

Title	Morphological and Anatomical Characteristics of <i>Coccinia grandis</i> (L.) Voigt and <i>Cucumis trigonus</i> Roxb. in Mandalay Region
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# Morphological and Anatomical Characteristics of *Coccinia grandis* (L.) Voigt. and *Cucumis trigonus* Roxb. in Mandalay Region

Theingi Kyaw<sup>1</sup>& Yin Aye<sup>2</sup>

## Abstract

Morphological and anatomical characteristics of *Coccinia grandis* (L.) Voigt. and *Cucumis trigonus* Roxb. belonging to the family Cucurbitaceae were studied at Department of Botany, University of Mandalay. The specimens were collected from Chanmyathazi and Ngazun Townships of Mandalay Region from June to October, 2017. The morphological characteristics of the two species were annual, climbing or creeping herbs. Leaves were simple, alternate and exstipulate. Inflorescences were axillary or solitary cymes with unisexual, actinomorphic and epigynous flowers. In the anatomical characteristics, the anomocytic types of stomata present on both surfaces of laminae of the two species. The vascular bundles of the two species were bicollateral type in petioles, midribs and stems. The vascular bundles of the roots were radial type, and tetrarch in *Coccinia grandis* (L.) Voigt., and polyarchin *Cucumis trigonus* Roxb. The morphological and anatomical characteristics of the two species are useful in identification of the plant.

**Keywords:** *Coccinia grandis* (L.) Voigt., *Cucumis trigonus* Roxb., Morphology, Anatomy.

## Introduction

The family Cucurbitaceae belonging to the order Cucurbitales, class Magnoliopsida. The family Cucurbitaceae is one of the most important in the Angiosperm taxa (Gabbar 2015). Cucurbitaceae family consists of two subfamilies and eight tribes. Two subfamilies are Cucurbitoideae and Zanonioideae. These tribes are Benincaseae, Cucurbitae, Joliffieae, Melothrieae, Schizopeponae, Sicyeae, Trichosantheae and Zanoneiae (Heywood *et al.* 2007). In Myanmar, 26 genera and 69 species of Cucurbitaceae were recorded by Kress *et al.* (2003).

*Coccinia grandis* (L.) Voigt. is a dioecious plant. Fruit is a smooth, bright red, ovoid to ellipsoid berry 2.5 – 6 cm (Muniappan *et al.* 2009). All the parts of the plant used for liver diseases, diabetes mellitus,

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antimicrobial, asthma, ulcer, urinary tract diseases, allergy, bronchitis (Moideen *et al.* 2011).

*Cucumis trigonus* Roxb. is commonly known as bitter gourd. The fruit is shown to possess various activities such as antidiabetic activity, hepatoprotective activity, cardioprotective activity. The fruit pulp is bitter, acrid, thermogenic, anthelmintic, liver tonic, cardio tonic, appetizer, expectorant and intellect promoting (Subarayan & Thangaraj 2014).

The morphology and anatomy of the three species of Cucurbitaceae family was studied Kyaw San (1995). Mya Mya (1997) also reported a comparative morphology and anatomical study on two species of *Luffa*. Nwe Ni Tin (2009) described Taxonomy and pollen morphology of the Cucurbitaceae, Begoniaceae and Passifloraceae from Upper Myanmar. Some workers have described the morphological and anatomical characteristics of some members of Cucurbitaceae in Myanmar. However, the anatomical characteristics of *Coccinia grandis* (L.) Voigt., *Cucumis trigonus* Roxb. has not been done in Mandalay Region. Therefore, this study was performed for this research work.

The main objective of this study is to describe the morphological and anatomical characteristics of the two species, to compare the anatomical characters among the members of tribe Benincaseae and to get anatomical information that can be fulfill the need of systematic studies on the tribe Benincaseae.

### Materials and Methods

The specimens of *Coccinia grandis* (L.) Voigt. were collected from Aung Pin Le' village ( $21^{\circ} 57' 00.42''$  N and  $96^{\circ} 7' 48.03''$  E), and *Cucumis trigonus* Roxb. were collected from Nawaratt village ( $21^{\circ} 41' 21.39''$  N and  $96^{\circ} 42' 46.57''$  E), Ngazun Township, Mandalay Region from June to October, 2017. The collected specimens were studied and identified by using the literature of Dissanayake (1999) and Nian- he (2007), at the Department of Botany, University of Mandalay.

