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Comparative anatomy of tendril and fruit stalk in Curcubitaceae Juss. from Nigeria

Chimezie EKEKE*, Josephine AGOGBUA and 'Bosa Ebenezer OKOLI

Department of Plant Science and Biotechnology, Faculty of Biological Sciences, College of Natural and Applied Sciences, University of Port Harcourt, P.M.B. 5323, Port Harcourt, Rivers State, Nigeria.
**Corresponding Author, E-mail: ekeke.uc@gmail.com*

ABSTRACT

Comparative anatomy of the fruit stalk and tendril of nine (9) species representing 8 genera of Cucurbits from Nigeria has been carried out to complement the existing taxonomic data on the family. Fresh plant materials from representative members of the genera *Zehneria, Luffa, Momordica, Coccinnia, Telfairia, Cucurbita, Lagenaria* and *Cucumis* collected from the wild during field trips to various parts of Nigeria were used for this study. The specimens were wax embedded, sectioned, stained and photographed with Leitz Diaplan photomicroscope fitted with Leica WILD MPS 52 camera. The findings of this study showed that there are similarities and variations in the shape, number and size of vascular bundles, nature of epidermis, layers and nature of sclerenchymatuous, chllenchymatuous and chlorenchymatuous cells in the fruit stalk and tendril could be used to delimit the species of Cucurbitaceae in Nigeria. The variation in number and layers of these tissues among the species studied include vascular bundles (4 – 22 in fruit stalk, 4 – 10 in tendril), sclerenchymatuous cells (1 -8 layers in both tendril and fruit stalk), chlorenchymatuous cells (1 – 8 layers in both tendril and fruit stalk) and collenchymatuous cells (1 – 6 layers in friut stalks, 2 – 6 layers in tendrils). Druses and prismatic crystals were observed among the species and the taxonomic implications of these features are discussed and represent the first report on the anatomy of fruit stalk of these cucurbits from Nigeria.

Keywords: Anatomy, Cucurbitaceae, fruit stalk, Parenchyma, Sclerenchyma, tendril.

INTRODUCTION

The Cucurbitaceae family generally known as cucurbits is most diverse in tropical and subtropical regions with hotspots in Southeast Asia, West Africa, Madagascar, and Mexico (Schaefer and Renner, 2011). Generally, members of the family Cucurbitaceae (cucumbers, watermelons, pumpkin, luffas and zucchini, courgettes, summer squash) are edible and are found growing in all continents of the world. There are about 130 genera and 800 species (Jeffrey, 2005). In West Africa, this family is represented by 24 genera and 54 species (Hutchinson and Dalziel, 1954) while in Nigeria this family has 41 species in 21 genera made up of cultivated and wild species (Okoli, 2013). Some of the cultivated genera are *Citrullus*, *Cucumis*, *Cucurbita*, *Cucumeropsis*, *Lagenaria*, *Telfairia* and *Trichosanthes*. The wild genera are *Coccinia*, *Lageneria*, *Luffa*, *Momordica* and *Zehneria*

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(Okoli, 2013). Most of the Nigerian species of cucurbits are unexploited (Jeffrey, 1964).

All members of the Cucurbitaceae family have a lianous structure of the plant body, the development of characteristic fleshy fruits (referred to as pepo) and a similar mode of sex determination. The Cucurbitaceae are mostly prostrate or climbing herbaceous annuals or perennials, variably pubescent and sometimes with tuberous rootstock (Jeffrey, 1980, 2005; Brent, 2012-2013). They are further characterized anatomically by commonly having angled stems with bicollateral vascular bundles often arranged in two concentric rings. The leaves are petiolate, exstipulate, alternate and usually palmately veined, simple or sedately compound; often with extra-floral nectaries (Jeffrey, 1962; Okoli, 2013). The tendrils are lateral to the petiole base, usually 1 to 4 at each node, branched, simple bifid or multifid with sensitive or non-spiraling base.

