

## MORPHOLOGICAL AND HISTOLOGICAL CHARACTERS OF *CURCUMA AROMATICA* SALISB.

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### Abstract

The plant *Curcuma aromatica* Salisb. locally known as Taw-Sanwin, belongs to the family Zingiberaceae. It is collected from Hpa-an Township, Kayin State during the flowering and rhizomes period in 2019. In this paper, the morphological and histological characters of the leaves, midrib, petiole, leaf sheath, tuber, root, and rhizomes of *Curcuma aromatica* Salisb. were studied at Department of Botany, Hpa-an University. Verification of plant was carried out by available literatures. In histological study, free hand sections of leaves, midrib, petiole, leaf sheath, tuber, root, and rhizome were studied and examination of powdered samples was also carried out for standardization of drug. In morphological study, the plant is perennial herb with tubers aromatic rhizome. Leaves are distichous with open sheath. Inflorescences are terminal a leafy shoot directly from the rhizome. Flower bisexual, zygomorphic and epigynous. Calyx (3), synsepalous. Corolla (3), synpetalous. Androecium of two whorls, fertile stamen and staminodes. Ovary tricarpellary, axile placentation and discs are present. The fruits are fleshy and dehiscent. Seeds round, mostly covered with a large divided aril endosperm abundant, white, hard or mealy. In histological study, the anticlinal walls in the epidermal cell of both surfaces are straight. Tetracytic stomata are present on both surfaces but more abundant on lower surface. Oil cells contain parenchymatous layer of midrib, petiole, leaf sheath, tuber, root and rhizome. Secretory cells and starch grains are present in tuber, root and rhizome. Vascular bundles of lamina, midrib, petiole, leaf sheath, tuber, root and rhizome are collateral type and closed type.

**Keyword:** *Curcuma aromatica* Salisb., morphological and histological characters

### Introduction

The terms of medicinal plants include various types of uses in herbalism and some of these plants have medicinal activities. These medicinal plants consider as a rich resources of ingredients that can be used in drug development and synthesis. Moreover, some plants consider as important source of nutrition and as a result of these plants recommended for their therapeutic values (Hassan, 2012; and Revathy, *et al.*, 2013).

*Curcuma* is an aromatic rhizomatous herbs belonging to family Zingiberaceae. Zingiberaceae is a group of monocotyledonous plant that is economically important (Bhattacharjee, 2000; Heywood, *et al.*, 2007 and Sikha, *et al.*, 2015). It is used due to the secretory structure inside the plant's organs that produce metabolites that are used as medicine (Dassanayake, 1983; Charles, *et al.*, 1992 and Zhou, *et al.*, 2001).

The plant has been in traditional use and in medicinal values it is mentioned as a remedy for various diseases. *Curcuma aromatica* is already known in India as a tonic, carminative, as an antidote to snake bites and astringent. It is used for bruises, corn, sprains, snake bite and is a well-known for enhancing complexion, for skin infections, eruption. Paste of rhizome with milk is used for dysentery and gastric ailments.

The leaves are distichous with open sheath (Narayan, *et al.*, 2006 and Heywood, *et al.*, 2007). The inflorescences are terminal spikes (Judd, *et al.*, 2006 and Promod, *et al.*, 2018). Flowers fragrant are shorter than the bracts (Kirtikar and Basu, 1935 and Pandey, 2008). It is pinkish-white with an orange lip (Polunin *et al.*, 1997 and Narayan *et al.*, 2006). Flowers are zygomorphic (Judd,

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*et al.*, 2006 and Heywood, *et al.*, 2007; Pandey, 2008). Fruits are capsule and dehiscent. Seeds are arrillated (Heywood, *et al.*, 2007 and Pandey, 1998).

In this plant, anticlinal walls of both upper and lower surfaces of lamina are straight. Tetracytic stomata are present on both surfaces. Vascular bundle of lamina is collateral and closed type. Vascular bundle of midrib, petiole and leaf sheath are arranged in three rows. The main vascular bundles are between alternating with air canals. Oil cells are embedded in parenchymatous layers of midrib and leaf sheath (Pandey, 1998 and Ravindran, *et al.*, 2007).

In root, cortex layer lie below epiblema layer. Only one layer of endodermis and 1–2 layers of pericycle are present. Vascular bundle is polyarch in root. Oil cells, secretory cells and starch grains are scattered in the ground tissues. In rhizome, periderm layers present. Vascular bundles are scattered throughout the ground tissue. Oil cells, secretory cells and starch grains are scattered in the ground tissues (Tomlinson, 1956 and Shantha, *et al.*, 1991).