For anatomical study, the small portions of the specimens were cut into the 15-25  $\mu\text{m}$  thick sections by using a rotary microtome. The dehydration, infiltration, embedding, staining and mounting were made according to Johansen's method (1940).

## Results

### 1. Taxonomical Studies

#### 1.1 *Coccinia grandis* (L.) Voigt. Hort. Suburb. Calcutt. 59. 1845. (Figure 1)

*Bryonia grandis* L., Mant. 1:126. 1767.

*Coccinia indica* Wight & Arn, Prodr. Fl. Penins. Ind. Or. 1: 347. 1834; FKH 112. 1912.

Family : Cucurbitaceae

Scientific name : *Coccinia grandis* (L.) Voigt.

Local name : Kin-mon

Perennial, dioecious, climbing herb, stem and branch 5-angular or slender, solid, green, glabrous; tendril simple, about 1.5 cm long, green, pubescent. Leaves simple, alternate, exstipulate, blades broadly ovate or cordate, glabrous on both surfaces, gland dotted; cordate at the base, margin entire or denticulate along the margin, obtuse at the apex. Inflorescence axillary cyme 1 to 3 flowers, cluster in staminate, solitary in pistillate. Flowers unisexual, actinomorphic, showy, white, ebracteate, pedicellate; pedicelate. Calyx campanulate, 5 – lobed, lobes linear, pale green, glabrous. Corolla campanulate, 5 – lobed, lobes ovate lanceolate, strongly nerved, light green on the base, pubescent. Staminate flowers, stamen 3, free, connate at the base; filaments connate 3.8 to 5.8 mm long, greenish white, pubescent; anther dithecos, conduplicate, basifixed, yellow. Pistillate flower, ovary inferior, oblongoid, many ovules, three parietal placentatae; style long; pale yellow; stigmas 3, each bifid, pale green. Fruits pepo, oblong- ovoid, 4.8 cm by 3.0 cm, indehiscent, smooth, fleshy, green, with white stripes when young, bright red when mature, sweet. Seeds many, compressed, smooth, white.

#### 1.2 *Cucumis trigonus* Roxb. Hort. Beng. 70. 1814. (Figure 1)

Family : Cucurbitaceae

Scientific name : *Cucumis trigonus* Roxb.

Local name : Kasit

Annual, monoecious or dioecious, stout, climbing or creeping herb, stem and branches 5-angular, green, scabrous; tendrils simple, glabrous near the tip, green, scabrous. Leaves simple, alternate, exstipulate; blade suborbicular, palmately 5 lobes, deeply cordate at the base, dentate along the margin, acute at the apex. Inflorescence axillary or solitary cymes. Flower unisexual, actinomorphic, epigynous, yellow, 2.6 cm across at anthesis, bracteolelate, ebracteolate; pedicels of staminate flower

cylindrical, pale yellowish green, pubescent. Calyx campanulate, 5 – lobes; lobes ovate, pale yellowish green, pubescent without. Corolla campanulate, 5 – lobed, lobes elliptic obovate, yellow, pubescent within and without; tube short, glabrous, entire along the margin. Staminate flowers, stamens 3, inserted on the mouth of the corolla tube; filament free, short, pale yellow, glabrous; anther dithecos. Pistillate flowers, ovary inferior, ovoid, unilocular with many ovules on the three parietal placentae; style short; stigmas 3. Fruits pepo, indehiscent, obtusely ellipsoid or trigonous, 3.0 – 5.5 cm by 2.0 to 3.5 cm; yellow when ripe, smooth, glabrous. Seeds many, compressed, corrugate, smooth.

## **2. Anatomical Studies**

### **2.1 Internal structure of the leaves of *Coccinia grandis* (L.) Voigt. (Figure 2)**

#### **Petiole**

In transverse section, the petiole of *Coccinia grandis* (L.) Voigt. studied were cordate-shaped in outline.

