Comprehensive Anatomical Analysis of *Solanum Pubescens* Willd.

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Abstract

Background: The present study focuses on the anatomical standardization of *Solanum pubescens* Willd. through detailed microscopic characterization of its leaf, stem, unripe fruit, seed and powder. **Materials and Methods**: Sections were prepared using a rotary microtome and were conducted following standard protocols. Quantitative microscopy, key parameters such as stomatal number (SN), stomatal index (SI), vein islet (VI) number, vein termination (VT) number, palisade ratio, and powder microscopy were also recorded. **Result**: Anatomical observations revealed distinctive features: the stem exhibited a circular outline with a uniseriate epidermis bearing stellate and branched trichomes. Trichomes were present on both epidermal layers. T.S. of the leaf shows amphistomatic with anisocytic and anamocytic stomata which bear glandular and non-glandular trichomes like stellate and multicellular covering trichomes. The pedicle presented a wavy outline with stellate and glandular trichomes and a central parenchymatous pith. Calyx and corolla show few covering trichomes and few multicellular covering trichomes respectively. Another is bilobed and tetrasporangiate, inner layer of hypodermis is called endothecium, innermost single layer of anther wall is tapetum. Ovary bilocular, ovules are attached by funiculus and the central axis has cluster crystal. The pericarp featured thick-walled epicarp cells with prismatic crystals and a mesocarp containing starch-filled parenchyma with scattered vascular strands. The seed anatomy displayed a palisade layer in the testa, aleurone-rich endosperm, and starch and oil-containing cotyledon and radicle regions. These detailed studied parameters are used to detect adulteration and standardize the study plant scientifically.

Keywords: Macroscopical, Microscopical, Solanaceae, *Solanum pubescens,* Stellate trichome, Glandular trichome, Prismatic crystals, Aleurone grains, Anomocytic stomata.

Introduction

People have used medicinal plants, also known as medicinal herbs, for traditional healing. Since prehistoric times, civilizations such as those of India (through Ayurveda) and, China (through Traditional Chinese Medicine), and various Indigenous cultures of America have historically relied on plant-derived remedies for the treatment of a wide range of illness. These systems traditional medicine are empirical knowledge accumulated over the generations, emphasizing the therapeutic properties of specific plants and their preparations. Many of these practices have laid the foundation for modern research and drug discovery,

with numerous pharmaceutical compounds originally isolated from medicinal plants. While medicinal plants are found across the globe, certain regions particularly China and India stand out for their especially high concentration and extensive use of these plants [1]. According to most estimates, around fifty thousand plant species are utilized for medicinal purposes worldwide. This means that a substantial amount of the world's plant biodiversity is considered to have beneficial value [2].

India is harmony of the world's richest countries in standings of biodiversity, with a vast and diverse heritage of medicinal plants. Of the approximately 17,000 species of higher plants identified in the country, an estimated 7,500 species are known to have therapeutic value. These plants piece a vital role in traditional system, and various folk healing practices. These species are used in over 80% of traditional formulations in India, underscoring their essential role in both healthcare and the country's cultural heritage [3].

Today, here is a growing global interest in old medicine owing its effectiveness, affordability, and justifiable style to health care. Countless people are turning to traditional healing systems as corresponding options to modern medicine. These systems often emphasize natural remedies, holistic wellbeing, and long-term health maintenance, making them especially appealing in an era of rising healthcare costs and increasing awareness of environmental sustainability [4]. The WHO recognizes traditional medicine as an important for helping health and well-being worldwide. Traditional medicine includes a variety of practices, knowledge, and views that are extremely fixed in the cultures of various communities. This global approach helps integrate old-style remedy into current health care systems, thereby enhancing universal health coverage. It also makes healthcare more accessible, culturally relevant, and holistic, especially for underserved populations [5].

Medicinal herbs are presently used in several customs, primarily as a source for natural remedies conventional medical practices, along with being studied and extracted to develop modern pharmaceuticals, often used to treat a extensive variety of ailments including pain, inflammation, anxiety, digestive issues, and certain chronic diseases, with many people uniting them into their regular health routines through teas, supplements, and topical applications [6]. Secondary metabolites are organic compounds generated by living organisms that do not play a direct role in their growth or development, but instead play specialized roles in their survival, often acting as defense mechanisms against predators or pathogens, attracting pollinators, or helping them adapt to their environment [7]. Phytochemicals are compounds that occur naturally and are produced by plants, classified as secondary metabolites. Unlike principal metabolites, they are not directly involved in growth or reproduction, but serve important ecological functions. Plants produce phytochemicals for various purposes, such as defending themselves against insect pests, pathogens, and other environmental threats. These compounds show a dynamic part in both plant and human biology. In humans, roughly phyconstituents have remained initiate to offer health benefits, including antioxidant, anti-inflammatory, and anticancer properties [8]. Morphological and anatomical research on herbs used in medical system are very important for correct identification. Now a days numerous new sophisticated technologies are even available, but external and anatomical studies are cheap and easy method to identify correct and genuine

one [9-10]. The Solanaceae, or nightshade family, is a big group of sparingly important plants and culturally important species. With around 98 genera and more than 2,700 species, this family covers a wide array of herbs used as food, medicine, spices, and ornamentals [11]. *Solanum pubescens* Willd is an annual, erect, unarmed (prickly) shrub, up to 1.5m tall. Flowering and fruiting occur from July to February. It is a shrubby plant known for its distinctive pubescent (hairy) leaves and stems, which help differentiate it from other *Solanum* species. The plant typically grows in dry, hilly areas and is adapted to harsh environmental conditions. It was commonly used in India by tribal people for of liver disorders, diarrheal diseases, and cancer disorders. It has numerous curative properties, like treating epilepsy, febrile convulsions, and wounds, joint pains and bowel complaints. The essential oil of the fruit has antimicrobial and anti-inflammatory properties that help wound healing [12]. Although it's known for its wide range of medicinal benefits, existing literature reveals a lack of comprehensive pharmacognostical studies on its aerial parts. The present study gives detailed macroscopic and microscopic information, laying the groundwork for future pharmacological research and enhancing understanding of the phytochemicals that contribute to its therapeutic potential.

Materials and methods

Plant material

The test plant *Solanum pubescens* Willd. was collected from Muthampalayam, Rangampalayam, Erode District, Tamil Nadu, India (**Plate-1**(a-b-c) and, subsequently authenticated at Botanical Survey of India (BSI), Southern Circle, Coimbatore, India and the herbarium of the voucher specimen number BSI/SRC/5/23/2024/Tech.391 was deposited at the PG and Research Department of Botany, Vellalar College for Women (Autonomous) in Erode, Tamil Nadu, India. In instances where a herbarium specimen has been preserved for future reference.

a) Habit

b) Closure view of flower

c) Closure view of fruit

Plate – 1
Morphology of *Solanum pubescens* Willd.

Macroscopical Studies:

Macroscopic observations like shape, size, color, odor and its additional features were studied. The various plant parts were analyzed and studied in their natural habitat, photographed on-site and evaluated botanically [13].

Microscopical Studies:

Preparation of specimens of healthy aerial plant sections of *Solanum pubescens* were carefully chosen. Fresh samples of various sections (leaves and, stems) were made into small pieces and, preserved in FAA (5 mL of formalin, 5 mL of acetic acid and, 90 mL of 70% ethanol). Following a 24 hr fixing period, the samples underwent dehydration using a graded sequence of Tertiary Butyl Alcohol (TBA) in accordance with the timetable [14]. Melted Paraffin wax (58-60ºC) was added gradually to the specimens got super saturation of TBA solution. The samples were transversed into paraffin blocks.

Sectioning:

For sectioning Rotary Microtome was utilize, the specimens fixed in paraffin, yielding sections with a thickness of 10-12 µm. The sections were de-waxed according to established protocol [15], and then stained with Toluidine blue [16].

Staining:

For anatomical studies, a staining protocol was established in which Toluidine blue stain was dissolved in 0.25 g of the dye in a mixture containing 0.25 g of benzoic acid, 0.29 g of sodium benzoate and 200 mL of D water, achieving a pH of (4.2-4.4). As a polychromatic stain, Toluidine blue provided exceptional staining results, revealing distinct cytochemical reactions: cellulose walls appeared pink, lignified cells stained blue, suberin took on a dark green hue, mucilage was colored 134 violet and protein bodies appeared blue. When required, additional sections were stained with safranin, fast-green and IKI (Lugol's iodine. To investigate leaf constants (stomatal morphology, venation patterns and trichome distribution, paradermal cut taken parallel to the leaf surface) were prepared, alongside leaf clearing with 5% (sodium hydroxide or epidermal peeling) through partial maceration using Jeffrey's maceration fluid [14]. Glycerin-mounted provisional measures were created for the macerated materials. Following staining, powdered components from various tissues were cleaned with NaOH and, mounted in a glycerin medium, with various cell components being measured and examined.

Photomicrographs:

Following staining, using a graduated sequence of Xylol and Ethanol all permanent slides were dehydrated and then mounted in DPX. Where applicable, micrographs were included to complement the microscopic descriptions of the tissues. Nikon Lab Photo-2 Microscope was used to capture images at

various magnifications on Konica color film (100ASA). Observations were made using bright-field microscopy, to examine crystals, starch grains and, lignified cells the polarized light was used, as these structures exhibit birefringent and, appear bright against dark backgrounds. The scale bars show the figures magnifications [17].