The objectives of this study are to verify the plant *Curcuma aromatic* Salisb. by using vegetative and floral parts, to investigate the histological characters of leaves, leaf sheath, midrib, petiole, tuber, root and rhizome of this plants and to examine the leaves, tuber, root and rhizome powdered for standardization in traditional medicine of plant *Curcuma aromatic* Salisb.

## Materials and Methods

### Morphological study

The specimens of *Curcuma aromatic* Salisb. were collected from Hpa-an township, Kayin State, during May to October, 2019. It is situated between latitude 16° 47' 29 N and longitude 97° 38' 43 E, 56 feet above sea level. The collected specimens were made careful notes and recorded by taking photographs to classify and identify systematically. The morphological study of plant was undertaken with the help of available literatures such as (Wealth of India, 1951; Kirtikar and Basu, 1975; Dassanayake, 1983; Hundley and Chit Ko Ko, 2003 and Kress, *et al.*, 2003).

### Histological study of *Curcuma aromatic* Salisb.

In histological study, free hand section of lamina, midrib, leaf sheath, stem, root and rhizome from the fresh specimens were prepared by using chloral hydrate solution for clearing reagents, safranin for testing lignin and iodine solution B.P for testing starch and sudan III for oil cells. These characters were determined according to the literature of Tomlinson (1956), Wallis (1967) and Pandey (1998).

## Results

### Morphological Characters of *Curcuma aromatic* Salisb.

<b>Scientific Name</b>	-	<b><i>Curcuma aromatic</i> Salisb.</b>
<b>family</b>	-	<b>Zingiberaceae</b>
<b>Myanmar Name</b>	-	<b>Taw-sanwin</b>
<b>Common Name</b>	-	<b>Wild turmeric, Yellow zedoary</b>

The plant is perennial herb with tubers aromatic rhizome 70-75 cm high, rhizome thick, more than 10.0 - 14.0 cm long and 1.0 – 1.5 cm wide, tubers thick, 3.0-3.5 cm long and 2.5 - 3.0 cm wide, the fresh and aromatic, light yellow. Leaves are distichous with open sheath

17.5 – 32 cm long and 6.5 – 13.7 cm wide, uniformly green, the lamina is acuminate, pubescent below, with a prominent midrib and parallel, pinnate, lateral veins diverging obliquely from the midrib; petiole as long as the lamina, 9.5 - 25.0 and 3.0 – 4.0 cm wide; a distinct ligules, 1.0 – 1.4 cm long and 8.0 – 15.0 mm wide, present at junction of leaf blade and leaf sheath, glabrous. Inflorescences terminal spikes, 10.0 – 12.0 cm long and 4.0 – 5.0 cm wide, it comes out from the dominant underground rhizomes, the cymose units in the axile of usually conspicuous bracts and compact spike, flower bract, 2.5 – 3.5 cm and 1.5 – 2.0 cm wide, ovate, recurved, cymbiform, rounded at the tips, pale green, connate below forming pouches for the flowers; comma bract, 2.5 – 3.5 cm long and 1.0 – 1.5 cm wide, tinge with pink. Flower yellow, 4.0 – 4.5 cm long and 1.5 – 2.0 cm wide, sessile, complete, bisexual, zygomorphic, trimerous, fragrant, epigynous; calyx (3), synsepalous, tubular, spathaceous splitting above, 0.6 – 0.8 cm long and 0.2 – 0.3 cm wide, valvate, white; corolla (3), synpetalous, the tube cylindrical at the lower part, 2.0 – 2.5 cm long and 0.5 – 0.7 cm wide, the three linear lobes at the apex, 1.5 – 2.0 cm long and 0.5 – 0.7 cm wide, white, membranous, reflexed; androecium of two whorls, stamens and staminodes, only one stamen of inner whorl is fertile, the outer whorls are modified into large petaloid staminodes, within the three petaloid staminodes, two petal-like lateral staminodes, broadly lanceolate to oblong-ovate, 0.5 – 0.8 cm long and 0.2 – 0.3 cm wide, the tips obtuse, remain separate, petal-like staminodes which are united to form a bilobed labellum, 2.0 – 2.3 cm long and 0.5 – 0.7 cm wide, slightly longer with a yellowish or dull white patch, in the center fertile stamen erect, epipetalous, the filament short, 0.4 – 0.6 cm long and about 0.1 cm wide, white, the anther ellipsoidal, 1.4 – 1.5 cm long and 3.0 – 4.0 mm wide, ditheous, dorsifixed, introrse, pollen sacs usually longitudinal dehiscence; ovary inferior, globoids-oblongoid, about 0.5 – 1.0 cm long and 0.5 – 0.7 cm wide, tricarpellary, syncarpous, trilocular, axile placentation, white, pubescent, many ovules in each locule, the style 3.5 – 4.0 cm long and about 0.5 cm wide, passing through the groove of the fertile stamen, white, the stigma capitate and ciliate, white, about 1.0 mm long and 2.0 mm wide, yellowish discs are 0.5 – 0.7 cm long and about 1.0 mm wide (Figure 1).

### **Histological characters of *Curcuma aromatic* Salisb.**

#### **Lamina**

In surface view, the cuticle is thin and smooth. The anticlinal walls in the epidermal cell of both surfaces are straight. The cells are polygonal in shape, thin-walled, parenchymatous. Tetracytic stomata (each stoma with a pair of lateral subsidiary cells and a pair of terminal subsidiary cells) are present on both surfaces but more abundant on lower surface. The stomata are oval in outline with two reniform-shaped guard cells and contain abundant chloroplasts. Unicellular trichomes are present on both upper and lower surfaces.

In transverse section, cuticle layers are thick and smooth on both surfaces. Epidermal cells are barrel shaped. 1 – 2 layers of hypodermis are present in abaxial. These cells are polygonal in shape. The abaxial hypodermis is interrupted by large substomatal chambers. These cells are irregular in shape. The mesophyll cells composed of palisade parenchymatous and spongy mesophyll cells. Palisade parenchymatous layers are vertically elongated, tightly packed with one another and contained many chloroplasts. The spongy mesophyll cells are three-five layers the cells are loosely arranged, irregular in shape, thin walled parenchymatous cells and intercellular spaces. Vascular bundles are embedded in the mesophyll cells and are collateral and closed type. The xylem composed of vessels, tracheids, xylem fibres and xylem parenchyma. The phloem tissue composed of sieves tube elements, companion cells, phloem fibres and phloem parenchyma (Figure 2).

### **Midrib**

In surface view, the epidermal cells are thin-walled, parenchymatous cells, polygonal in shape, tetracytic stomata and oil cells are present (Figure 3).

In transverse section, the midrib is V-shaped in outline. Both upper and lower surfaces of epidermal cells are barrel shaped, thin-walled, parenchymatous cells. Lower epidermal cells are smaller than upper ones in width. Below the epidermis, both upper and lower collenchymatous cells are 2 – 3 layers, polygonal in shape. 4 – 10 layers of parenchymatous cells are found above main vascular bundles. These cells are polygonal in shape and thin-walled. Vascular bundles are arranged in three rows, developing unequally at different levels. The main vascular bundles are between alternating with air canals and embedded in chlorenchyma. The abaxial conducting system consists of an arc of vascular bundles of different sizes that are circular in outline. The adaxial conducting system consists of 1 – 3 vascular bundles (subsidiary vascular bundle) that are similar in appearance to the main vascular bundles but are smaller in size. The main vascular bundles are furnished with a massive fibrous or sclerenchymatous sheath above the xylem and below the phloem. Abaxial bundles are enveloped within almost a complete fibrous sheath. Air canals contain a loose network of lobed cells. The xylem composed of vessels, tracheids, xylem fibres and xylem parenchyma. The phloem tissue composed of sieve tube elements, companion cells, phloem fibres and phloem parenchyma. Oil cells are embedded in parenchymatous layers (Figure 3).

### **Petiole**

In surface view, the epidermal cells of both upper and lower surfaces are thin-walled, parenchymatous cells, polygonal in shape and thin walled parenchymatous cells. Tetracytic stomata and unicellular trichome are present (Figure 4).

In transverse section, the petiole is semi-circular in outline. Both upper and lower epidermal cells are barrel shaped and tightly arranged, thin-walled, parenchymatous cells. Lower epidermal cells are smaller than upper ones in width. Collenchymatous cells are 2-3 layers in upper epidermis and 3-5 layers in lower ones and polygonal in shape. Both upper and lower parenchymatous cells 6 – 10 layers. These cells are irregular and polygonal in shape and thin-walled. Vascular bundles are arranged in three rows, developing unequally at different levels. The main vascular bundles are between alternating with air canals and embedded in chlorenchyma. The abaxial conducting system consists of an arc of vascular bundles of different sizes that are circular in outline. The adaxial conducting consists of 1 – 3 (subsidiary vascular bundle) that are similar in appearance to the main vascular bundles but are smaller in size. The main vascular bundles are furnished with a massive fibrous or sclerenchymatous sheath above the xylem and below the phloem. Abaxial bundles are enveloped within almost a complete fibrous sheath. Air cannals contain a loose network of lobed cells. The xylem composed of vessels, tracheids, xylem fibres and xylem parenchyma. The phloem tissue composed of sieve tube elements, companion cells, phloem fibres and phloem parenchyma. Oil cells are embedded in parenchymatous layers (Figure 4).

### **Leaf sheath**

In surface view, the epidermal cells are polygonal in shaped, thin walled parenchymatous cells, tetracytic stomata and unicellular trichome (Figure 5).

In transverse section, both adaxial and abaxial epidermal cells are barrel shaped, thin-walled, parenchymatous cells. The abaxial epidermal cells are smaller than adaxial cells. Above the abaxial epidermal layer, 1 – 3 layers of collenchymatous cells are polygonal in shape. Parenchymatous cells are 4 – 5 layers in abaxial region and 7 – 10 layered in adaxial region. Both are polygonal in shape. Vascular bundles are arranged in three rows, developing unequally at different levels. The

main vascular bundles are between alternating with air canals and above the chlorenchyma. The abaxial conducting system consists of an arc of vascular bundles of different sizes that are circular in outline. The adaxial conducting system consists of vascular bundles (subsidiary vascular bundle) that are similar in appearance to the main vascular bundles but are smaller in size. The main vascular bundles are furnished with a massive fibrous or sclerenchymatous sheath above the xylem and below the phloem. Abaxial bundles are enveloped within almost a complete fibrous sheath. Air canals contain a loose network of lobed cells. The xylem composed of vessels, tracheids, xylem fibres and xylem parenchyma. The phloem tissue composed of sieve tube elements, companion cells, phloem fibres and phloem parenchyma. Oil cells are embedded in parenchymatous layers (Figure 5).

### **Tuber**

In surface view, the epidermal cells are polygonal in shaped and anticlinal walls are straight. Oil cells, secretory cells and starch grains are present (Figure 6).

In transverse section, periderm consists of 7-10 layers, thin-walled, parenchymatous cells and rectangular to irregular in shape. Periderm composed of phellem or cork, phellogen or cork cambium and phelloderm or secondary cortex. Cortex 35 – 45 layers, thin-walled, parenchymatous cells and polygonal in shape. The endodermis is one layer, lie the inner region of cortex layer, barrel-shaped, thin-walled parenchymatous cells. Pericycle layer lie below endodermal layers are only one layer, barrel shaped, thin-walled, parenchymatous cells. Vascular bundles are collateral below endodermis cells. Vascular bundles are furnished with a massive fibrous or sclerenchymatous sheath above the xylem and below the phloem. The xylem composed of vessels, tracheids, xylem fibres and xylem parenchyma. The phloem composed of sieve tube, companion cells, phloem fibres and phoem parenchyma. Oil cells, secretory cells and starch grains are scattered in the ground tissues (Figure 6).

### **Root**

In surface view, epiblemal cells are polygonal shaped, thin-walled parenchymatous cells (Figure 7). In transverse section, the root is more or less circular in outline. The roots hairs are present. The epiblemal layer is only one layer, barrel shaped and thin-walled parenchymatous cells. Periderm consists of 5-7 layers and composed of phellem or cork, phellogen or cork cambium and phelloderm or secondary cortex. Below the priderm, 5 – 6 layers of outer cortex which are polygonal in shape. In the middle cortical layers composed of 6-7 layers of aerenchymatous cells. Inner cortical layers composed of 4-6 layers polygonal in shaped. The endodermis is only one layer, barrel-shaped, thin-walled parenchymatous cells. Pericycle layer lie below endodermal layers are 1 – 2 layers, barrel shaped, thin-walled parenchymatous cells. Vascular bundle is polyarch. Bundles of the xylem are exarch i.e. the metaxylem towards the central and protoxylem towards the periphery. The xylem composed of vessels, tracheids, xylem fibres and xylem parenchyma. The phloem tissue composed of sieve tube elements, companion cells, phloem fibres and phloem parenchyma. Oil cells, secretory cells and starch grains are scattered in the ground tissues (Figure 7).

### **Rhizome**

In surface view, the epidermal cells are polygonal in shape, and anticlinal walls are straight. Oil cells, secretory cells and starch grains are present (Figure 8).

In transverse section, periderm consists of 5–7 layers, thin-walled, parenchymatous cells, rectangular to irregular in shape. Hypodermis consists of 2 – 4 layers and polygonal to irregular in shape. Periderm consists of 5-7 layers and composed of phellem or cork, phellogen or cork

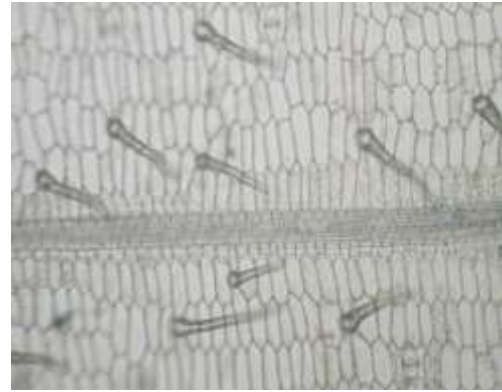
cambium and phelloderm or secondary cortex. Cortex 35 – 45 layers, thin-walled, parenchymatous cells and polygonal in shape. Endodermal cells lie the inner region of cortex layer, only one layer, thin-walled parenchymatous cells. Vascular bundles are collateral and all scattered throughout the ground tissue. Vascular bundles are furnished with a massive fibrous or sclerenchymatous sheath above the xylem and below the phloem. The xylem composed of vessels, tracheids, xylem fibres and xylem parenchyma. The phloem composed of sieve tube, companion cells, phloem fibres and phloem parenchyma. Oil cells, secretory cells and starch grains are scattered in ground tissues (Figure 8).



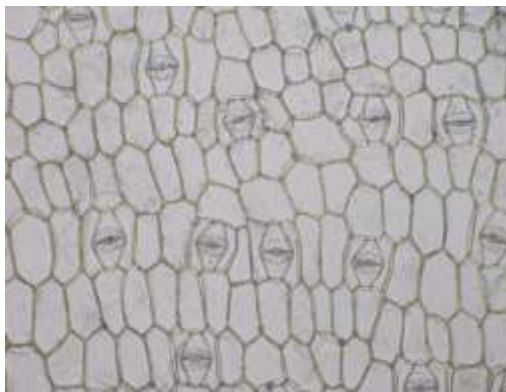
**Figure 1** Morphological characters of *Curcuma aromatic* Salisb.



Surface view of upper epidermis of lamina showing stomata (100x)



Surface view of upper epidermis of lamina showing trichomes (100x)



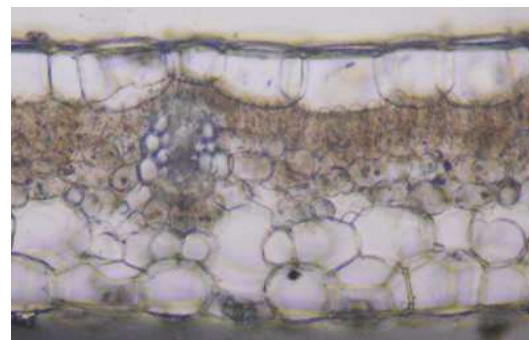
Surface view of lower epidermis of lamina showing tetracytic stomata (100x)



Surface view of lower epidermis of lamina showing unicellular trichome (100x)



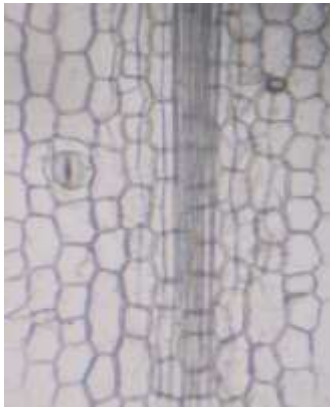
Transverse section of lamina showing mesophyll layer (400x)



Transverse section of lamina showing vascular bundle (400x)

**Figure 2** Histological characters of lamina of *Curcuma aromatic* Salisb.





Surface view of midrib showing tetracytic stomata and oil cells (400x)



Transverse section of midrib in outline (100x)

**Figure 3** Histological characters of midrib of *Curcuma aromatic* Salisb.



Surface view of epiderma cell of petiole (400x)

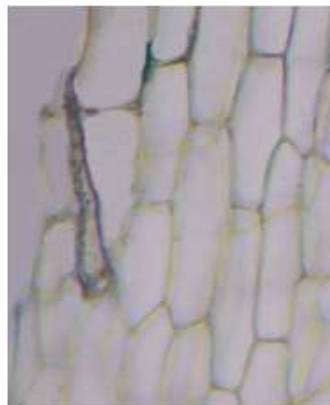


Transverse section of petiole showing in outline (400x)