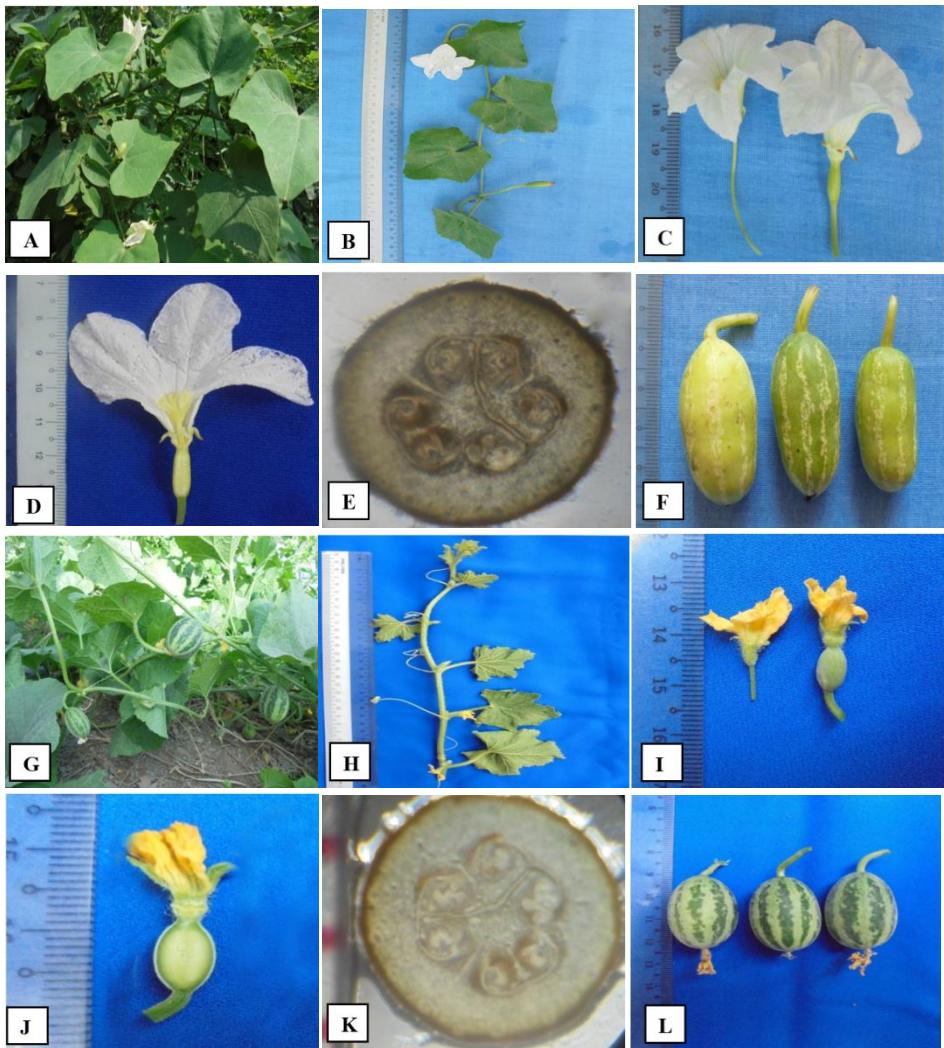
**Dermal Tissue System:** In transverse section, both upper and lower epidermis 1- layered, the cells barrel or oval or rounded in shape.

**Ground Tissue System:** Differentiated into outer collenchymatous and inner parenchymatous tissues. Outer collenchymatous tissue composed of 3-to 6- layered, the cells polygonal in shape; parenchymatous layers lying internal to collenchymatous cells, 3- to 9- layered, the cells polygonal in shape.

**Vascular Tissue System:** Vascular bundles embedded in ground tissue, occurred in 9 groups, bicoallelral type and open, 7 large bundles and 2 small bundles, each bundle surrounded by pericycle 6- to 8- layered, the cells polygonal in shape. Phloem lying on both side of xylem separated by cambium, phloem 5- to 9- layered, the cells rounded or oval in shape. Phloem composed of sieve tubes elements, companion cells, fibers and phloem parenchyma; xylem lying between the phloem, xylem 2- to 5- layered, the cells polygonal in shape, 24.0 – 48.0  $\mu\text{m}$  in length. Xylem composed of vessel elements, tracheids, fibers and xylem parenchyma.

#### **Lamina**

In transverse section, the lamina of *Coccinia grandis* (L.) Voigt. studied are dorsiventral with reticulate venation, 300.0 – 360.0  $\mu\text{m}$  thick.



**Figure 1. Morphological characters of *Coccinia grandis* (L.) Voigt and *Cucumis trigonus* Roxb.**

- A. Habit, B. Inflorescence , C. Close up view of flowers,
- D. L.S of pistillate flower, E. T.S of ovary, F. Fruits of *Coccinia grandis* (L.) Voigt.
- G. Habit, H. Inflorescence, I. Close up view of flowers,
- J. L.S of pistillate flower, K. T.S of ovary, L. Fruits of *Cucumis trigonus* Roxb.