Results

Macroscopical Observations

The morphology of the study plant *Solanum pubescens* is given in (Table-1). Unarmed pubescent shrubs, leaves to 12×7cm, ovate - elliptic to deltoid, apex acute, base unequally truncate, membranous, margins entire to wavy, petiole to 8 cm, pubescent. Racemes axillary, peduncle to 5cm, pubescent, pedicels 2cm, pubescent, flower purple, calyx lobes 6 mm, lanceolate, pubescent, corolla tube 5 mm, lobes 6 mm, lanceolate, pubescent, ovary 1.5 mm, style 1cm, stigma capitate.

Part of the plant	Characters noted	Observations
Leaf	Leaf	Simple
	Colour	Green
	Odour	Characteristic pungent
	Taste	Bitter
	Size	12cm in length &7cm in width
	Shape	Ovate-elliptic
	Texture	Pubescent(or) hairy
	Fracture	Uneven & fibrous
	Apex	Acute
	Margin	Entire
	Phyllotaxy	Simple (or) Alternate
	Petiole	8cmlong and velvety-hairy
Stem	Colour	Greenish brown
	Odour	Characteristic pungent
	Taste	Bitter
	Size	1-2 meter
	Shape	Terete
	Texture	Hairy
	Branching	Branched
	Fracture	Brittle

Flower	Inflorescence	Axillary raceme
	Colour	Purple to violet
	Size	3 cm long
	Sepal	5, green colour
	Petal	5, purple-violet
	Pedicel	1.2-1.6 cm long
	Stamen	5 sagittate
	Filament	Short cylindrical
	Ovary	Superior
	Ovules	Multiple ovules
Fruit	Colour	Green (or) unripe
	Type	Berry
	Apex	Obtuse(or) rounded
	Shape	Globose
Seed	Colour	Yellowish brown
	Shape	Broadly ovate
	Number	Many (20-30)
	Texture	Smooth texture

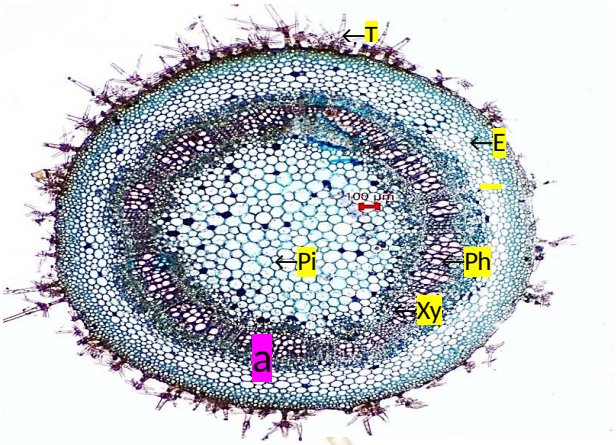
Microscopical Observations

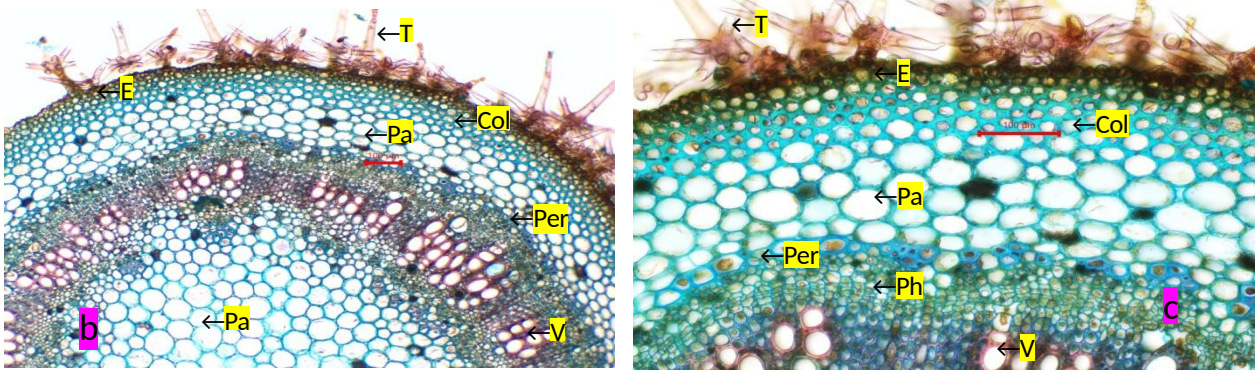
Stem

T.S of stem is circular in outline; it shows outer single layer of epidermis covered by cuticle and bears numerous non glandular stellate and branched covering trichomes; hypodermis is formed of 3 to 4 layers of collenchyma cells followed by 5 to 6 layers of parenchymatous cortex; a ring of 15 to 16 conjoint, collateral and closed vascular bundles are present at the inner cortex surrounded by discontinuous patches of pericyclic fibers; phloem is facing towards outside and xylem elements towards inner side; vascular bundles are formed of normal vascular elements; central pith is wide and parenchymatous filled with some cell contents (Plate – 2& 3a).

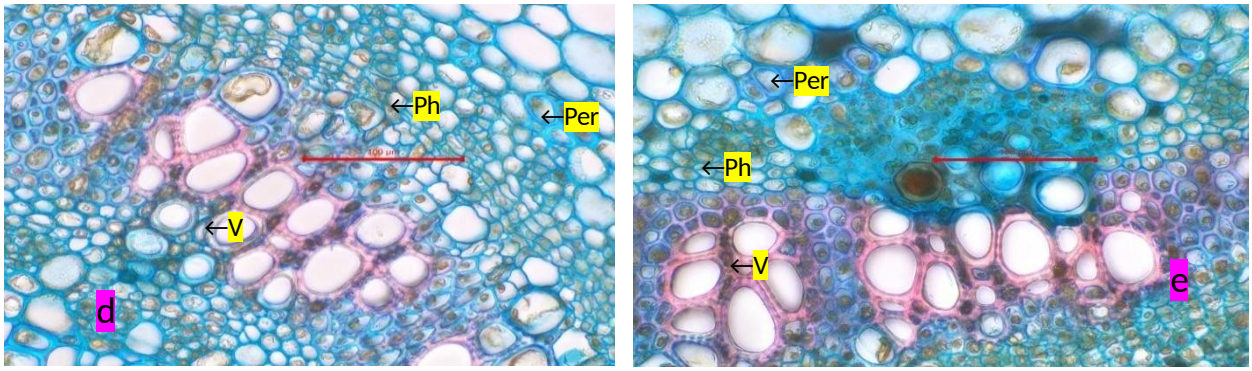
Plate-2

a) T.S. of *Solanum pubescens* stem





b) Enlarged view of upper portion



c) Vascular region enlarged

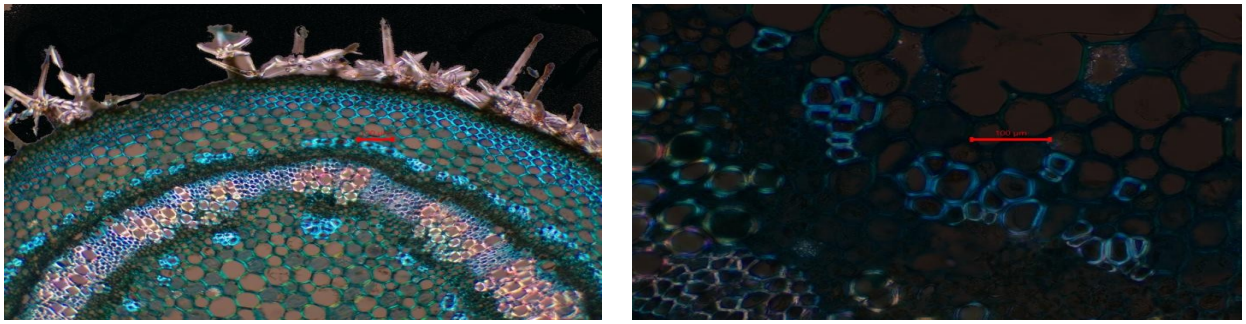


Plate- 3 a) T.S. of stem under polarized field

Col - collenchyma; **Ct** - cortex; **E** - epidermis; **Pa** - parenchyma; **Per** - pericycle; **Ph** - phloem; **T** - trichome; **V**- vessel; **Xy** - xylem

Petiole

T.S of petiole nearly circular with two lateral protuberances; outer layer is single layered epidermis covered by cuticle and bears numerous non glandular multicellular long covering trichomes and few stellate trichomes; hypodermal layer is formed of 3 to 4 layers of collenchyma cells followed by broad parenchymatous ground tissue embedded with central, conjoint, collateral, closed, arc shaped vascular bundle; a narrow patches of pericyclic fibers surround the vascular bundle; phloem is found facing towards lower side and xylem towards upper side; xylem and phloem are formed of normal vascular elements; trace bundles are present in each of the lateral wings **(Plate – 3b & 4).**

b) T.S. of petiole

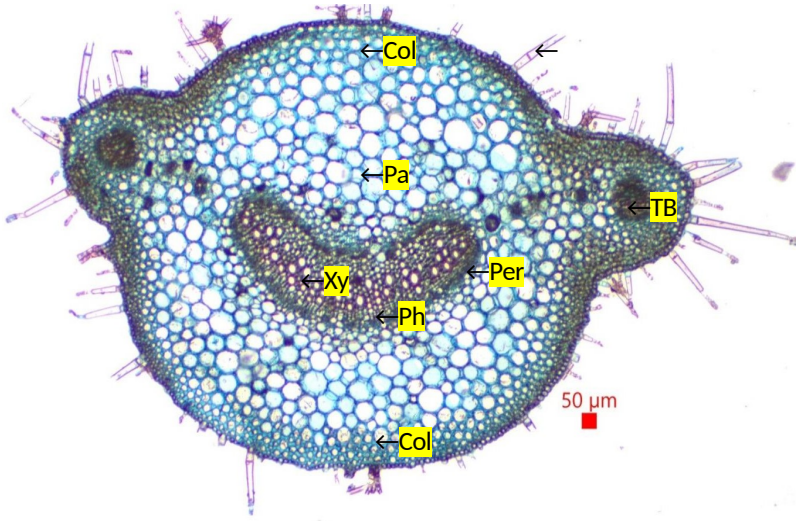
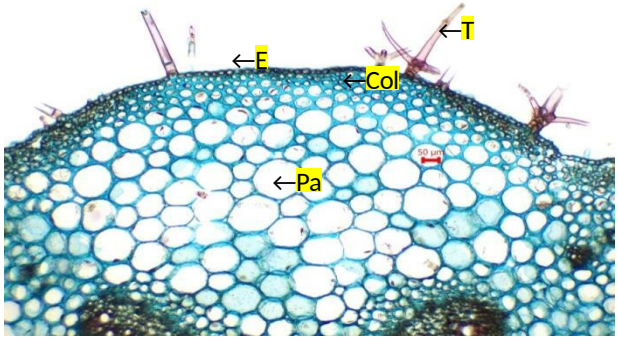
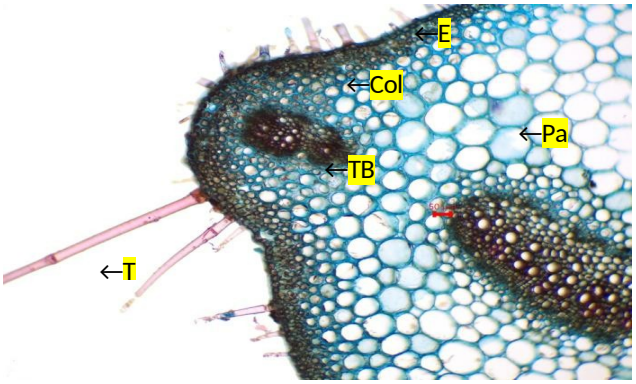


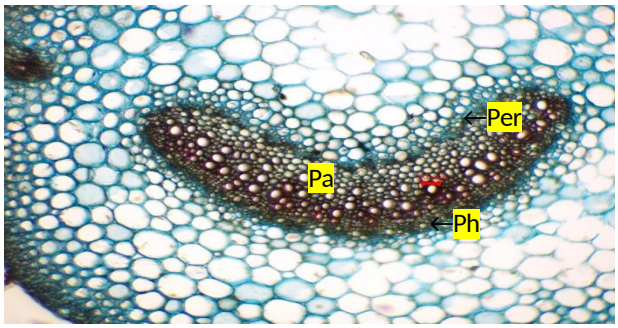
Plate-4

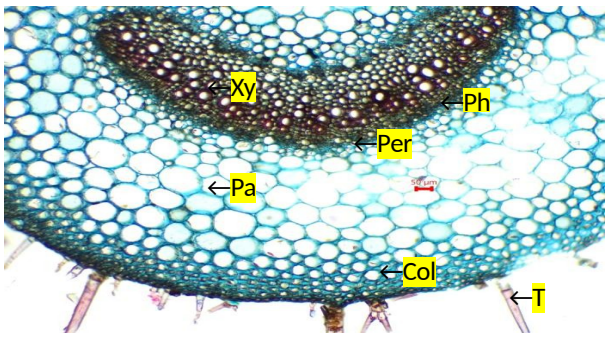


a) T.S. of Solanum Pubescens petiole outer region enlarged



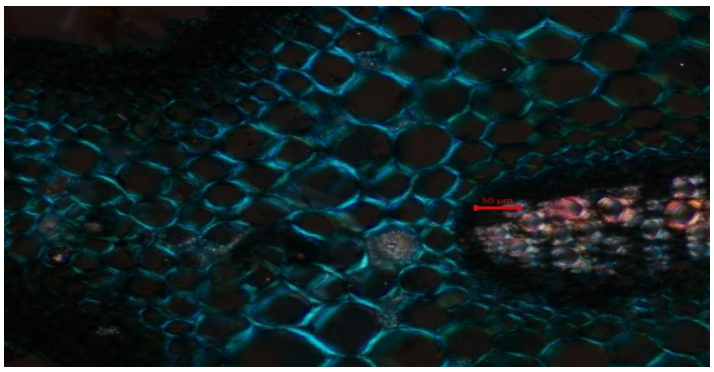
b) Lateral portion enlarged





c) Lower portion enlarged

ISSN NO : 1869-9391



d) under polarized field

Col - collenchyma; **E** - epidermis; **Pa** - parenchyma; **Per** - pericycle; **Ph** - phloem; **T** - trichome; **Xy** – xylem

Leaf

T.S of leaf shows convex shaped upper and lower surface with lateral laminar extensions (Plate – 5a).

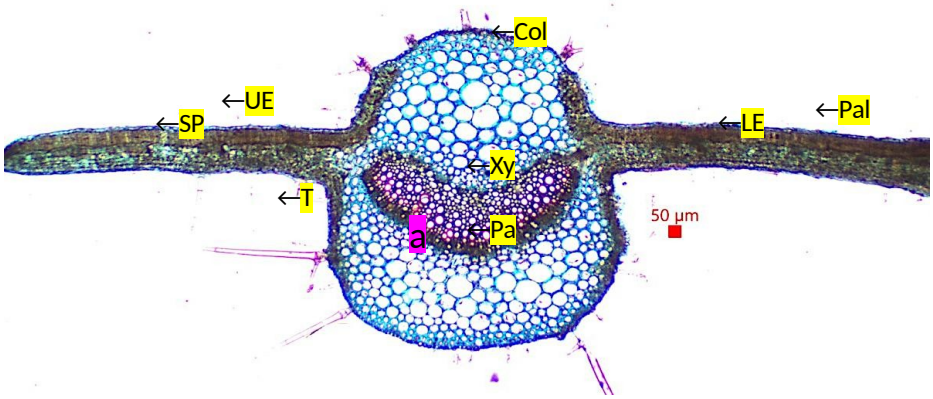
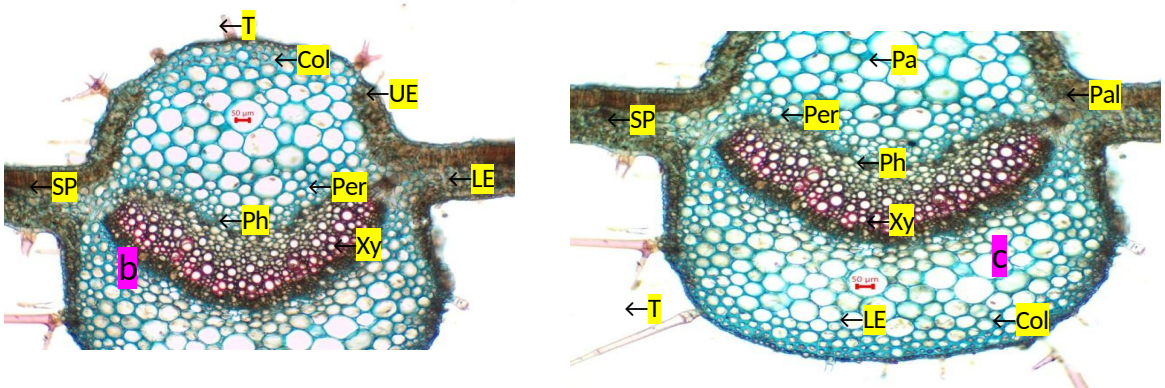


Plate-5

a) T.S. of Solanum Pubescens leaf

Midrib

T.S of midrib shows single layered upper and lower epidermis covered with cuticle and bears glandular and non-glandular trichomes like stellate and multicellular covering trichomes; 2 to 3 layered collenchymatous hypodermis can be seen followed by parenchymatous ground tissue embedded with arc shaped conjoint, collateral vascular bundle at the Centre; xylem and phloem are formed of normal vascular elements; small patches of pericyclic fibers surround the vascular bundle **(Plate – 5b).**



b) Midrib portion enlarged view

Lamina

T.S of lamina shows single layered upper and lower epidermis covered with cuticle and bears stellate and multicellular covering trichomes; mesophyll tissue is differentiated into upper single row of compactly arranged palisade cells followed by 3 to 4 rows of loosely arranged spongy parenchyma cells; some veins can be seen traversing through the mesophyll tissue (Plate - 6).

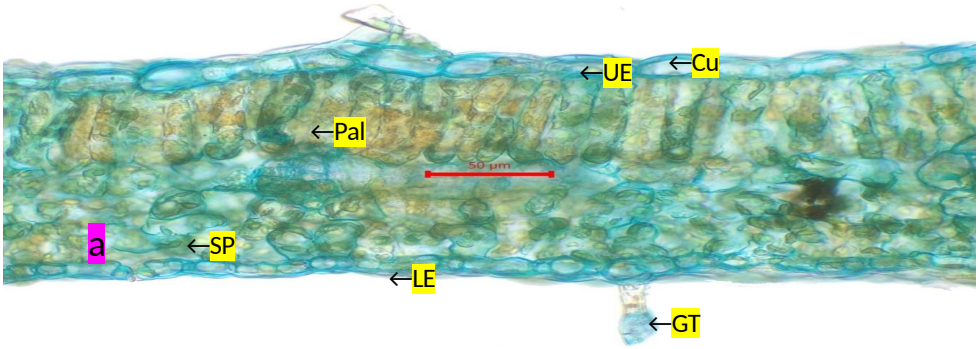


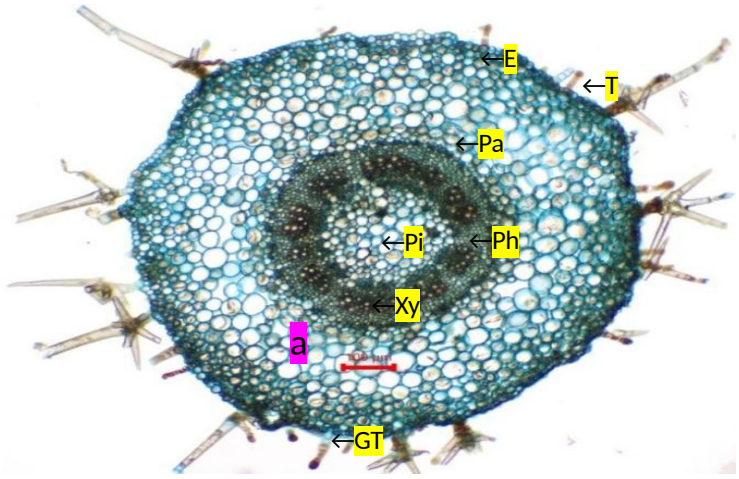
Plate-6 a) T.S. of lamina

Cu - cuticle; **Col** - collenchyma; **GT** - glandular trichome; **LE** - lower epidermis; **Pa** - parenchyma; **Pal** - palisade cells; **Per** - pericycle; **Ph** - phloem; **SP** - spongy parenchyma; **T** - trichome; **UE** - upper epidermis; **Xy** – xylem

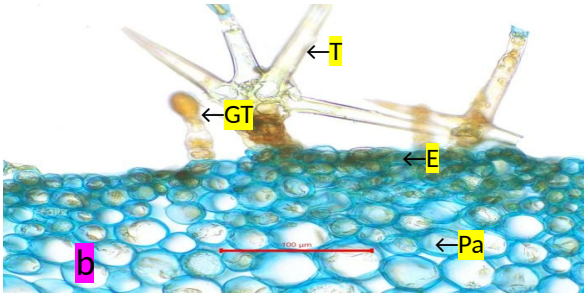
Pedicel

T.S of pedicel is round shaped with wavy outline; outer layer is single layered epidermis covered by cuticle and bears numerous stellate trichomes and glandular trichomes; cortex is parenchymatous with intercellular spaces; inner cortex consists of small ring of conjoint, collateral vascular bundle; small parenchymatous pith is present at the center (plate-7)

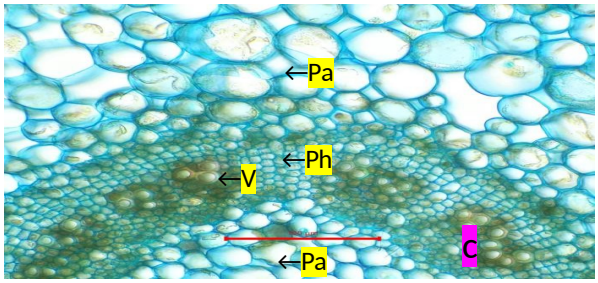
Plate- 7



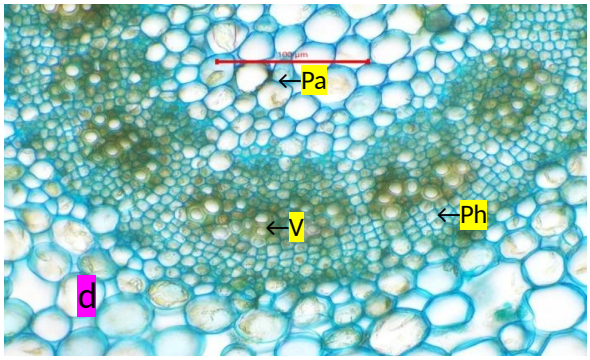
a) T.S. of solanum pubescens pedicel



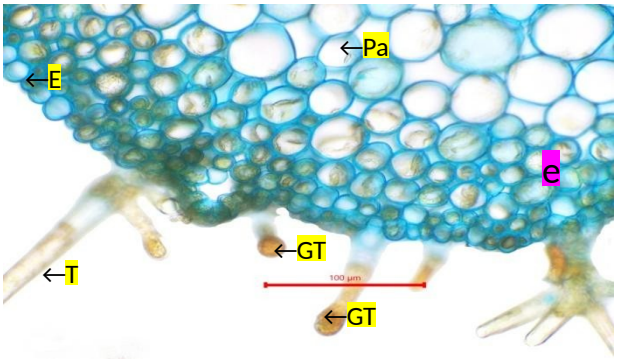
b) Upper portion enlarged



c) Middle region enlarged view



d) Middle region enlarged view



e) Lower portion enlarged view

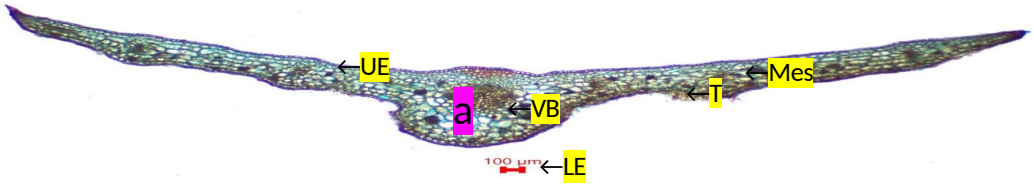
E - epidermis; GT - glandular trichome; Pa - parenchyma; Ph - phloem; Pi - pith; T - trichome; V - vessel; Xy - xylem

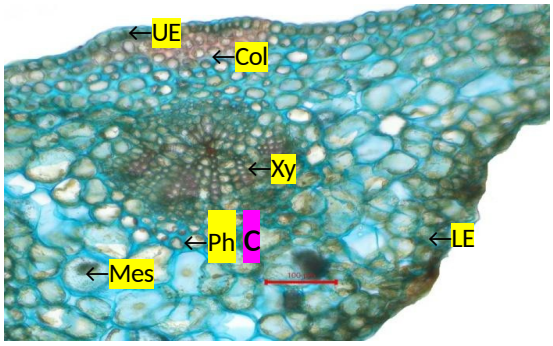
Calyx

T.S of calyx shows lower convex surfaced midrib and slightly elevated upper surface with lateral laminar extensions; outer layers are single layered upper and lower epidermis covered by cuticle and bears few covering trichomes; 2 to 3 layers of collenchyma cells are found below the epidermis in the midrib region followed by parenchymatous ground tissue embedded with central vascular bundle; in the lateral extension, 5 to 6 layers of mesophyll tissue is present in between the epidermis; small veins can be seen traversing through the mesophyll cells (Plate - 8)

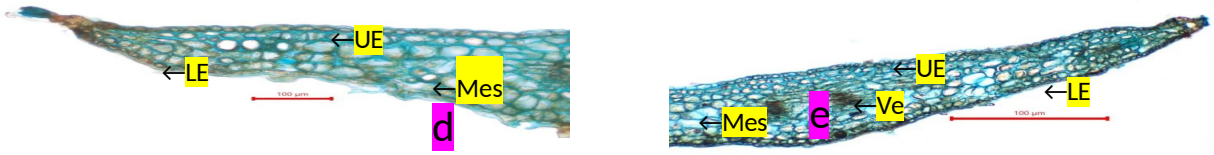
Plate - 8

a) T.S. of *Solanum pubescens* calyx





b) Enlarged view



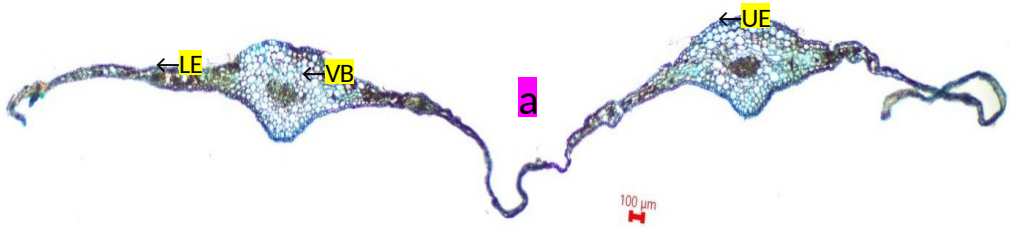
d) calyx margin

Cu - cuticle; **Col** - collenchyma; **LE** - lower epidermis; **Mes** - mesophyll cells; **Pa** - parenchyma; **Ph** - phloem; **T** - trichome; **UE** - upper epidermis; **VB** - vascular bundle; **Ve** - vein; **X y** - xylem

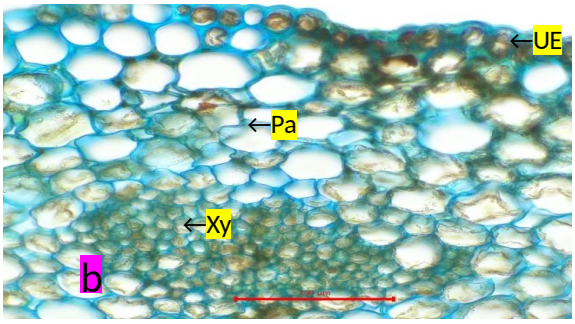
Corolla

T.S of corolla shows slightly convex upper and lower midrib surface with lateral laminar extensions; outer layers are single layered upper and lower epidermis covered by cuticle and bears few multi-cellular covering trichomes; 1 to 2 layers of collenchyma cells are found below the epidermis in the midrib region followed by parenchymatous ground tissue embedded with central vascular bundle; in the lateral extension, 4 to 5 layers of mesophyll tissue is present in between the epidermis; small veins can be seen traversing through the mesophyll cells (Plate – 9)

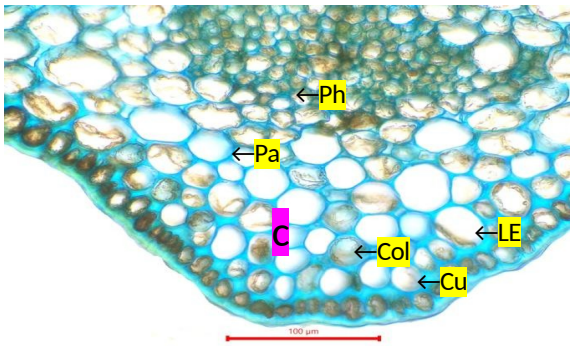
Plate – 9



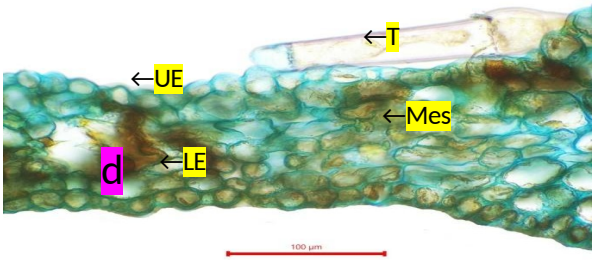
a) T.S. of *Solanum pubescens* corolla

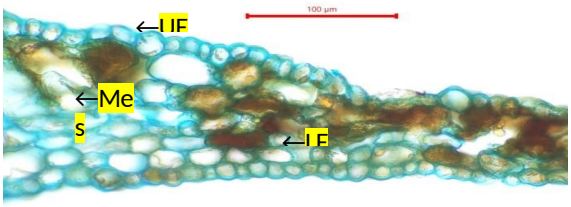


b) Upper portion enlarged



c) Lower portion enlarged





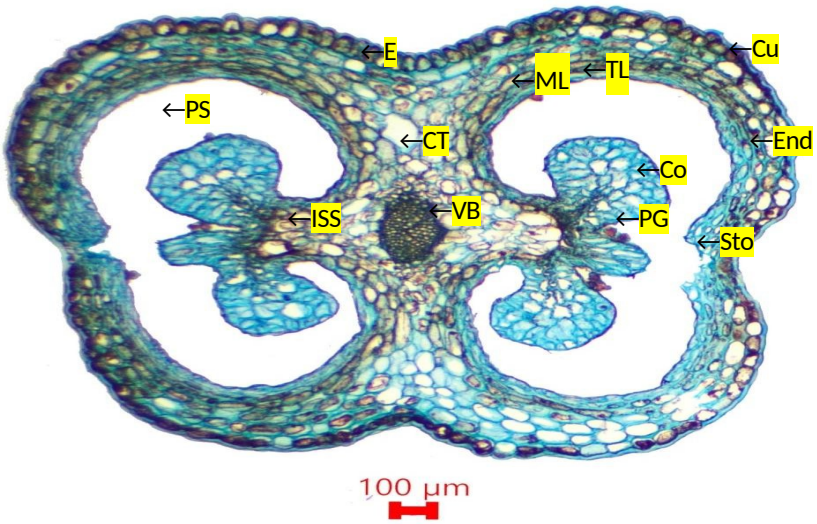
d) Enlarged view of lateral extension

Cu - cuticle; **Col** - collenchyma; **LE** - lower epidermis; **Mes** - mesophyll cells; **Pa** - parenchyma; **Ph**- phloem**; T** - trichome; **UE** - upper epidermis; **VB** - vascular bundle; **X y** –xylem

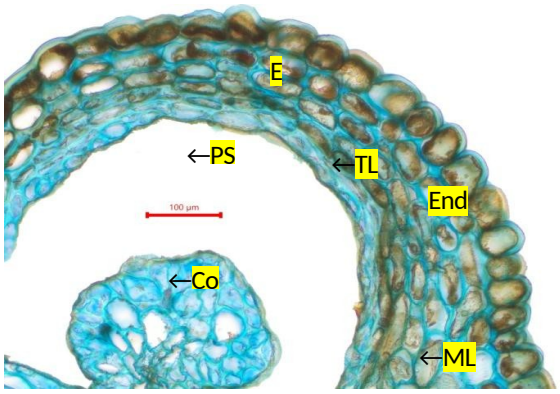
Anther

T.S of anther is bilobed and tetra-sporangiate; outer most layer of anther is single layered epidermis followed by inner layer of hypodermal cells called endothecium; 2 to 3 layers of thin walled cells called middle layers in continuous with the inner most single layer of anther wall called tapetal layer; the group of non-sporangial tissue formed of thick walled parenchymatous cells forms the connective tissue which connects the two lobes of anther; single vascular strand is present at the center of connective tissue; the connective tissue is extended into each of the paired hollow anther locules as a ridge extending along their full length to form a structure called columella; two microsporangia in each lobe are separated by sterile tissue called the inter-sporangial septum; pollen grains are found dehisced as the anther is matured leaving the locule of pollen sac (theca); pollen grains are released through a small pore or slit formed by splitting stomium layer (a cluster of cells in the groove of each anther lobe that marks the line of dehiscence) (Plate – 10 & 11)

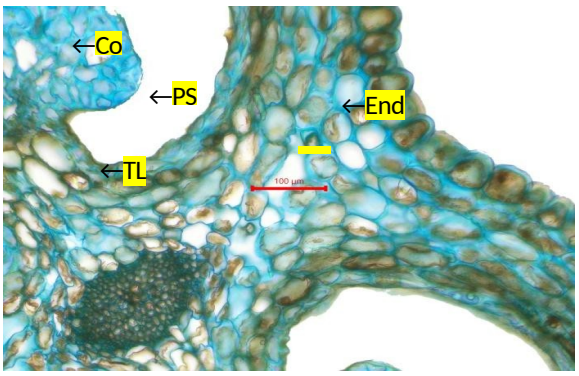
Plate -10



a) T.S. of *Solanum pubescens* anther

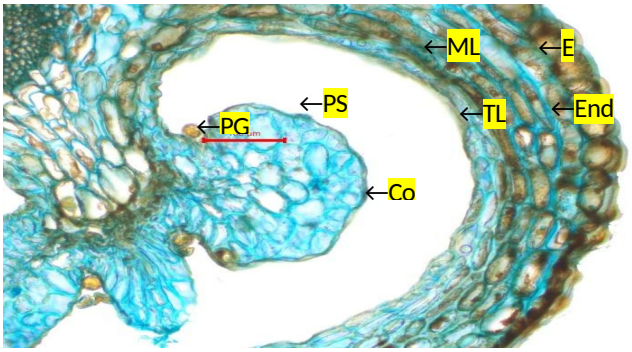


b) Enlarged view of sporangial sac



a) Enlarged view of connective tissue

Plate - 11



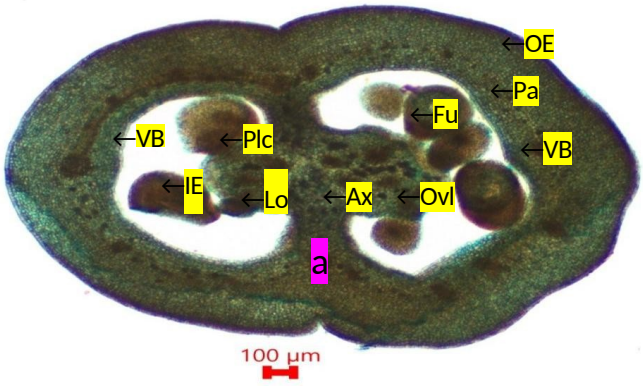
b) Enlarged view of pollen sac

Co - columella; **CT** - connective tissue; **E** - epidermis; **End** - endothecium; **ISS** - inter sporangial septum; **ML** - middle layer; **PG** - pollen grain; **PS** - pollen sac; **Sto** - stomium; **TL** - tapetal layer; **VB** - vascular bundle

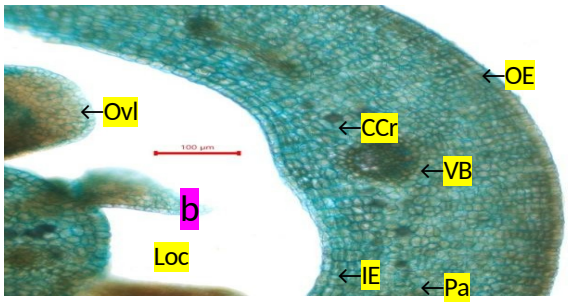
Ovary

T.S of ovary is nearly circular in outline; it is a superior, bi-locular ovary and each locule contains many ovules on axile placentation; it shows single layered rectangular cells of outer and inner epidermis covered with thin cuticle, enclosing 15 to 20 layers of parenchymatous mesophyll in between; mesophyll cells are made up of polygonal thin-walled parenchyma with small intercellular spaces; several small vascular bundles can be seen traversing through the mesophyll tissue; cluster crystals are found scattered in the parenchyma cells; a central axis made up of parenchyma cells separate each locule and bears a swollen placenta to the locules; ovules are attached to the placenta by a stalk like structure called funiculus; central axis also contains cluster crystals (Plate -12)

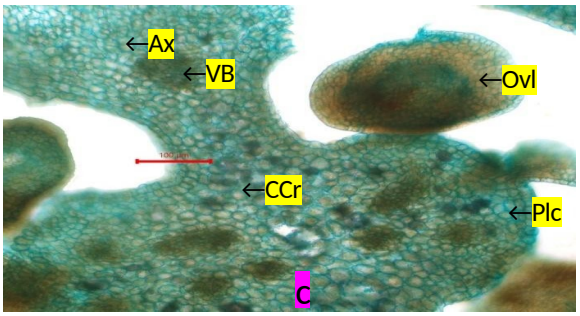
Plate - 12



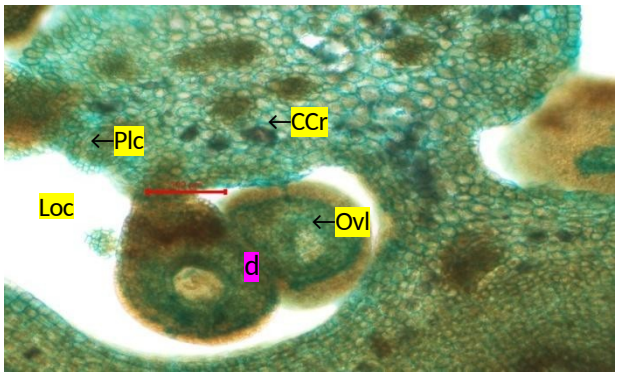
a) T.S. of *Solanum pubescens* ovary



b) Enlarged vie of ovary wall



c) Enlarged view of placenta ovule



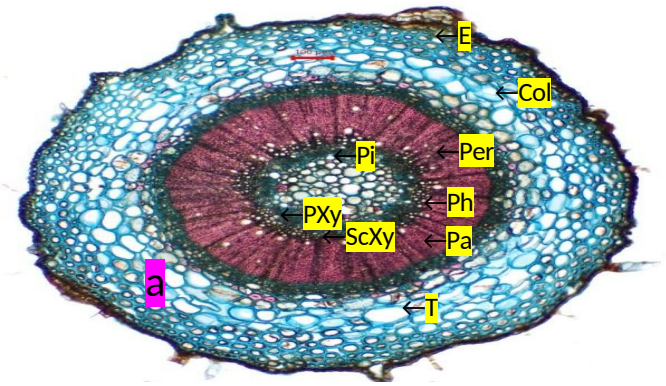
d) Enlarged view of placenta and ovule

Ax – axis; CCr – cluster crystal; Fu – funiculus; IE – inner epidermis; Loc – locule; Pa – parenchyma; Plc – placenta; OE – outer epidermis; Ovl – ovule; VB – vascular bund

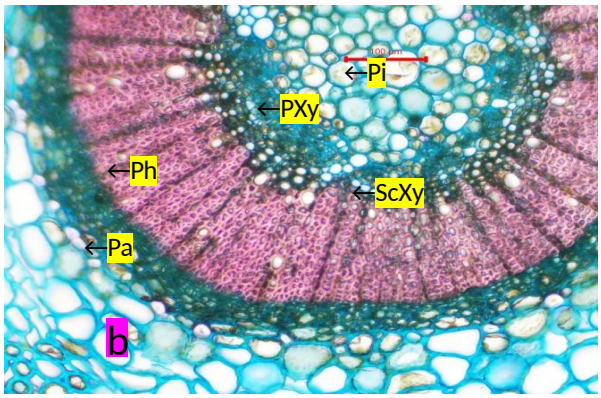
Peduncle

T.S of peduncle is circular shaped with a wavy outline; outer layer is single layered epidermis covered by cuticle and bears covering trichomes; 3 to 4 layers of collenchymatous hypodermis is present followed by 4 to 5 layers of parenchymatous cortex; a ring of vascular bundles can be seen in the inner cortex surrounded by continuous 2to 3 layer of pericyclic fibers followed by narrow band of phloem; a developing secondary xylem region is present followed by primary xylem elements; xylem and phloem is formed of normal vascular elements; parenchymatous pith is present at the center (Plate -13)

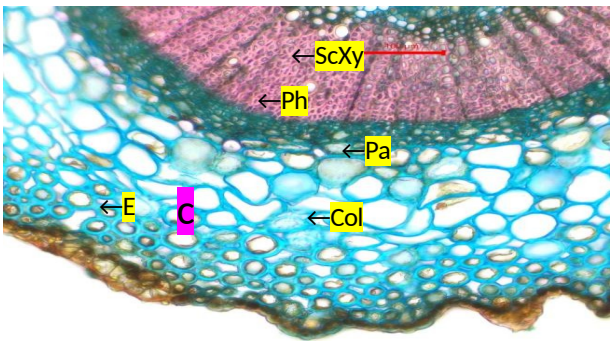
Plate – 13



T.S. of *Solanum pubescens* peduncle



Enlarged view of vascular region



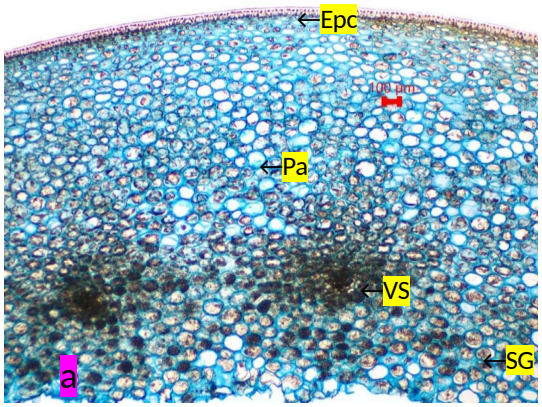
Lower region enlarged

Col - collenchyma; **E** - epidermis; **Pa** - parenchyma; **Per** - pericycle; **Ph** - phloem; **Pi** - pith; **Pxy** - primary xylem; **ScXy** - secondary xylem; **T** - trichome

Pericarp

T.S of pericarp shows outer 1 to 2 layers of thick walled epicarp cells with prismatic crystals, followed by broad mesocarp region formed of 30 to 34 rows of round shaped parenchymatous cells; plenty of starch grains are found inside the parenchyma cells; small vascular strands can be seen traversing through the mesocarp region (Plate -14)

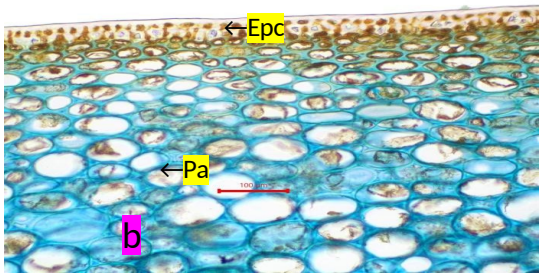
Plate -14



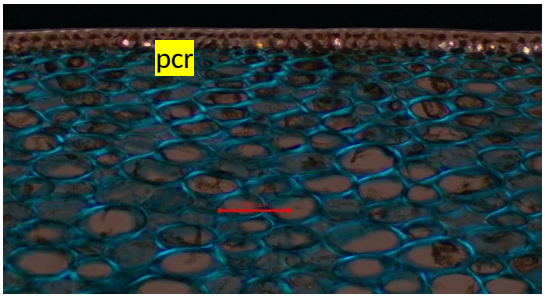
Epicarp

Mesocarp

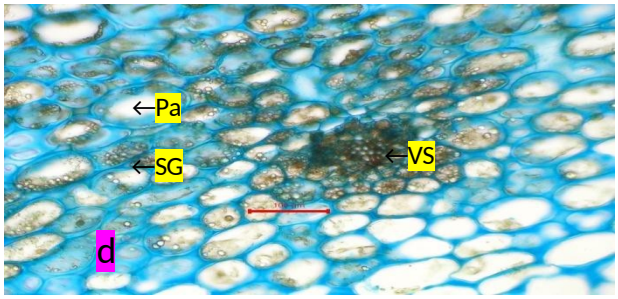
T.S. of *Solanum pubescens* pericarp



Enlarged view



T.S. of pericarp under polarized region



Enlarged view of mesocarp region

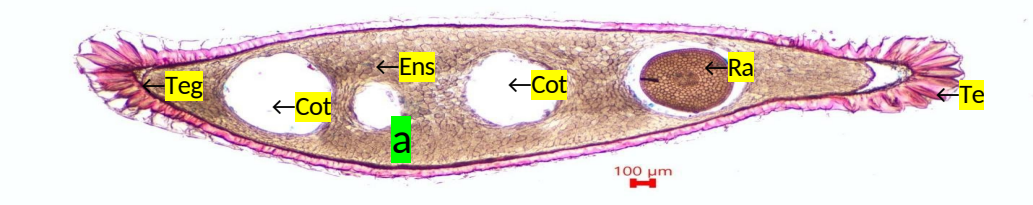
Epc - epicarp; **Pa** - parenchyma; **SG** - starch grain; **VS** - vascular strand

Seed

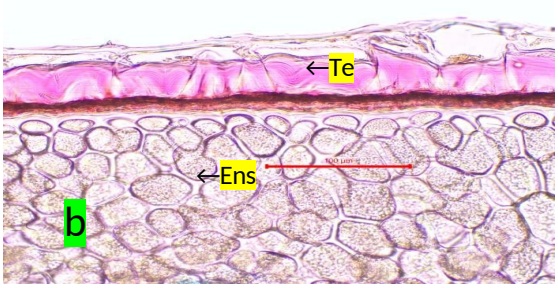
T.S of seed shows outer testa and inner endosperm region embedded with radicle and cotyledons; testa is formed of outer single layered epidermal layer covered by cuticle and followed by palisade like layer of testa in continuation with the inner most crushed layer called tegmen; endosperm consists of thick walled polygonal cells filled with aleurone grains; cotyledon is observed along the middle length of the seed and radicle on the other end; TS of cotyledon shows bean shaped in outline with single layered outer epidermis enclosing the mesophyll tissue; mesophyll tissue differentiated into upper single layered palisade cell followed by 4 to 5 compactly arranged spongy parenchyma cells embedded with a central vascular bundle; TS of radicle shows circular in outline with outer single layered epidermis, middle 8 to 10 layers

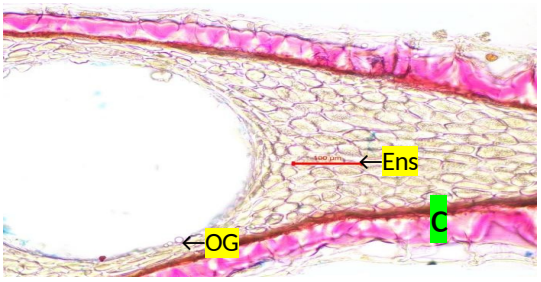
of parenchymatous cortex and center pith region made up of parenchyma cells; both radicle and cotyledon contains starch grains and oil globules. (Plate – 15 & 16)

Plate – 15

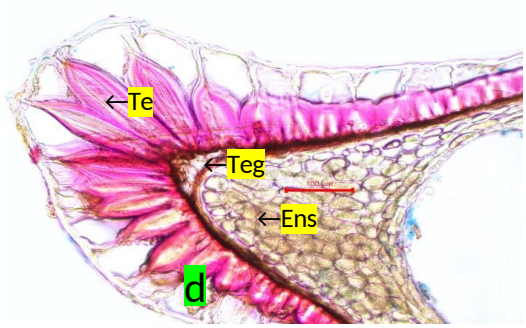


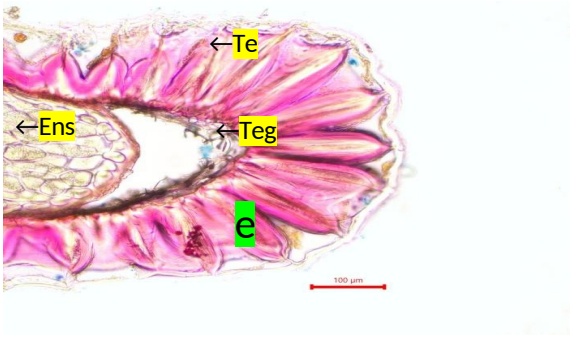
a) T.S. of *Solanum pubescens* seed





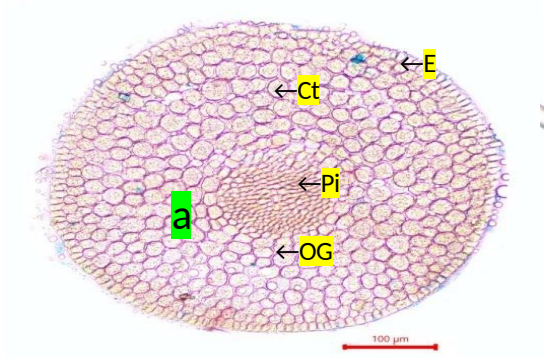
b) Outer portion enlarged **c) Middle portion enlarged**

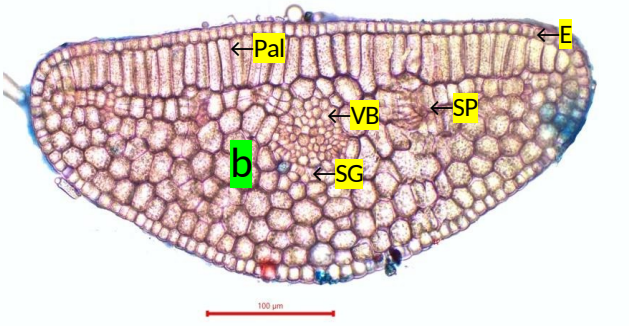




d) Enlarged view of lateral side

Plate -16





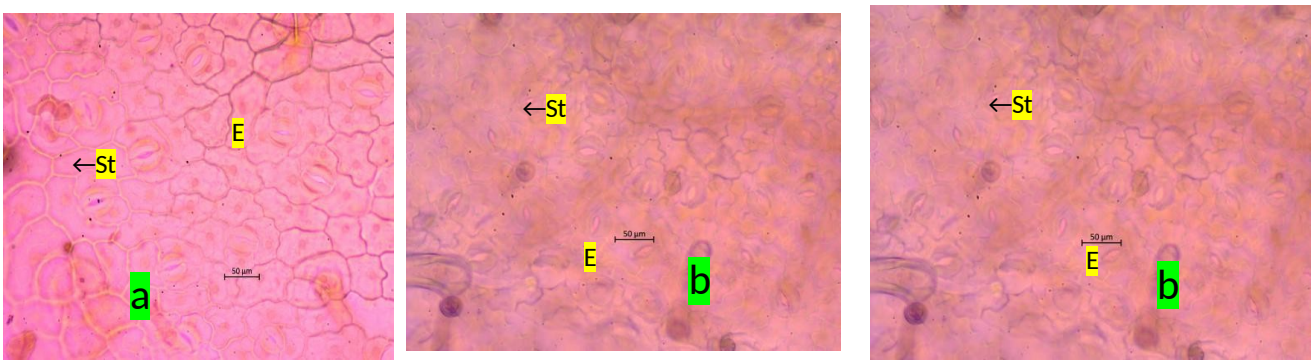
T.S. of radicle **T.S. of cotyledon**

Ct - cortex; **E** - epidermis; **Ens** - endosperm; **OG** - oil globule; **Pal** - palisade; **Pi** - pith; **SG** - starch grain; **SP** - spongy parenchyma; **Te** - testa; **Teg** - tegmen; **VB** - vascular bundle

Quantitative microscopy

The quantitative parameters obtained during microscopic observation of epidermal peelings of leaf were recorded in **Table 2**. The leaf is amphistomatic with anisocytic and anomocytic stomata (Plate-17 a-c)

Plate – 17



Upper epidermis **Lower epidermis** **Vein Islets and Terminations**

E - Epidermis; **St** - Stomata; **VI** - Vein Islet; **VT** - Vein Termination

Table 2. Quantitative microscopy of *Solanum pubescens* leaf

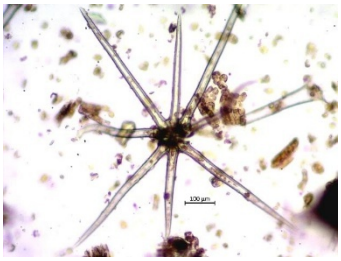
Parameters	Upper epidermis (/mm^2)	Lower epidermis (/mm^2)
Epidermal number	425 – 450	600 – 650
Stomatal number	75 – 80	150 – 160
Stomatal index	15	19.8 – 20
Palisade ratio	3 – 5	
Vein islets number	15 – 20	
Vein termination number	50 – 60	

Powder Microscopy

The powder is pale green colored with no characteristic odour and, slightly bitter taste; shows the characters like glandular trichomes from leaf and, pedicel, simple unicellular and armed covering trichomes from flower, foliar epidermis in surface view, epidermal cells from flower and stem, sectional view of palisade cells, epicarp cells from fruit, testa in surface view, fragment of endosperm cells with starch grains, vessels with spiral and, bordered pitted thickening, prismatic crystals, oil globules and, starch grains (Plate-18 -20)

Plate -18

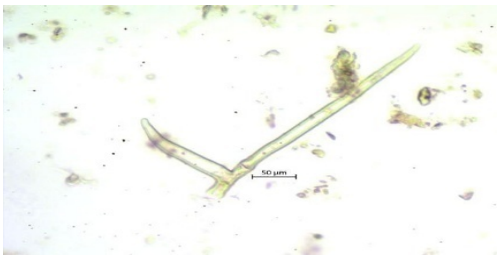
Powder microscopy of *Solanum pubescens* aerial parts



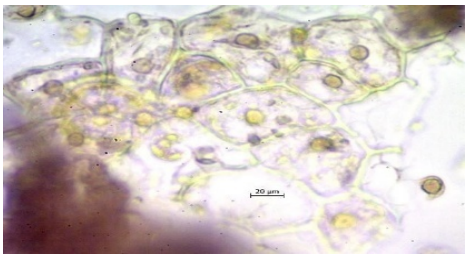
a) Stellate trichome

b) Unicellular covering trichome

c) Glandular trichomes



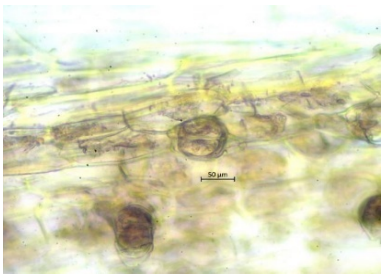
d) Branched trichome from flower



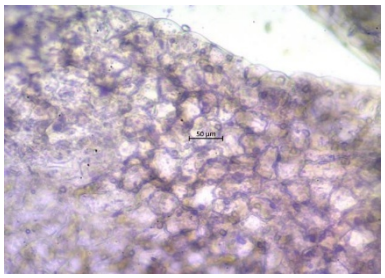
e) Surface view of foliar epidermis

Plate- 19

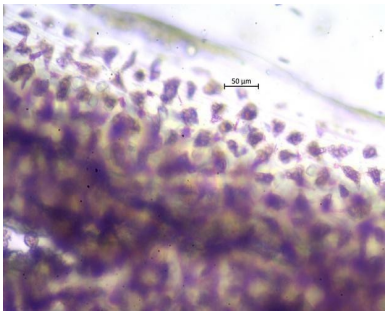
Powder microscopy of *Solanum pubescens* aerial parts



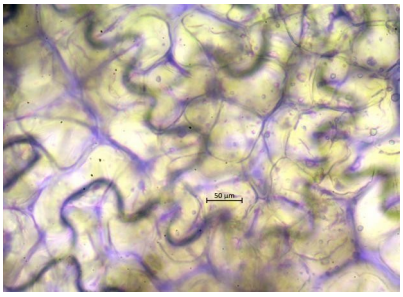
a) Stem epidermis



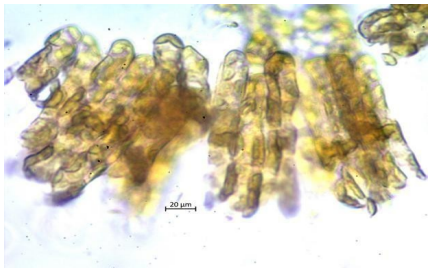
b) Epidermis tissue flower



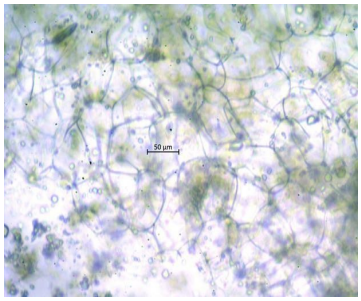
c) Epicarp of fruit



d) Testa of seed in surface view



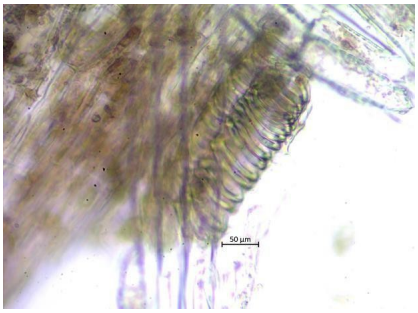
e) Palisade cells



c) Endosperm cells loaded with starch

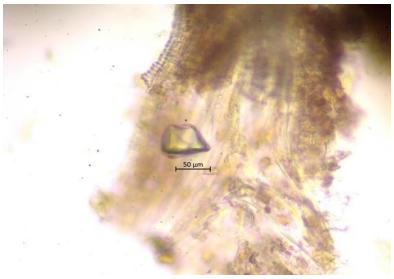
Plate- 20

Powder microscopy of *Solanum pubescens* aerial parts

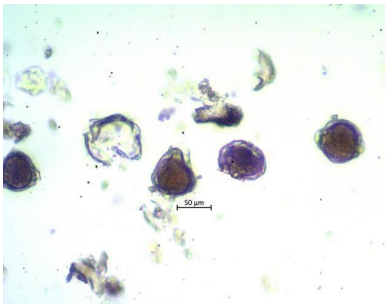


a) Spiral vessel

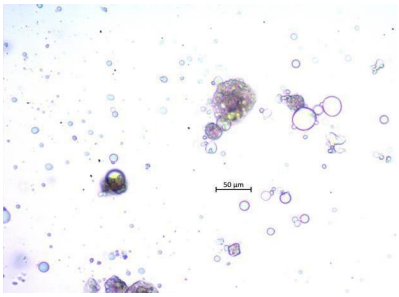
b) Bordered pitted vessel



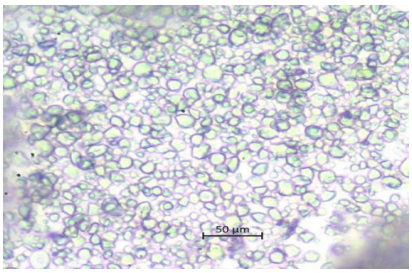
c) Crystal



d) Pollen grains



e) Oil globules



f) Starch grains

Discussion

Pharmacognosy offers a reliable and, systematic approach to obtaining detailed information about crude drugs, including their identification, composition, and, quality [18-20]. Pharmacognostic studies facilitate the correct genuine plant materials, ensuring their quality, efficacy, and safety, and, contribute to the gradual standardization of herbal drug evaluation [21-22]. Subsequently, current years have seen a significant rise in the standardization of various medicinal herbs documented for their therapeutic potential. For this, plant anatomy has traditionally been regarded as a dependable method for the accurate identification of fragmented plant materials [23-24]. In the present study, a wide-ranging examination of the anatomical features of *Solanum pubescens* was conducted to facilitate scientific standardization.

The transfer section of the leaf shows a convex shaped upper and, lower surface with lateral laminar extensions. Anatomical features of the leaf agree with the report [25]. Small hair-like structures on the surface of leaves play a most noteworthy role in both water control and, defense mechanisms in plants [26]. Non glandular trichomes provide a physical barrier that restricts insect movement and, feeding, thereby contributing to plant defense [27]. Glandular trichomes possess head structures that store a diverse range of compounds, including terpenes, flavonoids, alkaloids, acyl-sugars, and, defense related proteins[28] that provide protection against herbivores and, pathogens [29]. The occurrence of glandular trichomes is a prominent character of genus *Solanum* [30]. But in the current

study, the transfer section of midrib showed sole layered upper and lower epidermis enclosed with cuticle and, bears glandular and, nonglandular trichomes like stellate and, multicellular covering trichomes (Plate – 5b).

Stomatal characteristics serve as important distinguishing features within the Solanaceae family [31-32]. Amphistomatic leaves and, the presence of anisocytic and, anomocytic stomata are common in Solanaceae [33]. In the present study leaf is also having amphistomatic with anisocytic and, anomocytic stomata (Plate - 17), this also agrees with [34] who refer that the stomata of these species are anomocytic to anisocytic, somewhat larger in *S. nigrum*, which can be explained by its polyploidy. The distribution, stomatal size and stomatal index are used to species delimitation as it is initiate to be constant for certain species [35]. A centrally located, arc-shaped vascular bundle that is conjoint and collateral in nature. The xylem and phloem show normal differentiation, and the vascular bundle is partially surrounded by small patches of pericyclic fibers, adding further structural strength (Plate-5b). The results agree with reported [36]. Seith and Anderson. The presence of sandy crystals and, the bicollateral vascular bundles were reported in various other *Solanum* species [37]. But in this study the prismatic crystals are found in powder microscopy (Plate18-19). Often containing prismatic crystals in T.S of the pericarp (Plate-14). Cluster crystals are also found within the central axis of the ovaries (Plate-12). These can be solving taxonomic problems [38-39]. The T.S of stem shows a ring of 15 to 16 conjoint, collateral, and closed vascular bundles. These bundles are encircled by discontinuous patches of pericyclic fibers. The result agrees with, intra xylary phloem in family Solanaceae [37]. The has been found in *S. pseudocapsicum*. In mature stems the marginal pith cells acquired meristematic character and, differentiate into internal cambium during secondary growth [40] (Plate-3b-4). Presence of cambium for the first time in the Solanaceae [41], but in the T.S stem, phloem is facing towards outside and, xylem elements towards inner side; vascular bundles are formed of normal vascular elements; central pith is wide and parenchymatous filled with some cell contents (Plate-2-3a).

. In present observation shows outer 1 to 2 layers of thick-walled epicarp cells with prismatic crystals followed by broad mesocarp region formed of 30-34 rows of round shaped parenchymatous cells; plenty of starch grains are found inside the parenchyma cells; small vascular strands can be seen traversing through the mesocarp region (Plate-14). The hypodermal cells are usually concerned with mechanical support and, sometimes the dehiscence mechanism [42&43]. The seed coat of *Capsicum annuum, Datura fastuosa S. melongena, S. nigrum, S. surattense* and, *Withania somnifera* is built on a common pattern. Likewise, the transfer section of seed shows the outer testa and, inner endosperm region embedded with radicles and, cotyledons (Plate-15). The structure of the seed coat broadly resembles the account reported by earlier workers [45-47], but differ in minor details [48].

The detailed characterization is given here to enhances our understanding of *Solanum pubescence scientifically*, which emphasizing its common characters with other species in the genus and, supporting precise taxonomic identification.

Conclusion

This study offers an in-depth anatomical examination of *Solanum pubescence*, uncovering its defining structural features. Morphoanatomical structural studies on *Solanum pubescence* are very urgent to present scientific situation in modern medicine.

Acknowledgement

Authors thank, Siddha Central Research Institute (CCRS), Anna Govt. Hospital Campus, Arumbakkam, Chennai-600 106, Tamil Nadu, India. For their appreciated assistance, supervision to carry out this work.

Conflict of interest

The authors declare that there is no conflict of interest.

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