fig. 8: A photograph of the fruit of *D. capillifolius* Gilli.

A: Diagrammatic transverse section in the dried ripe fruit (x 50)

B: Detailed T.S of 1ry ridge showing trichome (x 100)

C: Detailed T.S of 1ry ridge showing vascular strand (x 140)

D: 2ry ridge showing triangular vittae and seed coat (x 51.7)

E: Reticulate parenchyma in coummissural surface (x 153.8)

F: Elements of powdered fruit.

b. bristle, endo. endosperm; end. endocarp, epi. epicarp, epi. w. tri, epicarp with trichomes; f.b., fibers of bristle; h. hook; m. mesocarp; p.r. primary ridge; r.p. reticulate parenchyma; s.r., secondary ridge, s.c. seed coat, tri trichome, v. vittae, v.s. vascular strand.

6- THE INFLORESCENCE

a- Sepal:

A transverse section in sepal (Fig. 9 D) is half circled in outline and showing two lateral wings, the midrib is prominent on the lower side. Detailed transverse section (Fig. 9 E) shows upper and lower epidermises formed of rectangular or square cells covered with striated cuticle and enclosing mesophyll which shows 2-3 layers of chlorenchyma under the lower and upper epidermises. The cortical tissue shows collateral vascular bundle formed of lignified xylem vessels and soft phloem tissues, below the vascular bundle there is a large rounded schizogenous duct. Trichomes (Fig. 9 C, E) are present on the wings and on the lower epidermis. They are unicellular non glandular covered with warty cuticle. The wings (Fig. 9 C) are formed of elongated polygonal thin walled cells with straight or slightly wavy anticlinal walls. They are covered with striated cuticle and showing non glandular unicellular trichomes with rounded apices and covered with warty cuticle.

b- Petals

A transverse section of the petal (Fig. 9 F) is nearly flat or slightly curved inward in outline and showing upper and lower epidermises their cells are square or rectangular cells and enclosing in between the homogenous mesophyll with small vascular strand. Hairs are completely absent.

c- Androecium

1- Filament

A transverse section in the filament (Fig. 10 A) is circular in shape and consists of an epidermis consists of nearly square cells enclosing parenchymatous ground tissue, the parenchyma cells are polygonal or nearly rounded and show vascular strand formed of few lignified vessels.

2- Anther

A transverse section in the anther (Fig. 10 B) consists of two anther lobes connected by connective. The lobe shows two pollen sacs which contain several pollen grains. The anther wall is formed of epidermis followed by the fibrous layer which is formed of cells showing lignified bar like thickening.

Pollen grains (Fig. 10 G) are cocoon shape and smooth in outer surface. Germ pores and germ furrows are indistinct. Fibrous layer (Fig. 10 H) appears in surface view as polygonal cells with beaded lignified walls.

d. Gymnasium

1- Ovary

A transverse section in the ovary (Fig. 10 C) has characteristic shape and showing bilocular structure. The locule shows three prominent primary ridges and four less prominent secondary ridges. The outer surface shows numerous non glandular hairs. The primary ridge (Fig. 10 D, I) shows hook. The ovary wall (Fig. 10 E) shows outer and inner epidermis enclosing parenchymatous cortical tissue. The outer epidermis show subepidermal layers of chlorenchyma. The cortical tissue shows five vascular bundles and six vittae four under the secondary ridges and two in the commissural surface. It shows vascular strand formed of soft phloem tissue and few lignified xylem vessels.

2- Style:

A transverse section in the style (Fig. 10 E) is rounded in shape. It is formed of epidermal cells surrounding the cortical tissue. The epidermal cells are rectangular in shape and the ground tissue is polyhedral parenchyma and transversed by two vascular bundles formed of soft phloem tissue and few lignified xylem vessels each vascular bundle is accompanied with large rounded schizogenous ducts.

e. Rachis of the inflorescence and floret

The transverse sections in the flower pedicle and inflorescence rachis (Fig. 11 A, B and 12 A, B) are nearly similar. They are circular in outline with several raised ridges some of these ridges ended with unicellular covering trichomes as show in (Fig. 11 B and 12 B). The raised ridges are more prominent with rounded apices in the rachis of floret. The transverse section consists of epidermis surrounding a narrow cortex with alternating patches of sub epidermal chlorenchyma and collenchyma. The cortex shows schizogenous ducts and several collateral vascular bundles. Each vascular bundle is formed of narrow phloem and few xylem vessels surrounding wide central parenchymatous pith. There are several batches of pericyclic fibers between the vascular bundles.