According to Stace (1980), the anatomical characterization of plants is not affected by environmental changes. Anatomical knowledge has been utilized to delimit species, genera and families in plants. It is widely used in systematic identification, placing anomalous groups in a satisfactory position in classification and explaining patterns of relationship that may have not been clearly expressed in morphological features. However, though the use of plant morphology and anatomy to delimit Nigerian species of cucurbits has been reported (Hutchinson and Dalziel, 1954; Okoli and Ndukwu, 1992; Agbagwa and Ndukwu, 2004; Ajuru and Okoli, 2013), report on the anatomical features of tendrils and fruit stalk of the species from Nigeria is lacking (Amonwu and Okoli, 2013). Therefore, the objective of this article was to study and highlight the anatomical differences in the tendril and fruit stalk of representative members of 8 genera of Cucurbitaceae in Nigeria with the aim of using the characters to complement the existing taxonomic data on the family. This work represents the first report on the anatomy of fruit stalk of these species from Nigeria.

MATERIALS AND METHODS

Sources of plant materials

Fresh plant materials from representative members of the genera *Zehneria, Luffa, Momordica, Coccinnia, Telfairia, Cucurbita, Lagenaria* and *Cucumis* collected from the wild during field trips to various parts of Nigeria were used for this study (Table 1). The specimens were sent to Forestry Herbarium Ibadan (FHI) for proper identification and authentication.

Anatomical studies

Specimens for anatomical analysis were obtained fresh from matured plants and fixed in FAA (1 part of 40% formaldehyde, 1 part of glacial acetic acid and 18 parts of 70% ethanol) for 12 hrs. They were transferred to 50% and 70% ethanol (each for 2 hours) and finally kept in absolute ethanol at room temperature until required. When required the fruit stalk and tendril were collected from the absolute ethanol and hand-sectioned using sharp razor blades (Okoli and Ndukwu, 1992). Thin sections were stained in 1% Safranin red for two minutes, counter-stained with Alcian blue, mounted on a slide, viewed and photographed with Leitz Diaplan photomicroscope fitted with Leica WILD MPS 52 camera.

RESULTS

The summary of the results of this study are presented in Tables 2 – 3 and Figures 1 – 4.

Fruit stalk anatomy

The results for the anatomical studies of the fruit stalk of the species studied are shown in Table 2 and Figures 1 and 2.

Shape of fruit stalk

Among the different representatives of the genera studied, the shape of the fruit stalk and tendril varied from one genus to another (Table 2). For instace, the fruit stalk is fairly

triangular in *Momordica charantia* (Figure1a), 4-angled in *Zehneria capillacea* (Figure 1c), oval or spherical in *Luffa aegyptiaca* (Figure 1e), *Zehneria scabra* (Figure 1k), *Coccinia barteri* (Figure 2c) and *Cucumis sativus* (Figure 2e), 6-angled in *Cucurbita moschata* (Figure 1g), 5-angled in *Lagenria breviflora* (Figure 1i) and irregular in *Telfairia occidentalis* (Figure 2a).

Number and arrangement of vascular bundles in the fruit stalk

Among the genera, vascular bundles of various sizes and numbers were found to occur in one (1), two (2) or more concentric ring(s) in the fruit stalk or tendril. Differences in number of rings formed by the vascular bundles was predominantly observed in the friut stalk (Figures 1 and 2). In *Momordica charantia, Zehneria capillacea* and *Cucurbita moschata,* the number of vascular bundle was constant numbering 6, 4 and 6 respectively (Table 2). *Luffa aegyptiaca* has 10 – 16 vascular bundles in a single ring (Figure 1e), *Lagenaria breviflora* has 14 – 18 vascular bundles in 2 or more rings (Figure 1i), *Zehneria scabra* 5 – 7 vascular bundles in a sinlge ring, *Telfairia occidentalis* 20 – 22 vascular bundles in 2 or more rings (Figure 2a), *Coccina barteria* has 11 – 15 vascular bundles (rarely 15) in a ring (Figure 2c) and *Cucumis sativus* 7 – 10 vascular bundles in single ring (Figure 2e).

Sclerenchyma tissues in the fruit stalk

The numbr of layers and nature of sclerenchyma tissues varied from one species or genus to another among the genera studied. In some of the species, the sclerenchyma formed continuous layer of cells while in others it is discontinuous (Table 3 and Figures 1-2**).** This character was found to be diagonistic among the representative members of genera studied. For instance, *M. charantia* (Figure 1a) and *C. moschata* (Figure 1g) have 2-6 layers of sclerechyma tissues but in *M. charantia* the sclerenchyma formed continuous layer of cells (Figure 1a**)** while in *C. moschata* it is discontinuous (Figure 1g-h). In *Z. capillacea* (Figure 1c-d) and *L. breviflora* (Figure 1i-j), it formed continuous layer of cells. However, in *Z. capillacea,* it has 1-3 layer of cells (Figure 1f) while in *L. breviflora* it has 2-5 layers of cells (Figure 1l). On the other hand, the sclerenchyma tissues in species are discontinuous in nature with varying number of layers. These include: *L. aegyptiaca* (4-6 layers) (Figure 1e-f), *Z. scabra* (1-4 layers) (Figure 1k-l), *T. occidentalis* (5-8 layers) (Figure 2a-b), *C. barteri* (2-4 layers) (Figure 2c-d) and *C. sativus* (3-5 layers) (Figure 2e-f).