**Dermal Tissue System:** In surface view, the epidermal cells of both surfaces were parenchymatous, polygonal in shape, cell walls straight and thin walled. Stomata present on both surfaces, anomocytic type, oval-shaped with reniform shaped guard cells. In transverse section, both adaxial and abaxial epidermis composed of 1- layered, parenchymatous, the cells rectangular or barrel- shaped.

**Ground Tissue System:** Mesophyll differentiated into palisade parenchyma at upper side and spongy parenchyma at the lower side; palisade cells 1-layered, the cells elongated in shape, compactly arranged; the spongy parenchyma cells 2- to 4- layered, the cells rounded to oval in shape.

**Vascular Tissue System:** Vascular bundles of lateral veins were embedded in the mesophyll tissues, bicollateral type and different in size according to their position; bundle sheath distinct and composed of parenchymatous cells, rounded or oval in shape. Phloem composed of sieve tubes elements, companion cells, fibers and phloem parenchyma. Xylem composed of vessel elements, tracheids, fibers and xylem parenchyma.

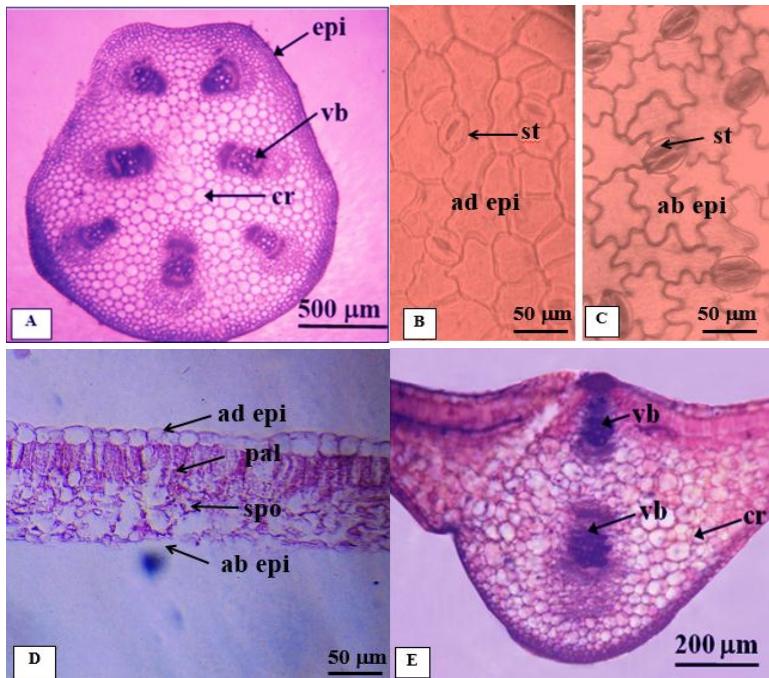
### Midrib

In transverse section, the midrib of *Coccinia grandis* (L.) Voigt. studied were subcircular in shape.

**Dermal Tissue System:** In transverse section, both upper and lower epidermis 1-layered, parenchymatous, the cells barrel or oval – shaped, anticlinal walls straight, outer and inner walls convex.

**Ground Tissue System:** Ground tissue composed of outer collenchymatous and inner parenchymatous cells. Outer collenchymatous cells lying internal to the epidermis, adaxial side collenchymatous cells 3- to 6- layered; abaxial side of collenchymatous cells 2- to 4-layered; parenchymatous cells lying internal to the collenchymatous cells, 3- to 7- layered, the cells oval, rounded or polygonal in shape; at the adaxial side; 4 - to 6- layered, intercellular space present.

**Vascular Tissue System:** Vascular bundles embedded in the ground tissues and occurred in 2 groups of fracially in crescent-shaped, collateral type, open, the middle bundle large and peripheral small, polygonal in shape; phloem present on both side of xylem separated by cambium, phloem 3- to 5- layered, the cells irregular in shape. Phloem composed of sieve tubes elements, companion cells, fibers and phloem parenchyma; xylem 4 - to 6-layered. Xylem composed of vessel elements, tracheids, fibers and xylem parenchyma.



**Figure 2. Internal structure of leaf *Coccinia grandis* (L.) Voigt.**

- A. T.S of petiole.
- B. Adaxial surface view of lamina.
- C. Abaxial surface view of lamina showing stomata.
- D. T.S of lamina.
- E. T.S of midrib  
(ab epi = abaxial epidermal cell, ad epi = adaxial epidermal cell, cr = cortex, pal = palisade parenchyma cell, ph = phloem, spo = spongy parenchyma cell, st = stoma, xy = xylem)

## 2.2 Internal structure of the leaves of *Cucumis trigonus* Roxb. (Figure 3)

### Petiole

In transverse section, the petiole of *Cucumis trigonus* Roxb. studied were oval shape in outline.

**Dermal Tissue System:** In transverse section, both upper and lower epidermis 1-layered, the cells barrel or oval or rounded in shape; upper epidermal cells anticlinal walls straight, outer and inner walls convex; trichomes multiserate, 1- to 3- celled.

**Ground Tissue System:** Differentiated into outer collenchymatous and inner parenchymatous tissues. Outer collenchymatous tissue composed of 2- to 3- layered, the cells polygonal in shape; parenchymatous cells lying

internal to collenchymatous cells, 5- to 10- layered, the cells polygonal in shape, intercellular space present.

**Vascular Tissue System:** Vascular bundles embedded in ground tissue, occurred in 6 to 9 groups, bicollateral type, open, 6 large bundles and 3 small bundles, each vascular bundles surrounded 5- to 7- layered of pericycle. Phloem lying on both side of xylem separated by cambium, phloem 5- to 7- layered. Xylem lying between the phloem, xylem 3- to 4-layered, the cell polygonal in shape.

### Lamina

In transverse section, the lamina of *Cucumis trigonus* Roxb. studied were dorsiventral with reticulate venation, 240.0 – 300.0  $\mu\text{m}$  thick.

**Dermal Tissue System:** In surface view, the epidermal cells of both surfaces were parenchymatous, polygonal in shape, cell walls straight and thin walled, secretory cells present. Stomata present on both surfaces, anomocytic type, oval-shaped with reniform shaped guard cells.

**Ground Tissue System:** Mesophyll differentiated into palisade parenchyma at the upper side and spongy parenchyma at the lower side; palisade cells 1-layered, the cells elongated in shape, compactly arranged; the spongy parenchyma 2- to 4- layered, the cells rounded to oval in shape.

**Vascular Tissue System:** Vascular bundles of lateral veins were embedded in the mesophyll tissues. They were bicollateral type and different in size according to their position; bundle sheath distinct and composed of parenchymatous cells, the cells rounded or oval in shape. Phloem composed of sieve tubes elements, companion cells, fibers and phloem parenchyma. Xylem composed of vessel elements, tracheids, fibers and xylem parenchyma.

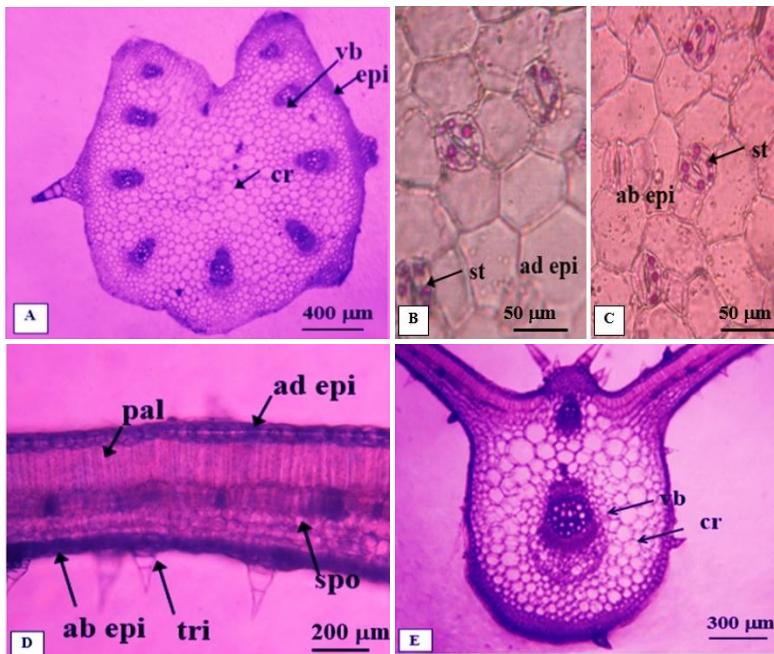
### Midrib

In transverse section, the midrib of *Cucumis trigonus* Roxb. studied were subcircular in shape.

**Dermal Tissue System:** In transverse section, both upper and lower the epidermis 1- layered, the cells oval to barrel in shape; trichome multicellular uniseriate.

**Ground Tissue System:** Ground tissues composed of outer collenchymatous cells and inner parenchymatous cell. Pericycle 5- to 6- layered, the cells polygonal in shape; parenchymatous cells lying internal to the collenchymatous layers, 5- to 9-layered, the cells rounded or polygonal in shape; 5- to - 10 layered at the abaxial side; intercellular space present.

**Vascular Tissue System:** Vascular bundles embedded in the ground tissues, 2 bundles, collateral type, open; phloem 7- to 9- layered, the layers 60.0 – 80.0  $\mu\text{m}$  thick, the cells irregular in shape. Phloem composed of sieve tubes elements, companion cells, fibers and phloem parenchyma; xylem strands arranged in 5- to 7- radial rows, 3- to 6- celled in each row, protoxylem inward and metaxylem outward.



**Figure 3. Internal structure of leaf *Cucumis trigonus* Roxb.**

- A. T.S of petiole.    B. Adaxial surface view of lamina.
  - C. Abaxial surface view of lamina showing stomata.
  - D. T.S of lamina.    E. T.S of midrib
- (ab epi = abaxial epidermal cell, ad epi = adaxial epidermal cell,  
 cr = cortex, pal = palisade parenchyma cell, ph = phloem,  
 spo = spongy parenchyma cell, st = stoma, tri = trichome,  
 vb = vascular bundle, xy = xylem)

### 2.3 Internal structure of the stem of *Coccinia grandis* (L.) Voigt. (Figure 4)

In transverse section, the stem of *Coccinia grandis* (L.) Voigt studied were oval – shaped in outline, distinguishable into dermal, ground and vascular tissue systems.

**Dermal Tissue System:** In transverse section, composed of epidermis and trichomes; epidermis 1-layered, parenchymatous, the cells oval to barrel in shape, both outer and inner walls convex; trichomes present.

**Ground Tissue System:** Composed of cortex, endodermis, pericycle and pith. The cortex differentiated into outer collenchymatous and inner parenchymatous tissues, the outer cortex collenchymatous tissue composed of 3- to 6- layered, the cells polygonal in shape. The inner cortex parenchymatous tissue composed of 3- to 8- layered, the cells were polygonal in shape. Endodermis layer lying inter most of cortex, 1- layered, parenchymatous, the cells barrel- shaped, thin wall. Pith present.

**Vascular Tissue System:** Vascular bundles embedded in the ground tissues, two circle, each with four bundles, b collateral type, open, cambium composed of 2- to 3- layers of tangentially elongated rectangular cells; bundle sheath present and composed of parenchymatous cells, the cells round or oval in shape. Phloem 5- to 8- layered, the cells oval or irregular in shape. Xylem 3- to 5- layered, the cells round or oval in shape.

#### 2.4 Internal structure of the stem of *Cucumis trigonus* Roxb. (Figure 4).

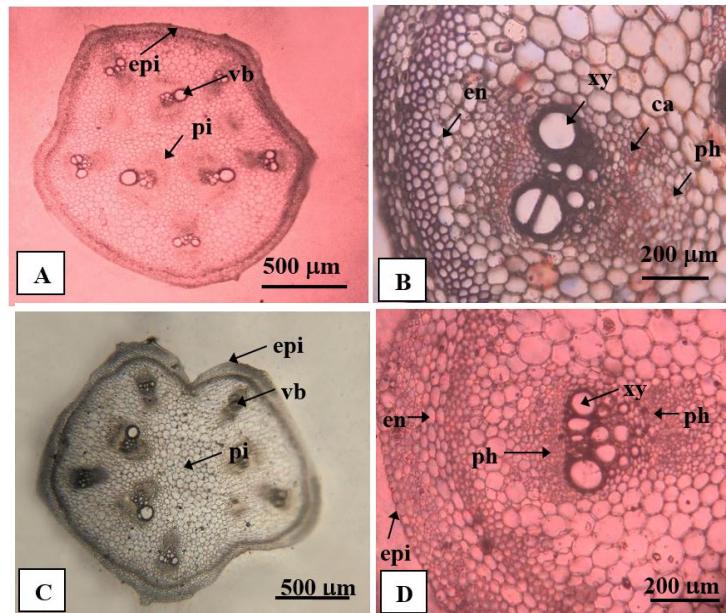
In transverse section, the stem of *Cucumis trigonus* Roxb. studied were cordate-shaped in outline.

**Dermal Tissue System:** In transverse section, composed of epidermis and trichomes, epidermis 1- layered, parenchymatous, the cells rectangular or barrel in shape; trichomes present.

**Ground Tissue System:** Composed of cortex, endodermis, pericycle and pith. The cortex differentiated into outer collenchymatous and inner parenchymatous tissues, the outer cortex collenchymatous tissue composed of 3- to 7- layered, the cells polygonal in shaped. The inner cortex parenchymatous tissue composed of 3- to 10- layered. Endodermis inconspicuous. Pericyclic sclerenchymatous layer forming continuous rings. Outer collenchymatous cells lying internal to the epidermis, adaxial side collenchymatous cells 3- to 6- layered, the cells polygonal in shape; abaxial side collenchymatous cells 3- to 4- layered, the cells irregular or polygonal in shape. Pith present.

**Vascular Tissue System:** Vascular bundles embedded in the ground tissues, two- circled, about 8- to 9-bundles, b collateral type, phloem lying on both sides of xylem separated by cambium; cambium composed of 2- to 3- layers of tangentially elongated rectangular cells; bundle sheath present and composed of parenchymatous cells, the round or oval in shape; phloem

5- to 8-layered on both sides. Xylem 3- to 4-layered, the cells round or oval in shape.



**Figure 4. Internal structure of stem of *Coccinia grandis* (L.) Voigt. and *Cucumis trigonus* Roxb.**

- A. T.S of stem, B. Close up view of vascular bundle of *Coccinia grandis* (L.) Voigt.
- C. T.S of stem, D. Close up view of vascular bundle of *Cucumis trigonus* Roxb.
- (ca = vascular cambium, cr = cork, en = endodermis, epi = epidermis, pi= pith, ph = phloem, vb = vascular bundle,

## 2.5 Internal structure of the root of *Coccinia grandis* (L.) Voigt. (Figure 5)

In transverse section, the root of *Coccinia grandis* (L.) Voigt. studied were circular-shaped in outline.

**Dermal Tissue System:** In transverse section, epiblema 1- layered, parenchymatous, the cells oval or barrel in shape.

**Ground Tissue System:** Composed of cortex, endodermis, pericycle and pith. Cortex homogenous parenchymatous cells, 2- to 12- layered, the cells oval or rounded in shape. Endodermis and pericycle inconspicuous. Pith absent.

**Vascular Tissue System:** Vascular bundles radial type, polyarch, ray cells occur between the xylem and phloem; phloem distributed at the periphery of

the xylem, 4- to 6- layered, the cells polygonal or rounded in shape; xylems trands arranged as radiated group, the cells round or polygonal in shape.

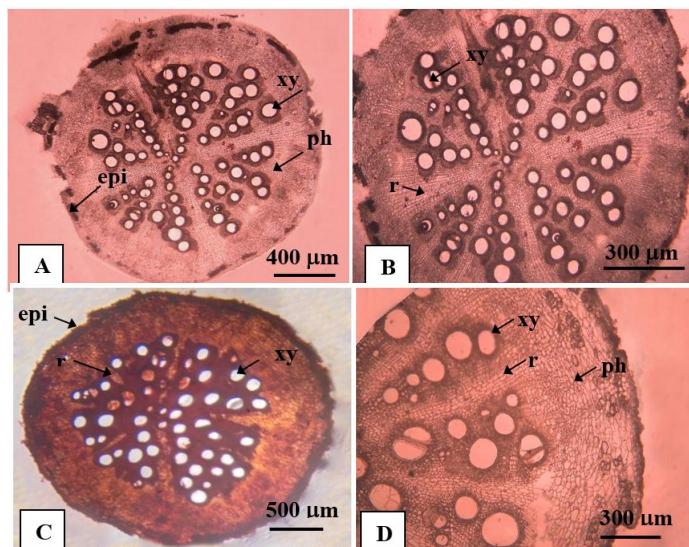
## 2.6 Internal structure of the root of *Cucumis trigonus* Roxb. (Figure 5).

In transverse section, the root of *Cucumis trigonus* Roxb. studied were circular-shaped in outline.

**Dermal Tissue System:** In transverse section, epiblema 1-layered, parenchymatous, the cells oval or barrel in shape.

**Ground Tissue System:** Composed of cortex, endodermis, pericycle and pith. Cortex 2- to 12-layered, parenchymatous, the cells oval or rounded in shape. Endodermis and pericycle inconspicuous. Pith absent.

**Vascular Tissue System:** Vascular bundles radial type, polyarch; ray cells occur between the xylem and phloem; phloem distributed at the periphery of the xylem, 3- to 5-layered. Xylem strands arranged as radiated group, 900.0 – 1320.0  $\mu\text{m}$  thick, the cells polygonal or rounded in shape.



**Figure 5.** Internal structure of root of *Coccinia grandis* (L.) Voigt. *Cucumis trigonus* Roxb.

- A. T.S of root, B. Close up view of vascular bundle of *Coccinia grandis* (L.) Voigt.
- C. T.S of root, D. Close up view of vascular bundle of *Cucumis trigonus* Roxb.

### Discussion and Conclusion

Morphological and anatomical characteristics of *Coccinia grandis* (L.) Voigt. and *Cucumis trigonus* Roxb. belonging to family Cucurbitaceae were studied. The leaf apices were found to be acute in *Cucumis trigonus* Roxb. and obtuse in *Coccinia grandis* (L.) Voigt. Tendrils of the two species were simple. The colour of flowers were white in *Coccinia grandis* (L.) Voigt. and yellow in *Cucumis trigonus* Roxb. The filaments of *Coccinia grandis* (L.) Voigt. were connate and *Cucumis trigonus* Roxb. were free. The shape of fruits was found to be oblongoid in *Coccinia grandis* (L.) Voigt. and ellipsoid in *Cucumis trigonus* Roxb. These characters were agreed with those mentioned by Dissanayake (1997) and Nian-he (2007).

In the transverse sections of petiole, the ground tissues were differentiated into collenchymatous and parenchymatous cells, collenchymatous cells located below the epidermis. The collenchymatous cells of *Cucumis trigonus* Roxb. were 2- to 3-layered and 3- to 6-layered found in *Coccinia grandis* (L.) Voigt. The parenchymatous cells were found 5- to 10-layered in *Cucumis trigonus* Roxb. and 3- to 9-layered in *Coccinia grandis* (L.) Voigt. The vascular bundles of two species were embedded in the ground tissues and separated, arranged in a ring, bicollateral type. The number of vascular bundles were differed from one species to another, these characters were agreed with Metcalfe & Chalk (1957).

In transverse sections, the thickness of laminae was different in both species. Dermal tissues are composed of 1-layered of epidermal cells on both surfaces of the two species. Anomocytic type of stomata were found in adaxial and abaxial surface view of laminae of the two species, these characters were agreed with Metcalfe and Chalk (1957).

In transverse sections of midrib of two species were oval or shield-shaped and subcircular. The ground tissues of midribs were differentiated into two types of tissues, collenchymatous and parenchymatous cells. The vascular bundles of midribs were bicollateral type and circular in shape, these characters were agreed with Pandey & Chadha (1993).

Transverse section of stem of *Cucumis trigonus* Roxb. were found cordate-shaped and *Coccinia grandis* (L.) Voigt. were oval-shaped. The collenchymatous cells layers of *Cucumis trigonus* Roxb. were found to be 3- to 7-layered, 3- to 6-layered were found in *Coccinia grandis* (L.) Voigt. The parenchymatous cells layers of *Cucumis trigonus* Roxb. were 3- to 10-layered, 3- to 8-layered were in *Coccinia grandis* (L.) Voigt. The vascular bundles of two species were bicollateral type. The vascular bundles of stem are organized

into 6 to 8 bundles in both species, these characters were agreed with Metcalfe & Chalk (1950).

In transverse section of the root of the two species were circular-shaped in outline. The vascular bundles of the root were radial type and tetrarch *Coccinia grandis* (L.) Voigt., and polyarch in *Cucumis trigonus* Roxb. These characters were agreed with Metcalfe & Chalk (1957), Pandey & Chadha (1993).

In conclusion, the present research can provide the information of similarities and differences of morphological and anatomical characteristics of the two species. It is hoped that the results of the present work will be useful in identification of family Cucurbitaceae.

### Acknowledgements

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