Detailed transverse section of the rachis (Fig. 11, 12 B) shows epidermis formed of single layer of square or tangentially elongated cells, covered with thick striated cuticle and showing diacytic stomata. The covering trichomes are few in the inflorescence rachis and

numerous in floret pedicle. They are unicellular non glandular covered with thick warty cuticle. The cortex is differentiated into outer and inner zone. The outer zone consists of 7-9 rows of rounded or oval collenchymatous cells in raised ridge and 1-2 rows in other regions. The collenchymatous layer is followed by 3 to 4 rows of palisade like chlorenchyma except in the ridge regions. The inner zone of the cortex is formed of few rows of parenchymatous cells traversed in the raised ridges by oval or rounded schizogenous secretory ducts. The vascular tissue is formed of several collateral vascular bundles arranged in ring around the pith. Each vascular bundle consists of narrow soft phloem, few lignified spiral and annular xylem vessels. Between the vascular bundles there are batches of lignified thick walled, narrow lumen fusiform fibers with pointed or rounded apices. The pith is wide and consists of large polygonal parenchymatous cells with narrow intercellular spaces.

The powder of the inflorescence

The powder of the inflorescence (Fig. 9, 10, 11, and 12) characterized microscopically by the presence of:

- 1- Cocoon shape pollen grains which are smooth in the outer surface. Germ pores and germ furrows are indistinct.
- 2- Fibrous layer of the anther appears in surface view as polygonal cells with lignified beaded walls.
- 3- Fragment of polygonal or tangentially elongated epidermal cells covered with striated cuticle and showing diacytic stomata, (inflorescence rachis).
- 4- Fragment shows few unicellular non glandular covering trichomes covered with thick warty cuticle with or without epidermal cells. (inflorescence rachis and ovary wall)
- 5- Fragment of epidermis with several unicellular non glandular covering trichomes covered with warty cuticle and showing the arrangement of the basal cells, (floret rachis).
- 6- Fragments of lignified spiral and annular xylem vessels. (rachis).
- 7- Fragments of thin walled chlorenchymatous cells appearing oval or rounded and having narrow intercellular spaces (rachis).