Collenchyma and chlorenchyma tissues in the fruit stalk

Among the species studied, the chlorenchyma was not distinct from the collenchyma in three species namely; *M. charantia* (Figure 1b), *C. moschata* (Figure 1h) and *Z. scabra* (Figure 1l). The layers of collenchyma in *M. charantia* and *C. moschata* are the same (1-6 layers) while in *Z. scabra it* is 2-3 layers. In contrast, collenchyma is distinct from chlorenchyma in other species studied. For example, the layers of collenchyma in the other species include *Z. capillacea* (2-3 layers) (Figure 1d), *L. aegyptiaca* (3-4 layers) (Figure 1f), *L. breviflora* (3-5 layers) (Figure 1j), *T. occidentalis* (2-4 layers) (Figure 2b), *C. barteri* (2-5 layers) (Figure 2d), *C. sativus* (3-6 layers) (Figure 2f) (Table 2). Also the layers of chlorenchyma varied among these species and include *Z. capillacea* (1-2 layers), *L. breviflora* 1-3 layers), *L. aegyptiaca* (2-3 layers), *T. occidentalis* (1-2 layers), *C. sativus* (4-8 layers) and *C. barteri* (4-7 layers).

Nature of Epidermis in the fruit stalk

In all the species studied, the epidermis had only 1-layer and predominantly oval in shape (Tables 2 and 3, Figures 1 – 3). However, there are slight variations in their shape and elongation pattern. Most of the epidermal cells were periclinally elongated as found in *M. charantia, C. moschata L.*

aegyptiaca, *Z. scabra*, *C. sativus* and *C. barteri* while in *T. occidentalis*, it is elongated anticlinally.

Tendril anatomy

The results for the anatomical studies of the fruit stalk of the species studied are shown in Table 3 and Figures 3 and 4.

Shape of tendril

The shapes of the tendrils in the different genera are mostly angular (4-angled, 5-angled or 6-angled), oval or irreguler (Table 3). In *Momordica charantia* (Figure 1b) and *Zehneria capillacea* (Figure 1d) the tendril is 4-angled while that of *Cucurbita moschata* is distinct from all the other species studied having 6-angled shape with hollow pith (Figure 1h). In *Luffa aegptiaca* (Figure 1f), *Lagenaria breviflora* (Figure 1j), *Zehneria scabra* (Figure 1l) and *Cucumis sativus* (Figure 2f) it is 5-angled but *Zehneria scabra* and *Cucumis sativus* have furrows which help the species to grasp and climb on tree or other plant species. This similarity in the shape of the tendrils showed how related the genera are and indicated that the genera *Cucumis* and *Zehneria* are closely related.

Number and arrangement of vascular bundles in the tendril

The number and size of vascular bundles vary from species to species. In some of the species, the number of vascular bundles correspond to the number of angles in the tendril while in other species they are more than the number of angles and comprising big (bicolateral bundle) and small ones which are mostly found sandwiched between the large bicolateral bundles. The number of vascular bundles in the petiole of these species include; *M. charantia* 4 (Figure 3a), *Z. capillacea* 4 (Figure 3c), *L. aegptiaca* 8 (5 large bicolateral and 3 small ones) (Figure 3e), *C. moschata*, 6 (Figure 3g), *L. breviflora* 6 (Figure 3j), *Z. scabra* 5 (Figure 4c), *T. occidentalis* 6 (4 large bicolateral and 2 small ones) (Figure 4d), *C. barteri* 7-10 vacular bundles (Figure 4g) and *C. sativus* 5 (3 large bicolateral and 2 small ones) (Figure 4i) (Table 3). These vascular bundles occurred in a single ring.

Sclerenchyma tissues in the tendril

In all the species studied, the sclerenchymatous cells formed continuous layer beneath the epidermis (Table 3, Figures 3 and 4). However, the number of layers of cells varied from one species to another. For example, *M. charantia* has 2-3 layers (Figure 3b), *Z. capillacea* (1-3 layers) (Figure 3d), *L. aegyptiaca* (4-6 layers) (Figure 3f), *C. moschata* (4-6 layers) (Figure 3h), *L. breviflora* (3-5 undulating layers) (Figure 3i), *Z. scabra* (2-4 layers) (Figure 4c), *T. occidentalis* (3-4 layers) (Figure 4e), *C. barteri* (4-8 layers of undulating cells) (Figure 4g) and *C. sativus* (2-4 layers) (Figure 4i).

Collenchyma tissues in the tendril

Momordica charantia (2-4 layers, more on the protruded ends), *Zehneria capillacea* (2-3 layers prominent at protruded ends), *Cucurbita moschata* (4-6 layer of cells), *Luffa aegptiaca* (2-5 layers), *Lagenaria breviflora* (4-6 layers), *Zehneria scabra* (2-4 layers), *Telfairia occidentalis* (3-4 layers), *Cucumis sativus* (2-5 layers) and *Coccinia barteri* (4-5 layers) Table 3.

Chlorenchyma tissues in the tendril*: Momordica charantia* (2-3 layers, more on the protruded ends), *Zehneria capillacea* (1-3 layers), *Cucurbita moschata* (3-4 layers), *Luffa aegptiaca* (2-3 layers), *Lagenaria breviflora* (2-layer, elongates periclinally), *Zehneria scabra* (1-3 layers), *Telfairia occidentalis* (2-3 layers), *Cucumis sativus* (3-4 layers) and *Coccinia barteri* (3-8 layers) Table 3.

Nature of Epidermis in the tendril

Like the fruit stalk, in all the species studied, the epidermis had only 1-layer and predominantly oval in shape (Tables 3, Figures 3 – 4). However, there are slight variations in their shape and elongation pattern. The epidermal is anticlinally elongated (Table 3).

Calcium oxalate crytals and stomata

Calcium oxalate crystals (druses) were found in three of the genera (*Zehneria*, *Coccina* and *Cucumis*) while prismatic type was observed in only *Momordica* (Figure 1b). These occurred in the tendrils of *Zehneria capillacea*, *Coccina barteria*, *Cucumis sativus* and *Momordica charantia*. Also, giant stomata were observed on the tendrils of *Momordica charantia*, *Zehneria capillacea*, *Lagenaria breviflora* and *Telfairia occidentalis* (Figures 3b, 3j and 3k).

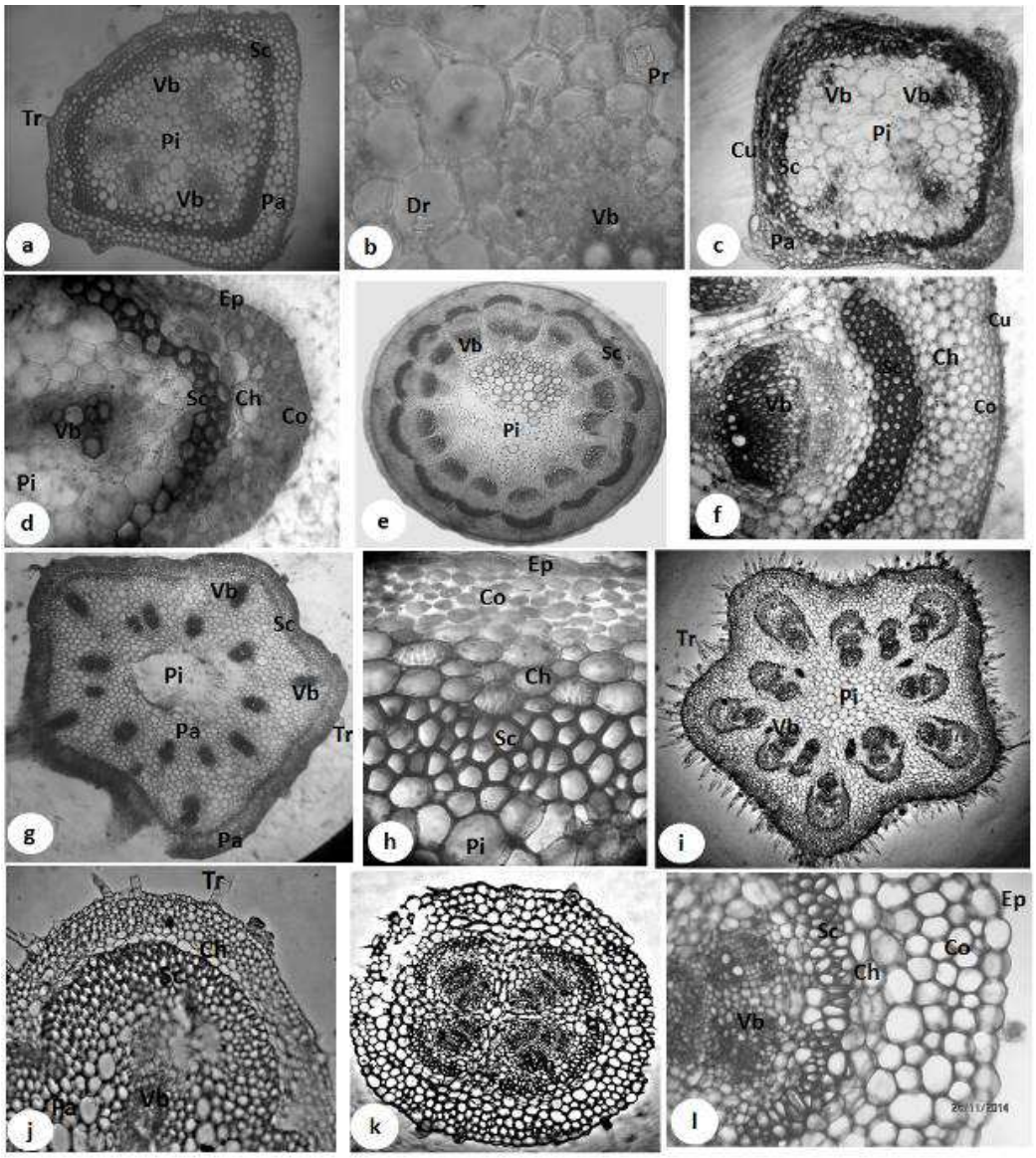

Figure 1: Cross-section of Fruit stalk Anatomy of Cucurbitaceae species. (a & b) *Mormodica charantia*; (c & d) *Zehneria capillacea*; (e & f) *Luffa aegytiaca;* (g & h) *Cucurbita moschata;* (i & j) *Lagenaria breviflora* and (k & l) *Zehneria scabra*; Dr (druse crystal); Pr (prismatic crystal); Vb (vascular bundle); Pi (Pith); Ep (epidermis); Pa (parenchyma); Sc (sclerenchyma); St (stomata) and Cu (cuticle); Tr (trichome).

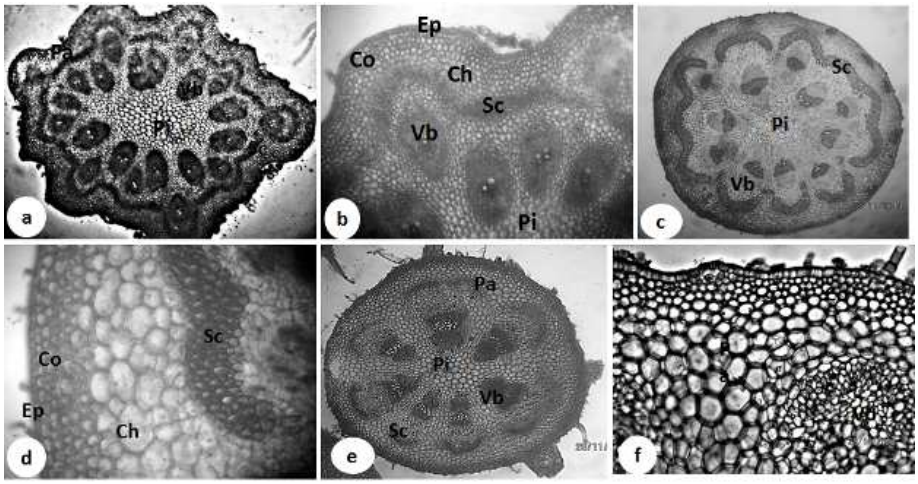

Figure 2: Cross-section of Fruit stalk Anatomy of Cucurbitaceae species. (a & b) *Telfairia occidentalis*; (c & d) *Coccinia barteri*; (e & f) *Cucumis sativus;* Vb (vascular bundle); Pi (Pith); Ep (epidermis); Pa (parenchyma); Sc (sclerenchyma); Cu (cuticle) and Tr (trichome).

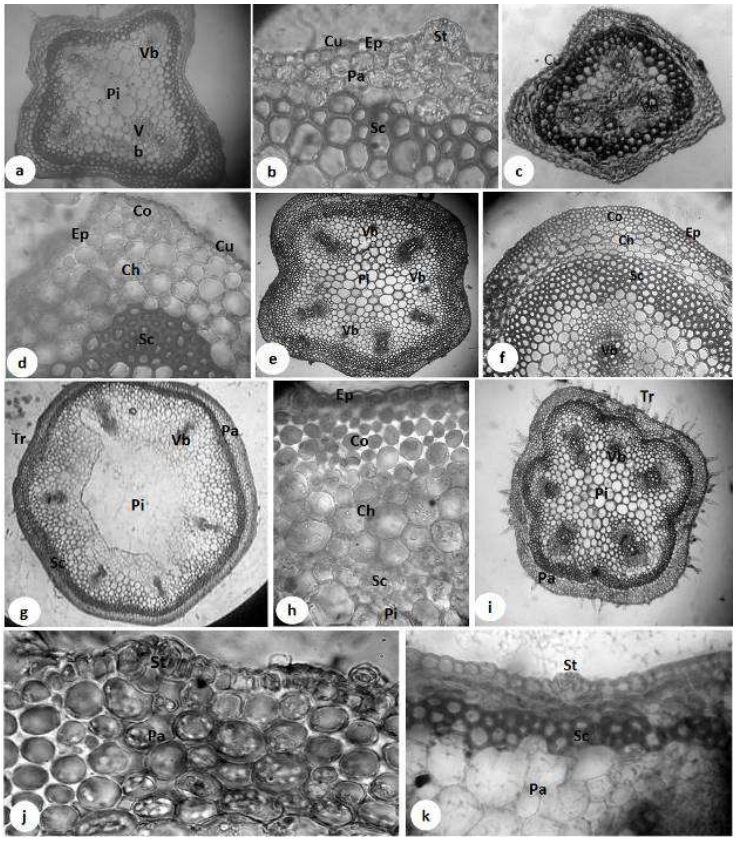

Figure 3: Cross-section of Tendril Anatomy of Cucurbitaceae species. (a & b) *Mormodica charantia*; (c, d & k) *Zehneria capillacea*; (e & f) *Luffa aegytiaca;* (g & h) *Cucurbita moschata;* (i & j) *Lagenaria breviflora*; Dr (druse crystal); Pr (prismatic crystal); Vb (vascular bundle); Pi (Pith); Ep (epidermis); Pa (parenchyma); Sc (sclerenchyma); St (stomata) and Cu (cuticle); Tr (trichome).

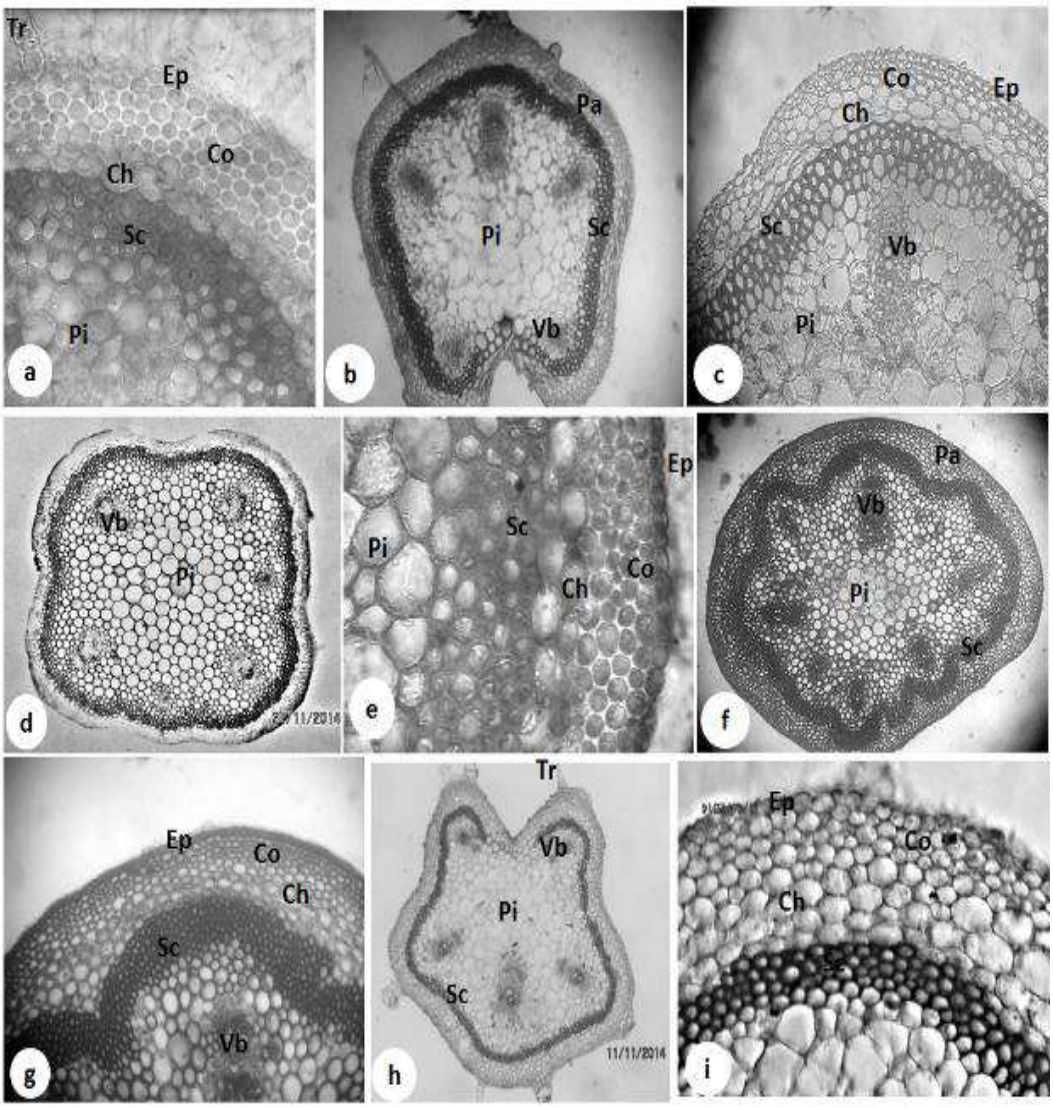

Figure 4: Cross-section of Tendril Anatomy of Cucurbitaceae species. (a) *Lagenaria breviflora*; (b & c) *Zehneria scabra*; (d & e) *Telfairia occidentalis*; (f & g) *Coccinia barteri*; (h & i) *Cucumis sativus;* Dr (druse crystal); Pr (prismatic crystal); Vb (vascular bundle); Pi (Pith); Ep (epidermis); Pa (parenchyma); Sc (sclerenchyma); St (stomata) and Cu (cuticle); Tr (trichome)**.**

Table 1: List and sources of plants studied.

S/N	*Species name*	Locality/State	Name(s) of Collector/ Date (s) of collection	Herbarium Number
1	*Mormodica charantia* L.	Obiga-Asa, Abia State; Igbogo Road, Rivers State	Ekeke, C.; 20/07/2014 and 15/09/2014	UPH/V/1267; UPH/V/1274
2	*Zehneria capillacea* (Schumach.) C. Jeffrey	Rumudike Road, Alakahia, River State	Ekeke, C. and Agogbua, J.; 10/11/2012	UPH/V/1012
3	*Lagenaria breviflora* Benth.	Behind Odums Hotel, East-west Road, Rivers State	Ekeke, C.; 04/08/2014	UPH/V/1270
4	*Cucurbita moschata* (Duch. ex. Lam) Duchesne	Obiga-Asa, Abia State	Ekeke, C.; 24/10/2012	UPH/V/1222
5	*Luffa aegyptiaca* Miller	University of Port Harcourt Biodiversity Centre, Rivers State	Ekeke, C.; 30/10/2013	UPH/V/1216
6	*Zehneria scabra* (L.f.) Sond.	Bank of Taylor Creek, Jamkrama, Bayelsa State	Ekeke, C. and Agogbua, J.; 10/10/2012	UPH/V/1206
7	*Telfairia occidentalis* Hooker	Obiga-Asa, Abia State; University of Port Harcourt Centre for Ecological Studies, Rivers State.	Ekeke, C. and Ogazie, J. C; 12/06/2013	UPH/V/1116
8	*Cucumis sativus* Linn.	Ogoni, