

## Chapter 11

**Medicinal plants of the Myrtaceae: *Psidium* (1), *Pimenta* (1)  
and *Syzygium* (1)**

1. *Psidium guajava* Linn.

**English name:** Guava

**Hindi-**Amrud, Safed Safari; **Beng.-** Goaachhi, Peyara, Piyara; **Mar.-** Jamba, Tupkel;

**Guj.-** Jamrud, Jamrukh, Peru; **Tel.-** Ettajama, Goyya, Tellajama; **Tam.-** Koyya;

**Kan. -** Sebe Hannu, Jamaphala; **Mal. -** Pera, Koyya

**Distribution:** It is a native of tropical America, probably from Mexico to Peru. Found cultivated in India at many parts such as Andhra Pradesh, Assam, Bihar, Madras, Maharashtra, Gujarat, Uttar Pradesh and West Bengal.

*P. guajava* is a small tree upto 8 m high. Leaves are of 3-4 in. long; light green and pubescent on very short petioles. They are ovate or oblong with acuminate apex. Peduncles are axillary with one to three flowers which are white and fragrant. Fruits are green to light yellow, but in some varieties, red, which vary in size and shape and are globose or pear shaped.

Of the many varieties distinguished on the basis of color of the fruit flesh, two which are available in Baroda: - 1) Allahabad Safeda type (white fleshed) and 2) red fleshed type are taken for the present study.

**Parts used** – Leaves, bark, flowers and fruits.

**Medicinal Uses:-**

Guava leaves are used for wounds, ulcers and as an astringent for bowels. Young leaves are used as a tonic in the diseases of the digestive functions. Decoction of leaves has been used in cholera, arrest vomiting and diarrhoea. An infusion of the leaves and roots is a popular astringent drink in Ghana. A decoction of the young leaves and shoots

is prescribed in febrifuge and antispasmodic baths. Infusion of leaves is used in cerebral affections, nephritis and cohexia. Pounded leaves are locally applied in rheumatism and an extract is used in epilepsy. Tincture is rubbed over the spine of children suffering from convulsions. A decoction of leaves when gargled relieves toothache and gum boils. **Bark** is valued for its astringent properties and has been employed in diarrhoea in children. It is gradually administered in the form of a decoction. **Flowers** cool the body and are used in bronchitis. They are also applied to eye sores. The **fruit** is tonic, cooling and laxative, good in colic and for bleeding gums. It is astringent and used in diarrhoea and dysentery (Anon., 1999).

#### **Previous phytochemical reports:-**

Most of the data available pertain to the fruit. Fruit pectin consisted of d-galacturonic acid, d-galactose & l-arabinose. It was poor in carotenoid pigments. **Pulp** of Allahabad Safeda type (white -fleshed) contained  $\beta$ -carotene, lycopene and very little  $\beta$ -carotene. Pink -fleshed type was generally considered to be a better source of  $\beta$ -carotene. Leucocyanidin & ellagic acid were the polyphenolic compounds identified in ripe fruit. The red skin of apple guava contained a cyanidin diglucoside (probably mecocyanin). Quercetin, its 3- arabopyranoside, guaijaverin, gallic acid & arabinose ester of ellagic acid, besides leucocyanidin have been isolated from the unripe fruit. It is the richest source of Vitamin C and citric acid. **Leaves** contained catechol & pyrogallol types of tannins.  $\beta$ -Sitosterol, quercetin and its arabinosides, guaijaverin & avicularin, a mixture of triterpenoid acids, viz. ursolic, oleanolic, cratagolic and guaijavolic, leucocyanidin, a new tripterene sapogenin & ellagic acid had been isolated from leaves. **Bark** contained tannins, leucocyanidin, luteic acid, ellagic acid & amritoside have been isolated. (Anon., 1999)

#### **Previous pharmacognostic studies:**

No information on pharmacognosy on the medicinal parts of this plant is available.

In the **present work**, the parts of both white fleshed variety and red fleshed variety have been analysed for flavonoids, phenolic acids, pro-anthocyanidins, quinones,

alkaloids etc. Pharmacognostic studies have been done on leaf and stem of the white fleshed fruit variety as well as the red fleshed fruit variety. Sections of both parts of both the varieties were similar, so only the sections of white fleshed fruit variety have been presented here.

### Materials and Methods:

Materials of both the varieties of *Psidium guajava* were collected from Baroda. The voucher specimens of the plants have been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO), Vadodara. Standard methods, presented in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals. Pharmacognostical studies were done by standard methods given in chapter 2.

### Results:-

#### Phytochemistry:-

- a) **Red variety:** Leaves contained flavonoids like quercetin; 3', 4' -diOMe quercetin and myricetin. Vanillic, syringic and gallic acids were the phenolic acids present. Presence of quinones and steroids were seen. The stem contained flavonoids like gossypetin, 3'-OMe gossypetin, 4'-OMe gossypetin and 3', 4' -diOMe gossypetin. Phenolic acids were similar to the leaves. Quinones and steroids were also present. Glycoflavones were absent in both parts of the plant.

Phytochemical markers (leaf) – Myricetin, quercetin, gallic acid

Phytochemical markers (stem) – Gossypetin, 4'-OMe gossypetin and 3', 4' - di  
OMe gossypetin

- b) **White variety:** Leaves consisted of flavonoids like quercetin, 3'-OMe quercetin and myricetin. Vanillic, syringic, gallic, melilotic and ferulic acids were the phenolic acids obtained. Quinones and steroids were observed. Stem contained 3'-OMe quercetin, 3', 4' -diOMe quercetin and gossypetin. Phenolic acids were same as that of the leaves except for ferulic acid. Quinones and steroids were present in both

parts. Absence of glycoflavones was seen in both.