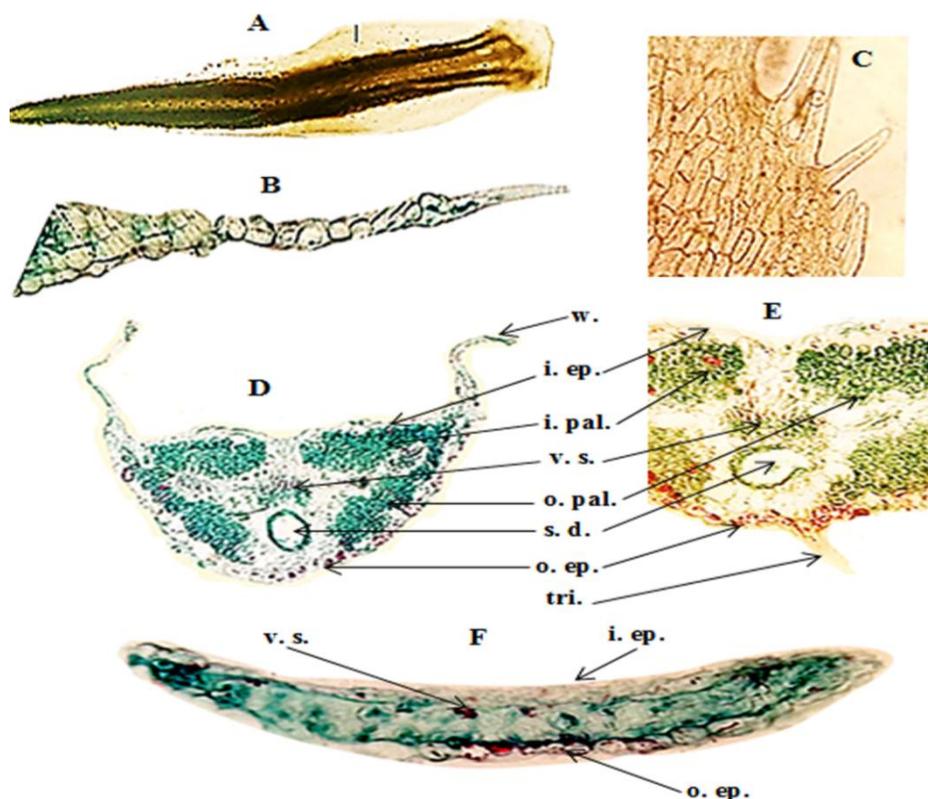


Fig. 9: A photograph of the sepal and petal of *D. capillifolius* Gilli.

A: Morphology of bract showing membranous wing (x 8)

B: Sectional view of the wing (x 25)

C: Surface view of the wing showing warty hairs and slightly wavy cells (x 100)

D: Diagrammatic transverse section of the bract showing wing (x 83)

E: Detailed transverse section of the bract showing covering trichome (x 120)

F: Diagrammatic transverse section of the petal (x 60)

chlo., chlorenchyma; l. ep. lower epidermis; s. d. schizogenous duct; tri., trichomes; u. ep., upper epidermis; w. wing; xy. v., xylem vessels.

col., collenchyma; chlo., chlorenchyma; ep., epidermis; par., cortical parenchyma; par. O. p., parenchyma of pith; ph., phloem; ph. f., phloem fibre; s. d. schizogenous duct; tri., trichome tri., trichome ; v. st., vascular strand; v., xylem vessels containing orange contents; xy.v., xylem vessel.