**Figure 4** Histological characters of petiole of *Curcuma aromatic* Salisb.



Surface view of leaf sheath showing stomata (400x)



Surface view of unicellular trichome (400x)



T.S. of leaf sheath in outline (400x)

**Figure 5** Histological characters of leaf sheath of *Curcuma aromatic* Salisb.





Surface view of epidermal cells of tuber (400x)



Transverse section of tuber in outline (100x)

**Figure 6** Histological characters of tuber of *Curcuma aromatic* Salisb.



Surface view of epiblema cells of root (400x)



Transverse section of root in outline (400x)

**Figure 7** Histological characters of root of *Curcuma aromatic* Salisb.



Surface view of epiblema cells of rhizome (400x)



Transverse section of rhizome showing vascular bundle (200x)

**Figure 8** Histological characters of rhizome of *Curcuma aromatic* Salisb.

## Discussion and Conclusion

In this research, morphological and histological characters of *Curcuma aromatic* Salisb. were carried out. Myanmar name Taw-Sanwin (Hundley and Chit Ko Ko, 2003 and Kress, *et al.*, 2003) and Na-Nwinherbaceous perennials, sympodially branched rhizomes covered and scales leaves (Burkill, 1935; Tomlinson, 1969; Dassanayake, 1983; and Kress, *et al.*, 2003) and tubers yellow and aromatic inside (Dassanayake, 1983 and Narayan, 2006).

The leaves are distichous with open sheath (Narayan, *et al.*, 2006 and Heywood, *et al.*, 2007). The inflorescences are terminal spikes (Medicinal plant of India, 1987; Judd, *et al.*, 2006 and Promod, *et al.*, 2018) and open raceme (Cronquist, 1981 and Heywood, *et al.*, 2007). Flowers fragrant are shorter than the bracts (Kirtikar and Basu, 1935 and Pandey, 2008). It is pinkish-white with an orange lip (Medicinal plants of India, 1987; Polunin *et al.*, 1997 and Narayan, *et al.*, 2006). Flowers are zygomorphic (Judd, *et al.*, 2006 and Heywood, *et al.*, 2007; Pandey, 2008). Calyx (3), synsepalous, are united into a tube with valvate aestivation (Judd, *et al.*, 2006; Heywood, *et al.*, 2007 and Pandey, 1998). Corolla tube cylindrical, the lobes linear and reflexed (Judd, *et al.*, 2006 and Heywood, *et al.*, 2007).

Fertile stamen one, staminodes three (Cronquist, 1981; Heywood, *et al.*, 2007 and Pandey, 2008). Ovary tricarpellary, axile placentation, many ovules in each locule (Heywood, *et al.*, 2007 and Pandey, 2008). The stigma capitate (Pandey, 2008). Fruits are capsule and dehiscent. Seeds are arrillated (Bhattacharj, 2000; Heywood, *et al.*, 2007 and Pandey, 1998).

In histological study, anticlinal walls of both upper and lower surfaces of lamina are straight. Tetracytic stomata are present on both surfaces but lower surface is more abundant than upper ones. Vascular bundle of lamina is collateral and closed type. Vascular bundle of midrib, petiole and leaf sheath are arranged in three rows. The main vascular bundles are between alternating with air canals. The abaxial conducting system consists of an arc of vascular bundles of different sizes that are circular in outline. The adaxial conducting system consists of vascular bundles that are similar in appearance to the main vascular bundles but are smaller in size. Oil cells are embedded in parenchymatous layers of midrib and leaf sheath (Esau, 1953; Tomlinson, 1956; Pandey, 1998 and Ravindran, *et al.*, 2007).

In tuber, periderm layers present. Only one layer of endodermis is present. Vascular bundles are collateral types and below the endodermis. Oil cells, secretory cells and starch grains are scattered in the ground tissues. In root, cortex layer lie below epiblema layer. Only one layer of endodermis and 1 – 2 layers of pericycle are present. Vascular bundle is polyarch in root. Oil cells, secretory cells and starch grains are scattered in the ground tissues. In rhizome, periderm layers present. Vascular bundles are scattered throughout the ground tissue. Oil cells, secretory cells and starch grains are scattered in the ground tissues (Tomlinson, 1956 and Shantha, *et al.*, 1991).

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