Phytochemical markers (leaves) - Myricetin, quercetin, gallic and ferulic acids

Phytochemical markers (stem) - Quinones and quercetin derivatives

### **Pharmacognosy of leaf:**

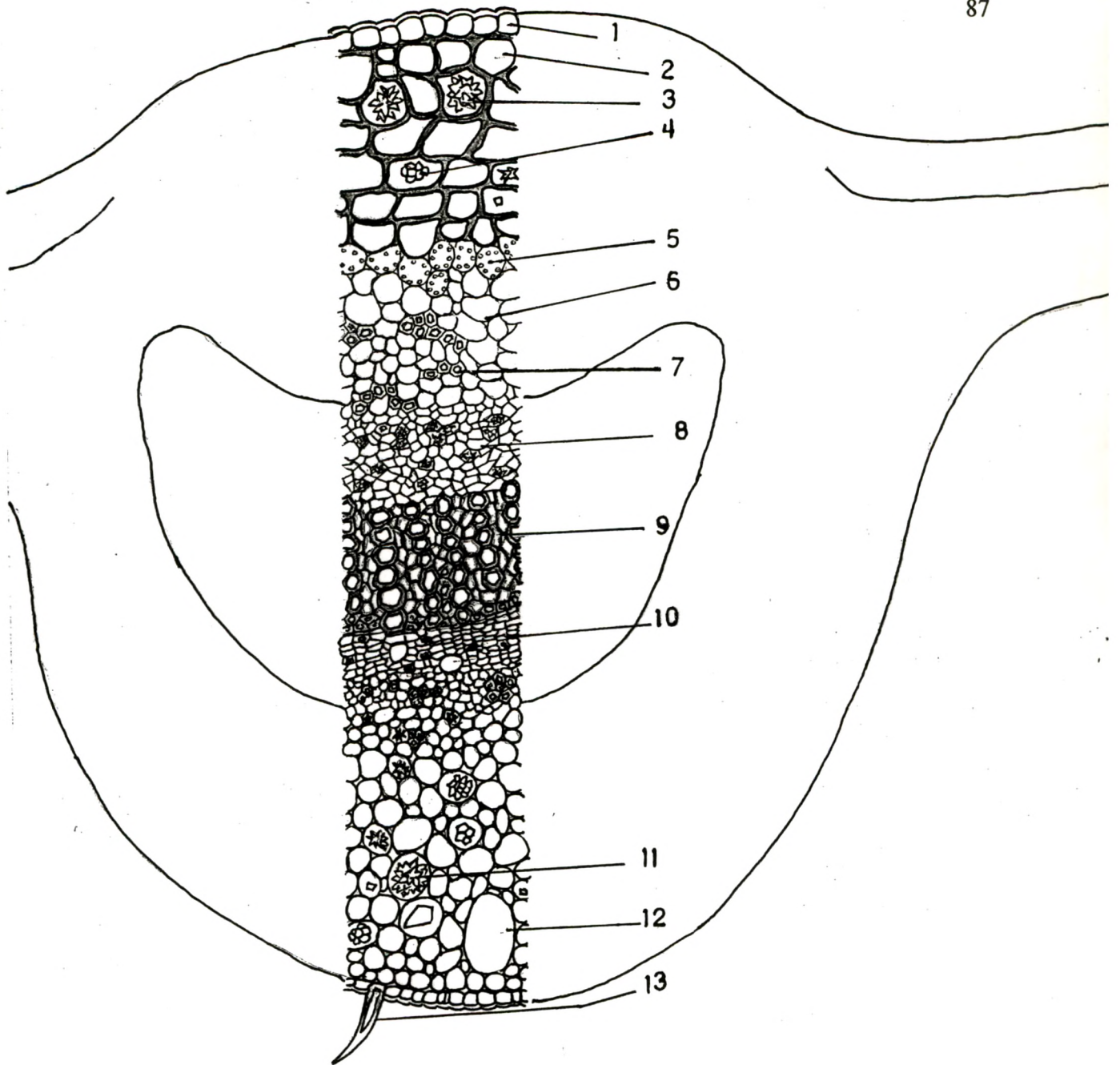
#### **Leaf micromorphology**

Stomata were anomocytic found only on lower epidermis. Stomatal index was 34-36. Trichome index for unicellular and multicellular uniseriate trichomes were 1-3 and 2-4 respectively in the upper epidermis.

#### **Leaf -T.S. (Fig. 2)**

Leaf was isobilateral. Midrib was slightly ridged on the upper portion. In the midrib region, cells of upper epidermis were single layered with rectangular (7 x 10 $\mu$ m) or barrel shaped cells covered by a thin cuticle. Hypodermis was composed of five to six layers of lacunar collenchyma of square to oval shaped (14-65 x 10-48 $\mu$ m). Sphaeraphides and starch grains (4-7 $\mu$ m) were seen in some of these cells. Below the hypodermis were one to two layered isodiametric chlorenchyma (14-24 $\mu$ m) containing eight to ten small chloroplasts. Ground tissue was of seven to eight layers of parenchyma cells (10-34 $\mu$ m). Vascular bundle was crescent shaped. Endodermis was not clearly distinct. Pericycle composed of patches of sclerenchyma (3-17 x 3-14 $\mu$ m) was seen surrounding the vascular bundle. Inner phloem elements (7-17 x 7-14 $\mu$ m) were more than those of outer phloem. Inner phloem cells were in nine to ten layers containing sphaeraphides in almost every cell. In xylem, tracheids (2-12 $\mu$ m) of hexagonal shape were observed in radial rows. Xylem rays (7-14 x 4-14 $\mu$ m) were seen in between the tracheids. The ground tissue below vascular bundle was of 10-14 layers of parenchyma cells containing sphaeraphides (17-31 $\mu$ m) and/or angular/rhomboidal crystals (15-20 $\mu$ m). Resin canals (51-95 x 51-65 $\mu$ m) also were seen in this region. Cells of lower epidermis (7-20 x 7-18 $\mu$ m) were smaller in size than those of upper epidermis. Unicellular trichomes (100-214 x 6-21 $\mu$ m) were seen in the lower epidermis.

In lamina portion (Fig. 3a), cells of both epidermises were similar to those of the midrib. A hypodermis of three to four layers of lacunar collenchyma were seen which



**Fig. 2** *Psidium guajava* Leaf, Midrib -T.S.: 1. Epidermis, 2. Lacunar collenchyma, 3. Sphaeraphide, 4. Starch grains, 5. Chlorenchyma, 6. Parenchyma, 7. Fibers, 8. Intraxylary Phloem, 9. Xylem, 10. Phloem, 11. Crystal, 12. Resin canal, 13. Unicellular trichome

contained lumps of starch grains as well as sphaeraphides. Mesophyll consisted of four to five layers of palisade cells (14-34 x 10-20 $\mu$ m) in which 10-12 small chloroplasts were seen. Spongy cells were absent. Some of these cells showed presence of sphaeraphides. A number of resin ducts also were seen in this region. Unicellular as well multicellular uniseriate trichomes (110-215 x 5-20 $\mu$ m) were seen in the upper epidermis.

#### **Powder study (Fig. 3b)**

The powder showed the presence of two types of trichomes – unicellular (100-214 x 6-21 $\mu$ m) as well as multicellular uniseriate (110-215 x 5-20 $\mu$ m). Stomata of anomocytic type alongwith lower epidermal cells, lacunar collenchyma cells (14-65 x 10-48 $\mu$ m) containing sphaeraphides (17-31 $\mu$ m), upper epidermal cells, parenchyma cells with starch grains (4-7 $\mu$ m), fibers, crystals (15-20 $\mu$ m), sphaeraphides, mesophyll cells (14-34 x 10-20 $\mu$ m) and resin canals (51-95 x 51-65 $\mu$ m) with parenchyma cells were observed.

**Pharmacognostic markers:** Resin canals in ground tissue

- : Rhomboidal or prismatic crystals.
- : Unicellular trichomes / uniseriate multicellular trichomes
- : Hypodermis of lacunar collenchyma
- : 4 – 5 layers of palisade
- : Scanty spongy tissues

## **2. *Pimenta dioica* (Linn.) Merril**

**Synonym:** *P. officinalis* Lindl.

**Local name:** Garam masala

**English name:** Allspice tree, Jamaica pepper tree, pimento tree

**Distribution:** West Indies and tropical America. Introduced in India recently.

It is a bushy evergreen tree of 6-9 meter height. Leaves are oblong to oblong-lanceolate and leathery. Flowers are white in terminal and axillary trichotomous

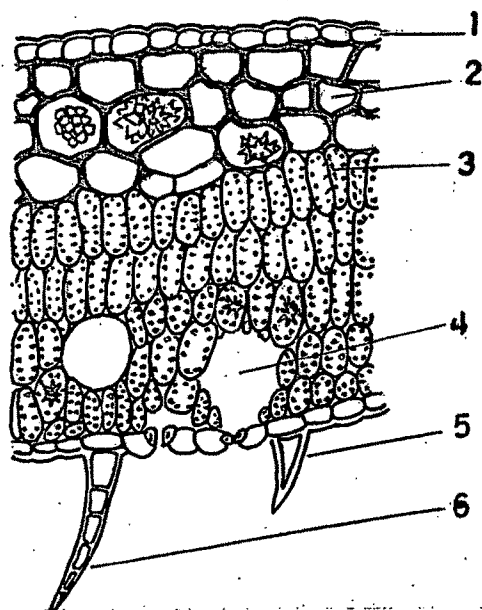


Fig. 3(a) *Psidium guajava* Leaf, Lamina-T.S.: 1. Epidermis, 2. Lacunar collenchyma with starch grains and sphaeraphides, 3. Mesophyll, 4. Resin ducts, 5. Unicellular trichomes, 6. Multicellular trichome

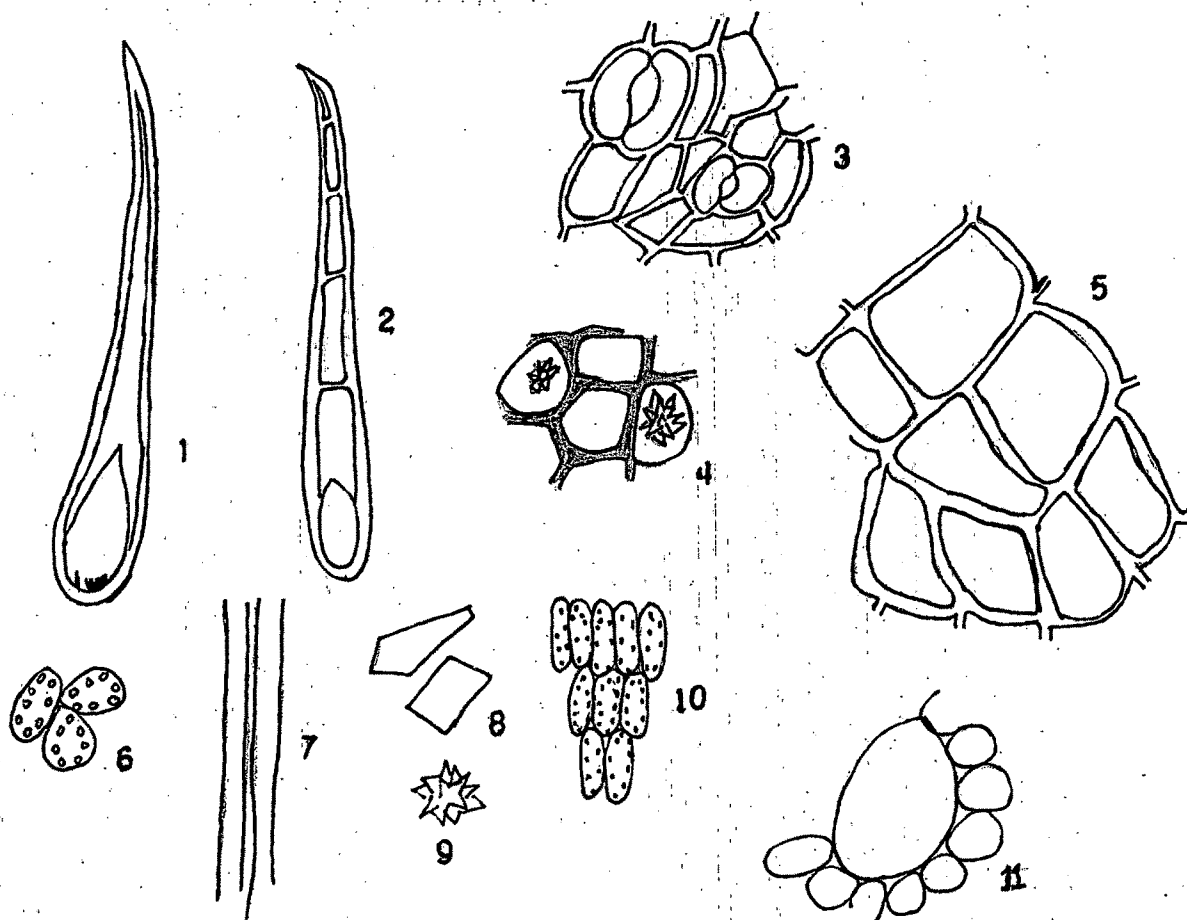


Fig. 3(b) *Psidium guajava* Leaf, Powder study: 1. Unicellular trichome, 2. Multicellular trichome, 3. Anomocytic stomata, 4. Lacunar collenchyma with sphaeraphides, 5. Epidermal cell, 6. Parenchyma with starch grains, 7. Fibers, 8. Crystal, 9. Sphaeraphide, 10. Mesophyll, 11. Resin canal

paniculate cymes. Fruit is globose berry about the size of a pea of black or purple color with two seeds. Seeds are reniform and deep brown.

**Part Used:** - Leaves

**Medicinal Uses:** -

Leaves are digestive stimulant, relieve flatulence and indigestion and treat diarrhoea, laxative and antiseptic.

**Previous phytochemical reports:** -

Leaves contain a volatile oil consisting of monoterpenes like eugenol, methyl eugenol, limonene,  $\beta$ -caryophyllene, 1-8-cineole,  $\alpha$ - phellandrene, terpinolene,  $\beta$ -selinene,  $\alpha$ - humulene, *p*-cymene (Anon., 1999).

**Previous Pharmacognostic reports:** -

No data are available on leaf.

In the **present work**, the plant has been studied for its chemical constituents like flavonoids, phenolic acid, quinones, etc. Pharmacognosy of leaf also has been studied.

**Materials and Methods:-**

The leaves are collected from Baroda. Voucher specimen of this plant has been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO), Vadodara. Standard procedures are described in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals. Pharmacognosy has been performed by standard methods mentioned in Chapter 2.

**Results: -**

**Phytochemistry: -**

Flavonoids identified in leaves were flavonoids such as quercetin, 3', 4'-diOMe quercetin and myricetin and phenolic acids like vanillic, syringic and gallic acids. Quinones and steroids were present. Flavonoids were absent in stem. Phenolic acids identified were same as the leaves. Glycoflavones, saponins and alkaloids were absent.



Phytochemical biomarkers of leaves: Volatile oils, myricetin, quercetin & gallic acid

Phytochemical biomarkers of stem: Absence of flavonoids

### **Pharmacognosy of leaf:-**

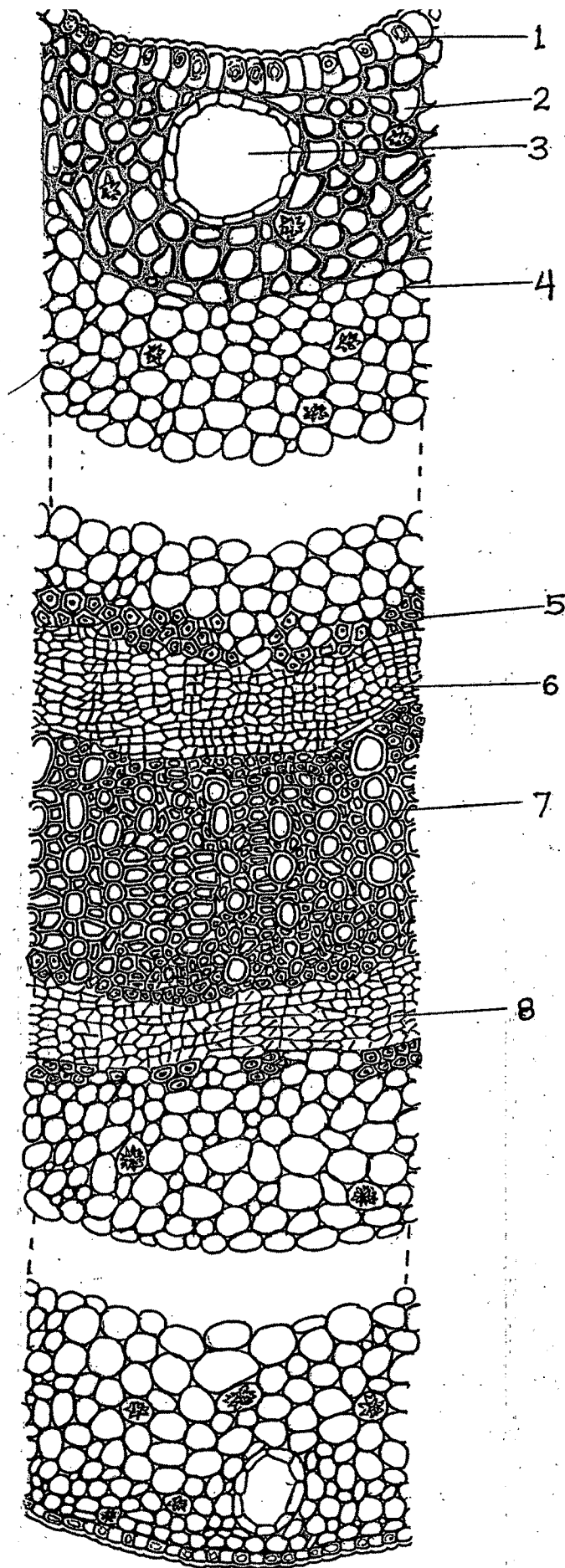
#### **Leaf micromorphology**

Leaf was amphistomatic. Stomata were anomocytic found on upper and lower epidermis. Stomatal index of upper epidermis was 0.2-3 and that of lower epidermis was 22-26. Trichomes were absent in the leaf.

#### **Leaf -T.S. (Fig. 4)**

Leaf was dorsiventral. Upper epidermal cells were of square to radially elongated cells (20-27 x 10-20 $\mu$ m) filled with some brown deposits of tannins covered by a thin cuticle. The midrib region was slightly concave on the upper side and hemispherical on the lower side. Hypodermis here consisted of six to seven layers of lacunar collenchyma (13-37x 10-24 $\mu$ m), some of which contained sphaeraphides. A few oil ducts were seen in this region. The ground tissue was broad and was composed of 12-14 layers of oval to spherical parenchyma (17-34 $\mu$ m). Some of these cells contained sphaeraphides (10-20 $\mu$ m). Pericycle was seen composed of two to three layer thick patches of gelatinous fibres (7-20 x 10-21 $\mu$ m) which surrounded the vascular bundle. The vascular bundle was crescent shaped. Intraxylary phloem of 12-13 layers of polygonal shaped elements was observed on the upper side of xylem. In xylem region, tracheids (6-14 $\mu$ m) were having oval to hexagonal shape arranged in longitudinal rows. Between the tracheids were xylem rays (6-10 x 3-10 $\mu$ m). The normal phloem was smaller in size than intraxylary phloem. One to two layers of collenchyma constituted the lower hypodermis. Oil ducts, 8-10 in number, (75-109 x 75-119 $\mu$ m) were observed surrounding the vascular bundle. Lower epidermal cells (10-17 x 6-13 $\mu$ m) were smaller in size than those of upper epidermis. These cells also possessed brown contents.

In lamina portion (Fig. 5a), cells of upper epidermis (15-20 x 6-17 $\mu$ m) were smaller in size than those of the midrib region. Mesophyll was differentiated into single layered palisade (17-27 x 7-10 $\mu$ m) and 11-12 layers of spongy cells (17-28 $\mu$ m). Palisade cells



**Fig. 4** *Pimenta dioica* Leaf, Midrib -T.S.: 1. Epidermis with tannin deposits, 2. Lacunar collenchyma with sphaeraphides, 3. Oil ducts, 4. Parenchyma, 5. Gelatinous fibres, 6. Intraxylary phloem, 7. Xylem, 8. Phloem

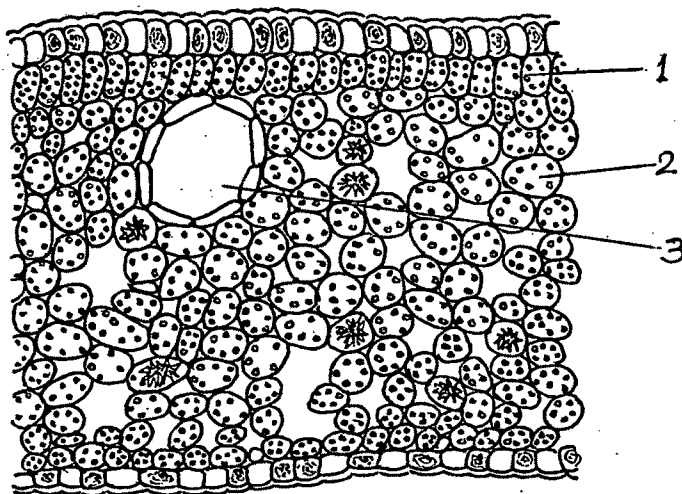


Fig. 5(a) *Pimenta dioica* Leaf, Lamina -T.S.: 1. Palisade tissue, 2. Spongy tissue; 3. Oil duct

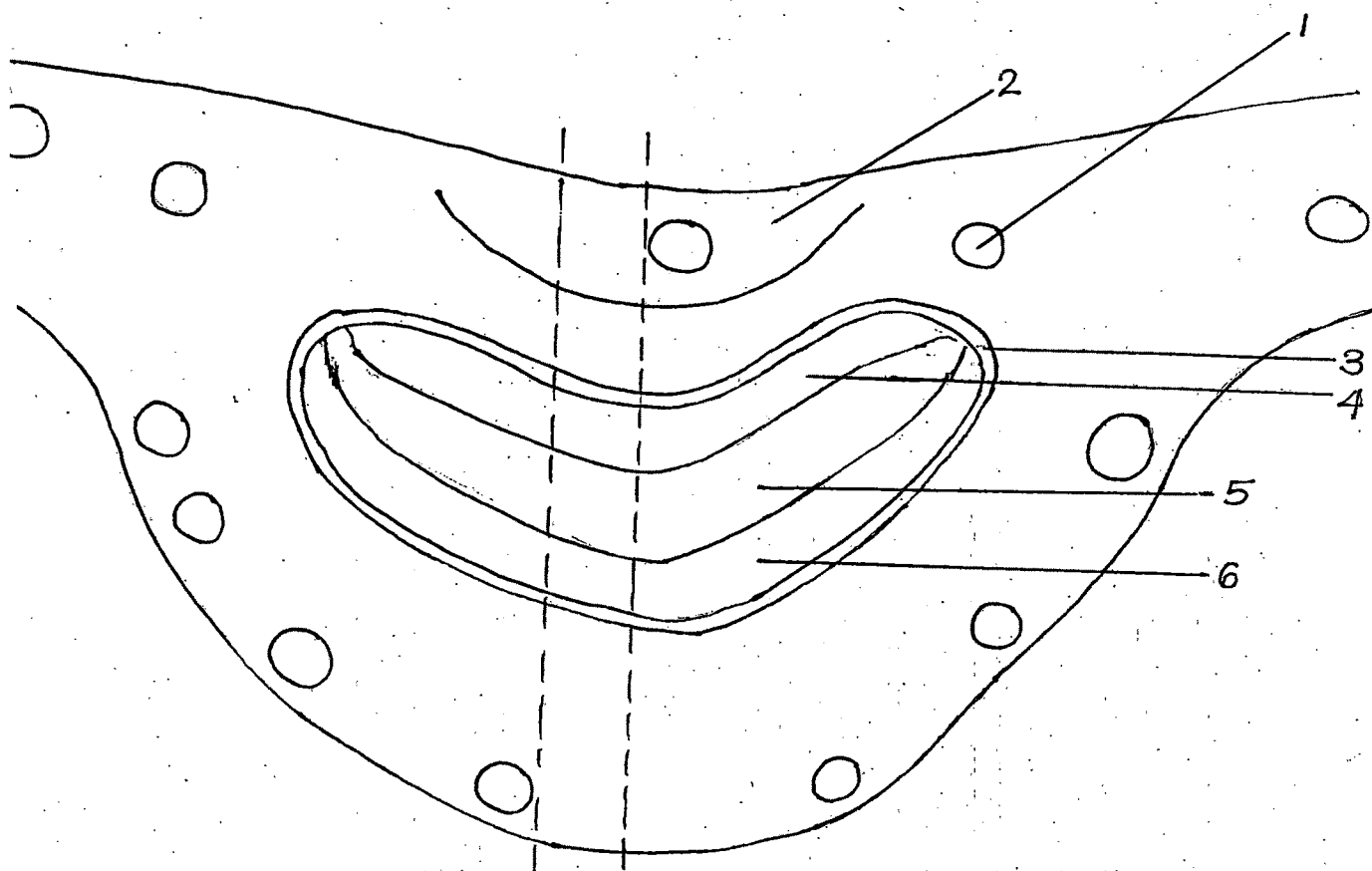


Fig. 5(b) *Pimenta dioica* Leaf, Schematic representation: 1. Oil ducts, 2. Lacunar collenchyma, 3. Stone cells, 4. Intraxylary phloem, 5. Xylem, 6. Phloem

were small and oval to elliptical in shape with four to six chloroplasts and some sphaeraphides. Resin ducts were seen among spongy cells. Cells of lower epidermis (6-10 x 10-14 $\mu$ m) were smaller than those of the upper epidermis. Cuticle was thin. No indumentum was observed.

**Powder study (Fig. 6)**

The powder of the leaf contained anomocytic stomata, sphaeraphides (10-20 $\mu$ m), resin ducts surrounded by spongy cells, epidermal cells with tannin deposits (20-27 x 10-20 $\mu$ m) and veins.

Pharmacognostic markers: Epidermal cells with tannin deposits

- : Oil ducts near epidermis
- : Gelatinous fibres
- : Oval or elliptical palisade cells of small size

### 3. *Syzygium malaccense* (Linn.) Merrill & Perry

**Synonym:** *Eugenia malaccensis* Linn.

**Local names:** - Jambavam, malakkachampa

**English name:** - Malay Rose Apple, Mountain apple

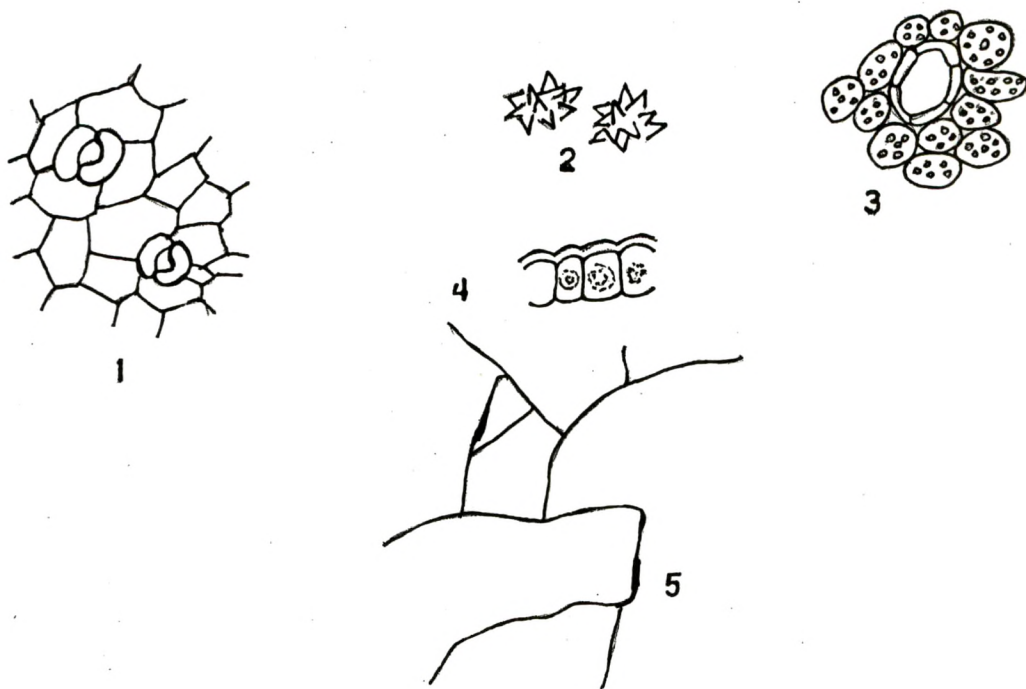
**Distribution:** Cultivated in Bengal and South India, chiefly in gardens.

This is a medium sized tree of 5-20 m high, with nearly straight trunk of 20-45 cm diam. and a densely foliated crown. Bark is dark grey. Leaves are elliptic-oblong or obovate-oblong, coriaceous having size of 15-50 by 7-20 cm. Flowers are deep pink or red with faint fragrance in dense, short peduncled racemes. Fruits are ellipsoid-globose and rarely elongate. Based on the nature of fruits, two varieties are recognized. The first one produces small fruits with pink or red color and the second variety produces slightly larger yellow fruits with purple streaks. These fruits are edible. Seeds are one to two, globose, brown and are 2.5-3.5 cm in diameter. The flesh of the fruit is thick (0.5-2.5 cm.), juicy and fragrant.

**Parts used:** All parts (roots, fruits, leaves, bark)

**Medicinal Uses:**

**Roots** are diuretic and applied against itches. **Stem** is astringent and used for making mouth-wash. Dried and powdered **leaves** are useful against cracked tongue. Extracts of



**Fig. 6** *Pimenta dioica* Leaf, Powder study: 1. Anomocytic stomata, 2. Sphaeraphide, 3. Resin duct surrounded by spongy cells, 4. Epidermal cell with tannin deposits, 5. Veins

seeds, fruits (without seeds), bark, stem and leaves show varying degrees of antibiotic activity against *Micrococcus pyogenes* var. *aureus*. An extract of fruits (without seeds) is moderately effective against *Escherichia coli*. An extract of bark and leaves is found active against *Shigella paradys* B H and *Shigella paradys* III Z. Extracts of the plant (excluding root) affect the rate and amplitude of respiration and also blood pressure (Anon., 1998).

#### **Previous phytochemical reports:-**

Only volatile constituents of the fruits of this plant were studied. About 133 compounds were identified of which 2-phenylethanol and its esters (2-phenylethyl acetate, 2-phenylethyl isopentanoate, 2-phenylethyl benzoate and 2-phenylethyl phenylacetate) were the major constituents which were responsible for its exotic aroma (Anon., 2004).

#### **Previous pharmacognostic studies:-**

There is no pharmacognostic work reported in any part of this plant so far.

In the present work, plants of both the varieties have been screened for their secondary metabolites such as flavonoids, alkaloids, quinones, saponins; etc in leaves and stem. Pharmacognostic studies of leaf and stem of both the varieties also have been conducted.

#### **Materials and Methods:-**

Both varieties of *Syzygium malaccense* was obtained from Kerala. Voucher specimens of these plants have been deposited in the Herbarium, Department of Botany, The Maharaja Sayajirao University of Baroda (BARO), Vadodara. Standard procedures described in chapter 2 were followed for the extraction, isolation and identification of the phytochemicals as well as for pharmacognosy.

#### **Results:**

##### **Phytochemistry: -**

a) **Red variety-** The leaves contained flavonoids such as quercetin, 3'-OMe quercetin, myricetin and gossypetin and phenolic acids like vanillic, syringic, gallic and melilotic acids. Stem contained 3'-OMe quercetin; 3', 4' -diOMe quercetin and

gossypetin. Vanillic, syringic, gallic, ferulic, *p*-hydroxy benzoic and melilotic acids were the phenolic acids present here.

Phytochemical markers of leaves – Gossypetin, myricetin and quercetin

Phytochemical markers of stem – *p*-Hydroxy benzoic, gallic and ferulic acids

b) **Yellow variety**- Leaves contained flavonoids like 3'-OMe quercetin; 3', 4' - diOMe quercetin and myricetin. Vanillic, syringic, gallic, ferulic, *p*-hydroxy benzoic and gentisic acids were the phenolic acids identified here. In stem, gossypetin as well as 3'-OMe gossypetin were located. Phenolic acids were similar to that of the leaves. Steroids were present in leaves and stem of both the plants. Quinones, glycoflavones and alkaloids were absent in both the plants.

Phytochemical markers of leaves – Gossypetin, myricetin, quercetin and gentisic acid

Phytochemical markers of stem – Same as the red variety

#### **Pharmacognosy of leaf and stem:-**

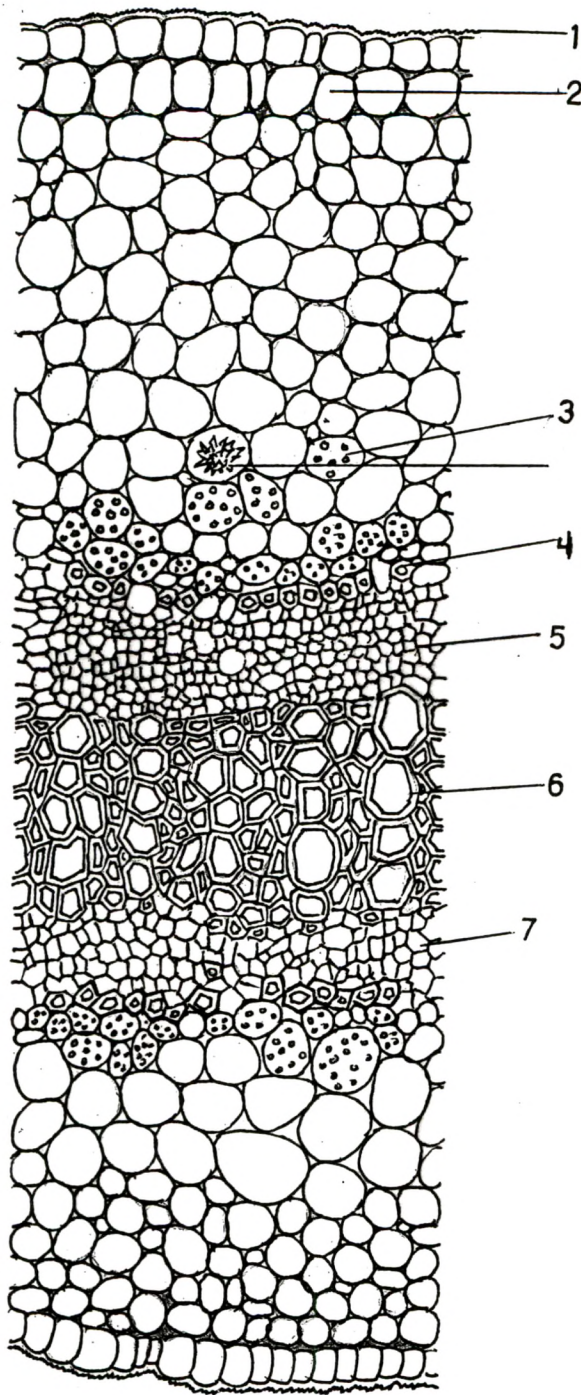
The leaves and stem of both red and yellow varieties were same in all the pharmacognostic characters. Therefore, the anatomical details of only red variety are described here.

#### **Leaf micromorphology**

Stomata were anomocytic and paracytic found only on lower epidermis. Stomatal index for anomocytic stomata was 2-4 and that of paracytic stomata was 22-25. Trichomes were absent here.

#### **Leaf - T.S (Fig. 7)**

Leaf was dorsiventral. Midrib region was not raised and was in level with lamina. Epidermis was single layered with square to barrel shaped cells (10-17 x 6-17 $\mu$ m). Cuticle above had minute ridges and furrows. Hypodermis consisted of one to two layered oval to round angular collenchyma cells (10-20 $\mu$ m). Below this was the ground tissue consisting of nine to ten layers of spherical parenchyma cells (20-34 $\mu$ m) containing cluster crystals (14-20 $\mu$ m). Parenchyma cells immediately around the vascular



**Fig. 7** *Syzygium malaccense* Leaf, Midrib-T.S.: 1. Cuticle with ridges and furrows, 2. Angular collenchyma, 3. Parenchyma with starch grains, 4. Stone cells, 5. Intraxylary phloem, 6. Xylem, 7. Phloem, 8. Sphaeraphides



bundle contained many starch grains (4-7 $\mu$ m). Vascular bundle was crescent shaped with phloem in both sides of xylem. Endodermis was not clearly differentiated. Pericycle was composed of a single layer of stone cells (3-14 $\mu$ m) which encircled the vascular bundle. This layer was at times discontinuous with parenchyma cells in between. Internal phloem (6-14 $\mu$ m) was of polygonal shape with nine to ten layers of cells. Xylem tracheids (10-17 $\mu$ m) of penta- or hexagonal shape were found in radial rows separated by xylem rays (7-14 $\mu$ m). Phloem below xylem was smaller in size as compared to the upper phloem. But the size of phloem elements was bigger here. Below the pericyclic band was the ground tissue of one to two layers of parenchyma cells filled with starch grains followed by five to seven layers of parenchyma (14-38 $\mu$ m) without any contents. In this region upper two to three layers were of larger size and the lower layers were small. Lower hypodermis consisted of one to three layers of collenchyma. Cells of lower epidermis (6-14 x 7-17 $\mu$ m) were smaller in size than those of the upper epidermis. Cuticle on the lower side also was with ridges and furrows.

In the lamina portion (Fig. 8a), cells of upper epidermis were rectangle in shape. Mesophyll was differentiated into single layered palisade (34-68 x 7-10 $\mu$ m) and four to five layered spongy cells (10-31 $\mu$ m). Palisade cells possessed eight to nine small chloroplasts. Cells of lower epidermis were smaller in size than the upper epidermis.

#### **Powder study (Fig. 11a)**

Simple starch grains (4-7 $\mu$ m), sphaeraphides (14-20 $\mu$ m), sclerenchyma fibres (6-10 $\mu$ m), anomocytic stomata, upper epidermal cells and parenchyma cells (20-34 $\mu$ m) filled with starch grains were observed in the powder.

**Pharmacognostic markers of leaves: Cuticle with ridges and furrows**

- : Pericycle of stone cells
- : Palisade single layered

#### **Stem -T. S. (Fig. 9)**

**Stem** was circular in outline in transverse sections. Cork cells were of two types, the outer two to three layers consisted of elongated, thick walled and oval to rectangled (with smooth curved angles) cells (10-20 x 24-38 $\mu$ m). The innermost layer was of large thin

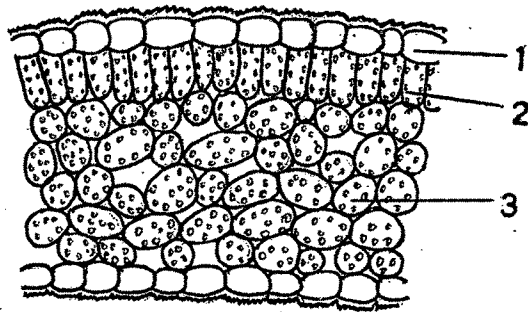


Fig. 8(a) *Syzygium malaccense* Leaf, Lamina-T.S.: 1. Epidermis, 2. Palisade tissue, 3. Spongy tissue

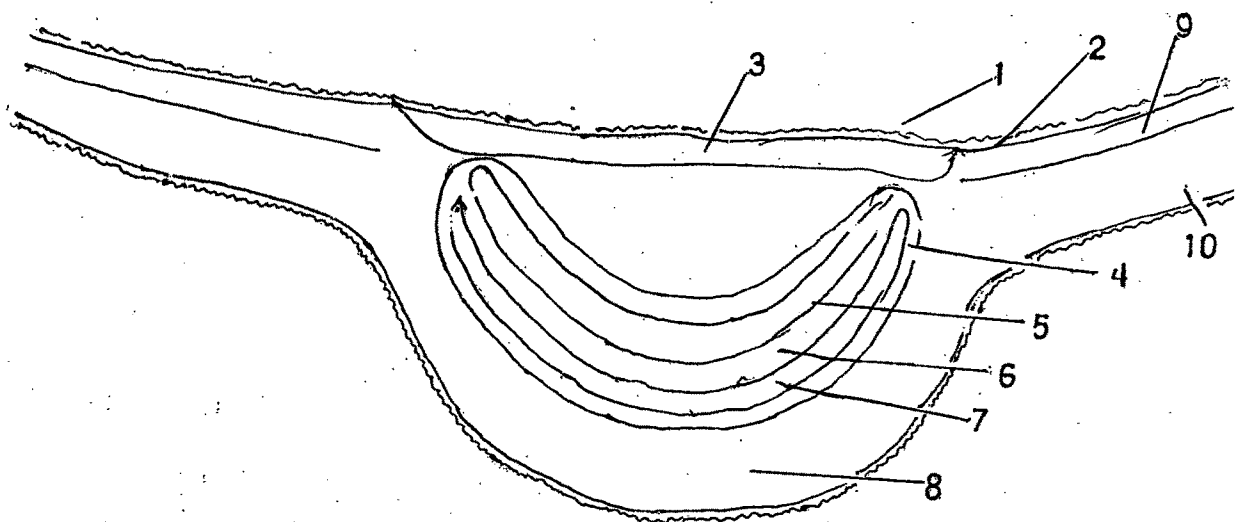
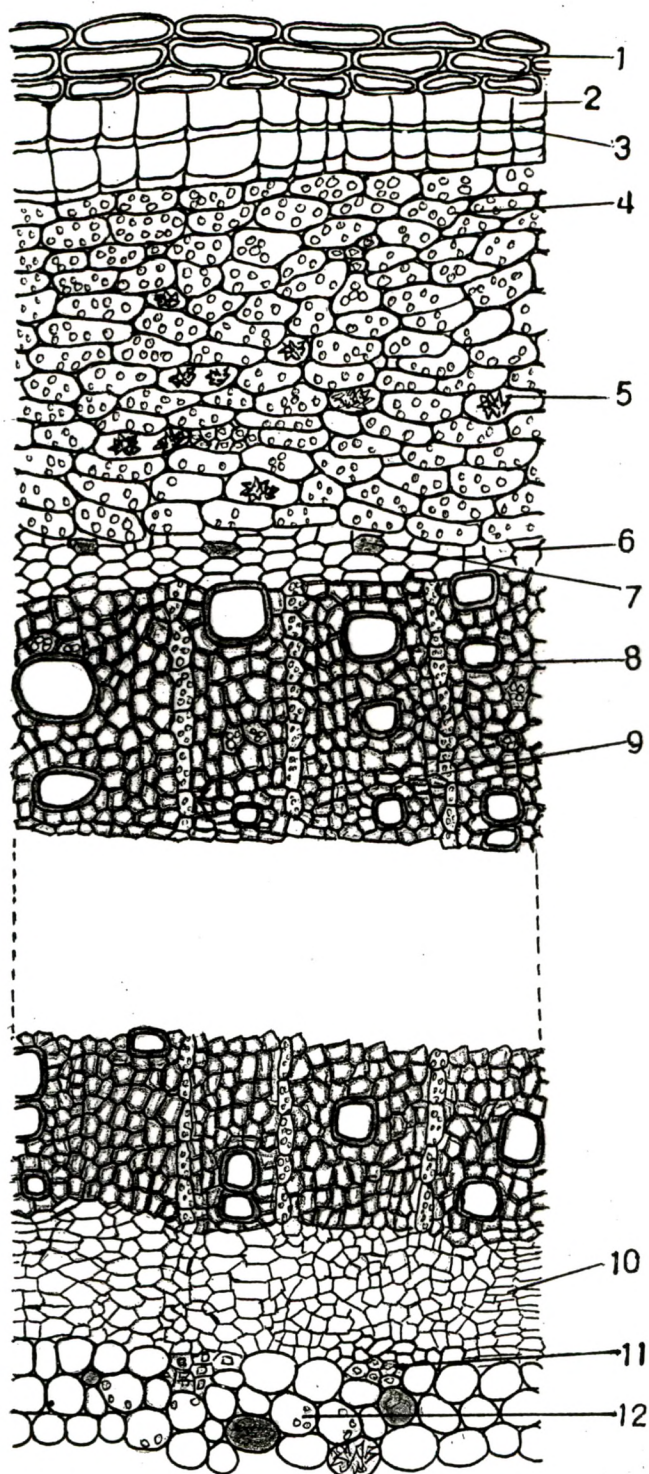


Fig. 8(b) *Syzygium malaccense* Leaf, Schematic representation: 1. Cuticle, 2. Epidermis, 3. Collenchyma, 4. Stone cells, 5. Intraxylary phloem, 6. Xylem, 7. Phloem, 8. Parenchyma, 9. Palisade tissue, 10. Spongy tissue.



**Fig. 9** *Syzygium malaccense* Stem- T.S.: 1. Thick walled cork cells, 2. Thin walled cork cells, 3. Cork cambium, 4. Parenchyma filled with starch grains, 5. Parenchyma filled with cluster crystals, 6. Intraxylary phloem, 7. Tannin cells, 8. Xylem, 9. Medullary rays with starch grains, 10. Phloem, 11. Fibres, 12. Cells with starch grains.

and square to rectangled shaped cells (14-20 x 7-17 $\mu$ m). A similar layer existed below cork cambium also. Cork cambium was single layered. A broad primary cortex composed of parenchyma cells (14-38 x 14-44 $\mu$ m) with starch grains of 14-15 layers was observed in which some were found containing cluster crystals (10- 24 $\mu$ m). Isolated groups of sclerenchyma (5-17 x 7-15 $\mu$ m) with small lumen (6 $\mu$ m) were also observed in this region. Endodermis and pericycle were not clearly differentiated. Phloem (7-10 x 10-17 $\mu$ m) consisted of three to four layers of polygonal to hexagonal elements. Some of these cells contained tannin. Xylem was very broad with solitary, round to square shaped vessels (21-27 $\mu$ m). Tracheids (7 -14 $\mu$ m) were in radial rows. Medullary rays were uniseriate and filled with starch grains. Protoxylem elements were solitary or in pairs. Internal phloem was bigger in size consisting of 8-10 layers of polygonal to hexagonal shaped cells. Next to this phloem was the pith containing patches of sclerenchyma with small lumen towards the periphery. Pith towards the centre was composed of large parenchyma cells (17-31  $\mu$ m), at times containing tannin or sphaeraphides.

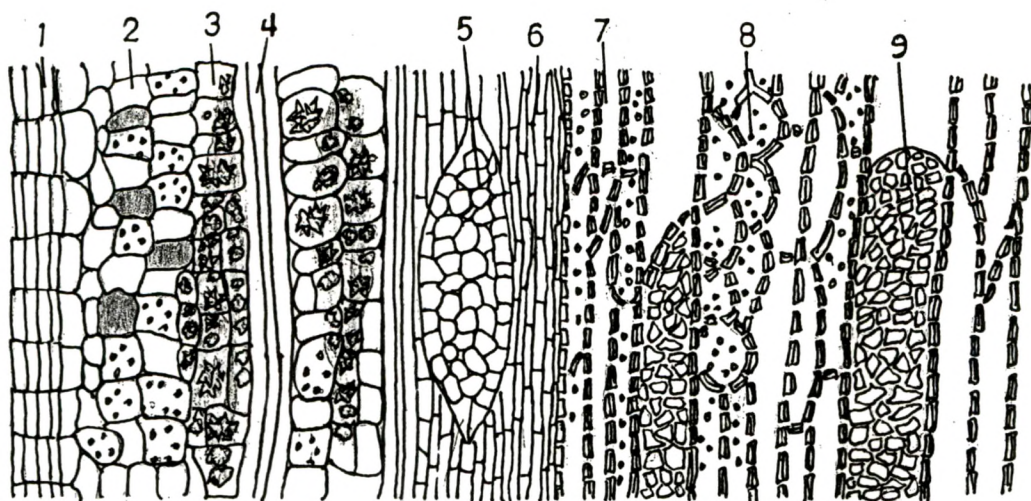
#### **Stem- T.L.S. (Fig. 10a)**

In T.L.S, cork cells were rectangular(7-10 x 17-24 $\mu$ m). Secondary cortex consisted of square to irregular shaped chlorenchyma cells (7-10 x 15-26 $\mu$ m). Tannin cells were also seen. Parenchyma cells (6-10 x 17-27 $\mu$ m) containing one to three cluster crystals of calcium oxalate in each cell were seen in vertical rows. In between these cells, sclerenchymatous fibres (lumen: 8-10 $\mu$ m) were observed. Phloem rays (155-303 x 15-30 $\mu$ m) were multiseriate. Phloem elements (6-9 x 31-37 $\mu$ m) were long and elongated. Tracheids (16-28 $\mu$ m) were found with simple pits. Vessels (24-48 $\mu$ m) were observed with pits in 2-3 rows. Xylem rays (10-24 $\mu$ m) were uniseriate to biseriate with starch grains.

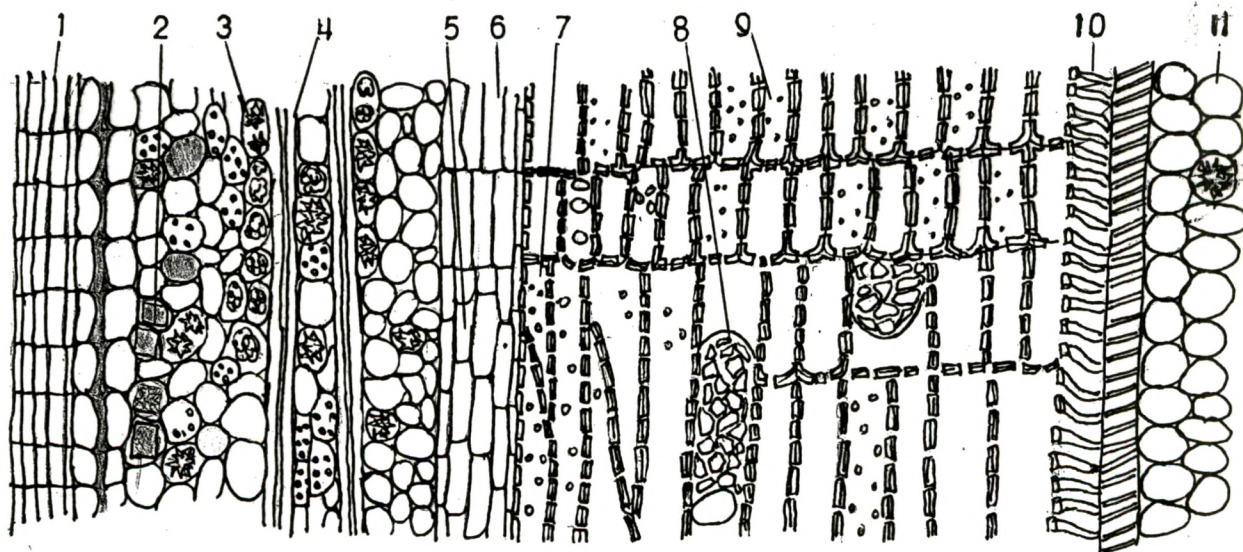
#### **Stem- R.L.S. (Fig. 10b)**

In R.L.S, rhomboidal crystals were observed in parenchyma cells in the cortex. Cells of the phloem rays (17-20 x 44-70 $\mu$ m) were erect, thin walled and were without starch grains or crystals. Xylem rays (17-25 x 50-80 $\mu$ m) were upright with simple pitting.





**Fig. 10(a)** *Syzygium malaccense* Stem, T.L.S.: 1. Cork, 2. Secondary cortex, 3. Parenchyma cells with cluster crystals, 4. Fibres, 5. Phloem rays, 6. Phloem, 7. Tracheids with pits, 8. Xylem rays, 9. Vessels with bordered pits



**Fig. 10(b)** *Syzygium malaccense* Stem, R.L.S.: 1. Cork, 2. Rhomboidal crystals in cortex, 3. Sphaeraphides, 4. Sclerenchyma, 5. Phloem, 6. Phloem rays, 7. Tracheids, 8. Vessels, 9. Xylem rays, 10. Protoxylem with annular thickenings, 11. Pith

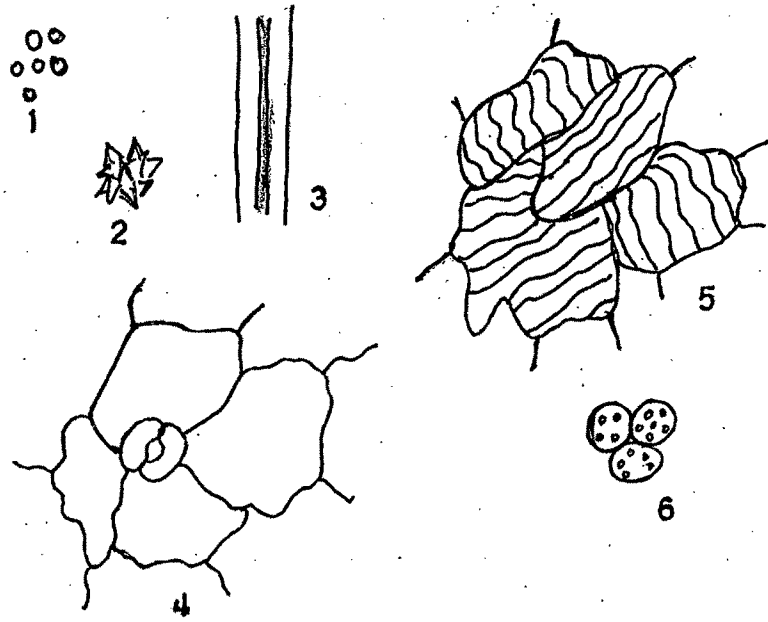
Pith consisted of large parenchyma cells (17-31  $\mu\text{m}$ ), a few of which contained sphaeraphides.

**Powder study (Fig. 11b)**

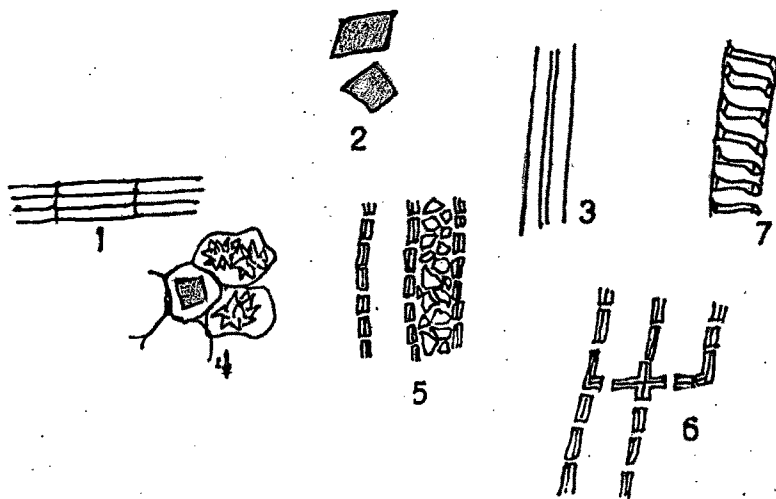
Powder of the stem showed the following components – cork cells (10-20 x 24-38 $\mu\text{m}$ ), crystals, sclerenchyma fibres (lumen: 6 $\mu\text{m}$ ), parenchyma cells (17-31  $\mu\text{m}$ ) containing crystals and sphaeraphides, vessels (24-48  $\mu\text{m}$ ) with bordered pits alongwith tracheids (17-28  $\mu\text{m}$ ), medullary rays (17-25 x 50-80 $\mu\text{m}$ ) and tracheids with annular thickening.

Pharmacognostic markers of stem: Cork cells of thin walled and thin walled cells

- : Fibres of small lumen
- : Large parenchyma cells with tannin deposits
- : Prismatic crystals in parenchyma



**Fig. 11(a) *Syzygium malaccense* Leaf, Powder study:** 1. Starch grains, 2. Sphaeraphide, 3. Sclerenchyma, 4. Anomocytic stomata, 5. Upper epidermis, 6. Parenchyma with starch grains



**Fig. 11(b) *Syzygium malaccense* Stem, Powder study:** 1. Cork, 2. Crystals, 3. Sclerenchyma, 4. Parenchyma with crystals and sphaeraphides, 5. Vessels with bordered pits alongwith tracheids, 6. Medullary rays, 7. Protoxylem with annular thickenings