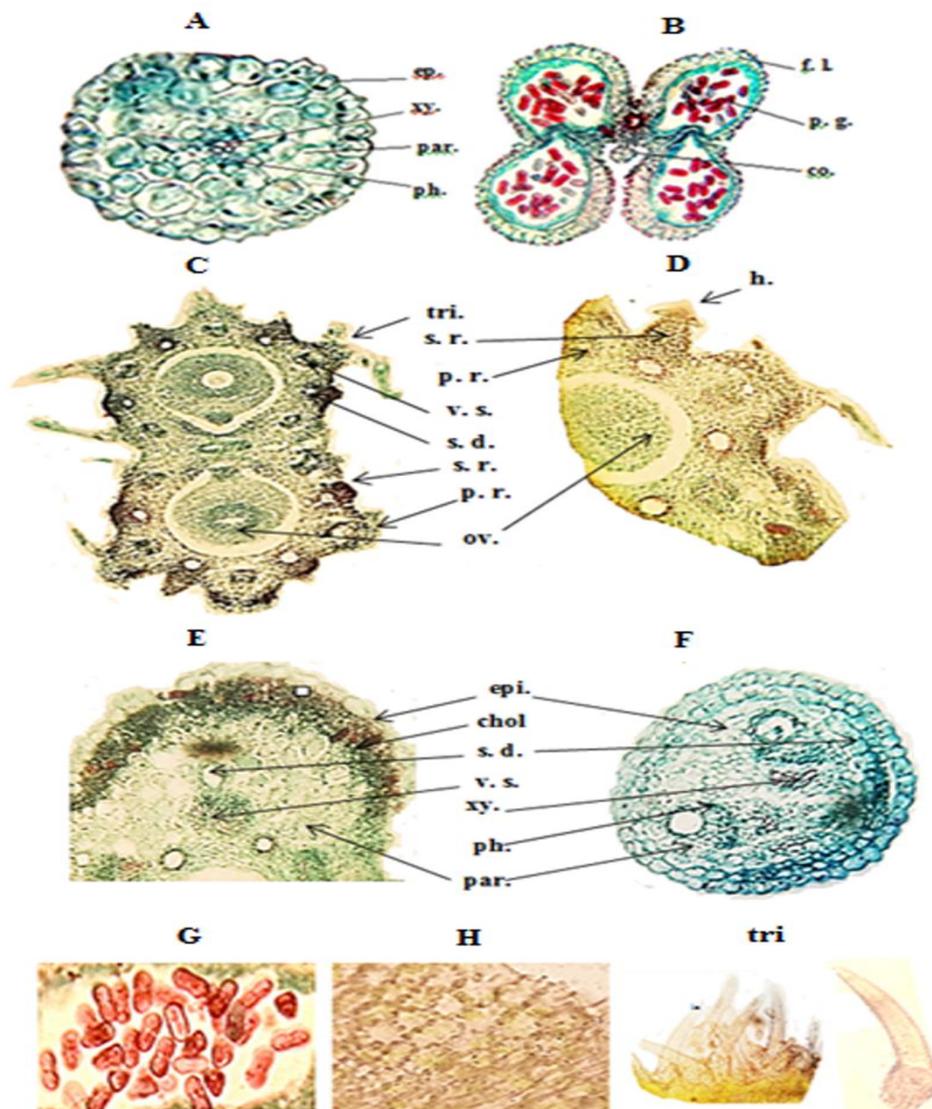


Fig. 10: A photograph of the androecium and gynoecium of *D. capillifolius* Gilli.

A: Transverse section in the filament (x 116.7) B: Transvers section of the anther (x 68.6) C: Transvers section of the ovary (89.3)

D: Detailed transverse section in the 1ry & 2ry ridge of the ovary (x 225)

E: Detailed transverse section in the wall of the ovary (x 350)

F: Transverse section of the style (x 140) G: Pollen grain (x 66.7)

H: Fibrous layer of the anther (x 70)

co., connective; chlo., chlorenchyma; ep., epidermis; f. l., fibrous layer; h., hook; ov., ovule; p. g., pollen grain; par., parenchyma; ph., phloem; p. r., primary ridge; s. r., secondary ridge; tri., trichome; xy., xylem.

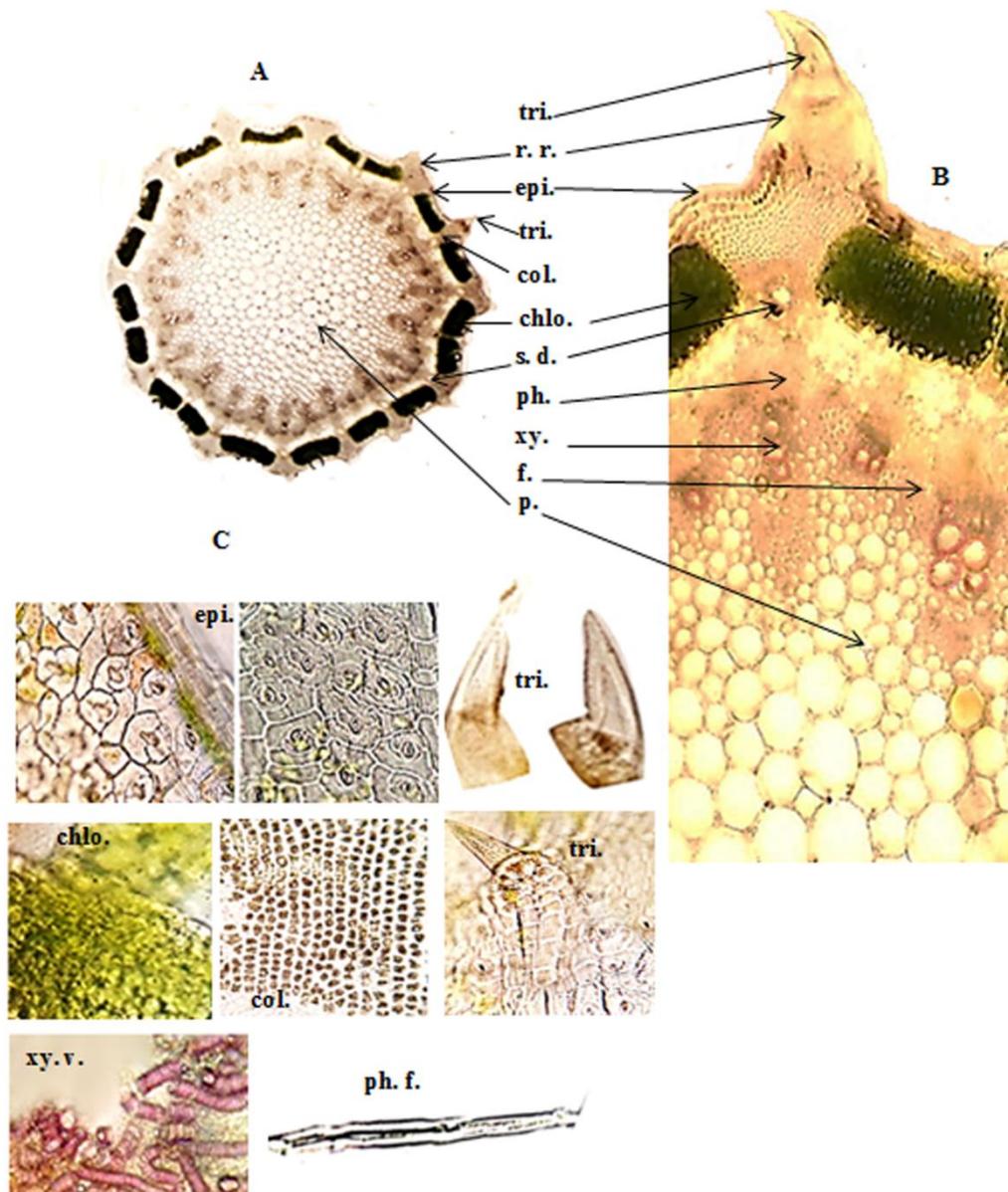


Fig. 11: A photograph of the rachis of the inflorescence of *D. capillifolius* Gilli.

A: Diagrammatic transverse section (x 90)

B: Detailed transvers section (x 300)

C: Epidermal cells and elements of the rachis

chlo., chlorenchyma; col., collenchyma; ep., epidermis; ph., phloem; ph. F., phloem fiber; r. r., raised ridge; s. d., schizogenous duct; tri., trichome; xy. v. xylem vessels.

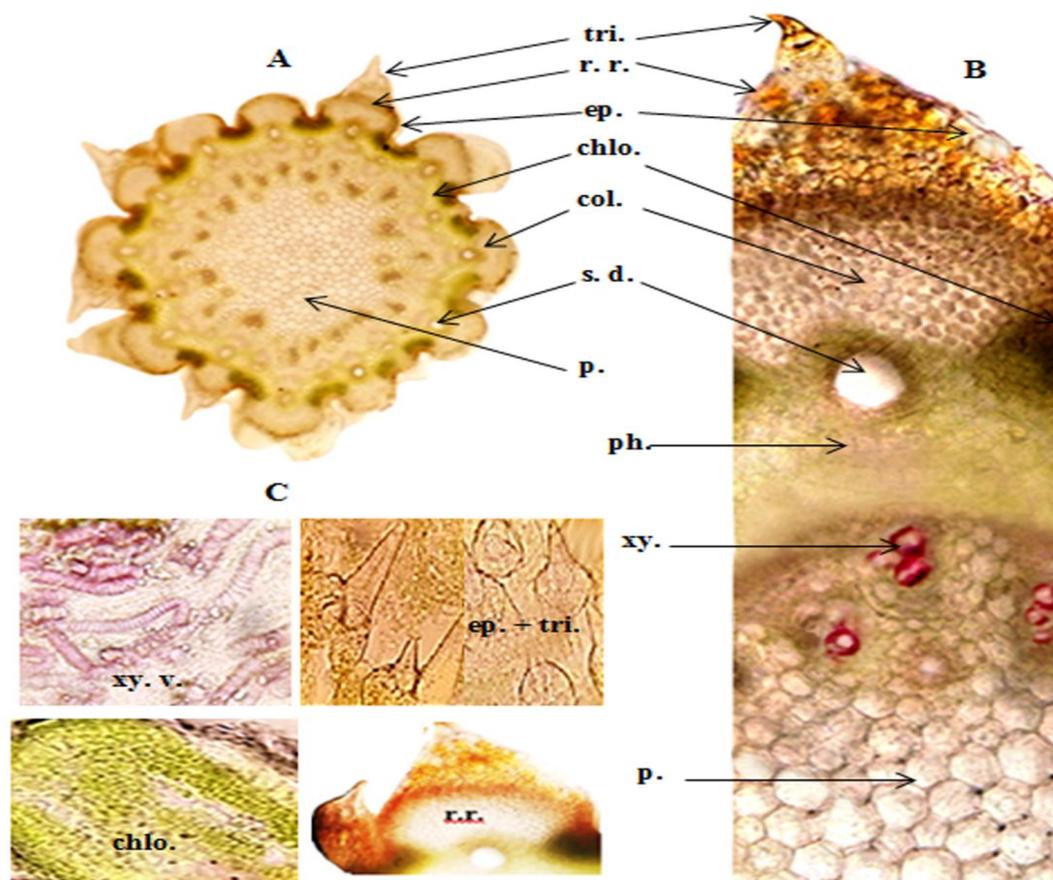


Fig. 12: A photograph of the pedicel of the flower of *D. capillifolius* Gilli.

A: Diagrammatic transverse section (x 122)

B: Detailed transvers section (x 482)

C: Epidermal cells and elements of the rachis

chlo., chlorenchyma; col., collenchyma; ep., epidermis; ph., phloem; r. r., raised ridge; s. d., schizogenous duct; tri., trichome; xy. v. xylem vessels.

Table 1: Cell dimentions in (μm) of the different tissues of leaf, stem and root of *D. capillifolius* Gilli.

Cells	Leaf				Stem	Root
	Segment	Rachis	Petiole	Base		
Upper epidermis	L 40-150 W 35-60	L 50- 108 W 20-33	L 55- 110 W 26-31	L 38- 121 W 20-43	L 20-67 W 21- 40	
Lower epidermis	L 30-110 W 25-60	-	-	-	-	-
Stomata	L 40-20 W 23-18	L 23-36 W 20-29	L 18-42 W 15-30	L 23-40 W 21-27	L 30 - 43 W 13- 23	-
Trichomes	L 60-150	L 230- 360	L 55-170	L 210-480	L 100- 250	-
Schizogenous duct	D 25-70	D 34- 67	D 12.5- 23.3	D 32-80	D 32-80	-
Cork	-	-	-	-	-	L 34-72 W 17-34
Fibres	D 12-30 L 290-380	D 12-36 L 35- 850	D 10- 29 L 300-400	D 17- 33 L 330-750	L 600-980 D 20-40	L 233-400 D 22- 38
Vessels	D 10-29	D 10-33	D 13-59	10-60	D 10- 35	D 24-134

D: diameter; L: length; W: width.

Table 2: Cell dimensions in (μm) of the different tissues of fruit and inflorescence of *D. capillifolius* Gilli.

Cells	Fruit	Flower pedicle	Inflorescence rachis	Sepal	Style	Ovary	Anther
Epidermis	-	L 20-60 W 10-33	-	-	-	-	
Stomata	-	L 10-15 W 20-32	-			-	
Trichomes	L 70-200	L 60-167	L 80-140	L 95-200	-	L 130-200	
Schizogenous duct	D 32-500	D 17-33	-	D 50-67	D 25-33	D 7-20	
Fibres	L 120-350 D 10-15	-	-	-	-		
Vessels	17-41	D 11-23	D 10-33	-	-		
Pollen grains							L 15-23 W 10-12

D: diameter; L: length; W: width.

CONCLUSION

In conclusion, the powdered aerial parts and root of *D. capillifolius* is yellowish green in color with characteristic odor and characterized microscopically by the presence of simple vittae, non-glandular unicellular rarely bicellular covering trichomes which are covered with warty cuticle. Characteristic non-glandular unicellular trichomes showing the large basal parts of raised ridges of the floret rachis. Cocoon shape pollen grains. Epidermal cells showing diacytic and rarely anomocytic stomata with one small cell in addition to other elements. So it is easily identified under microscopes.

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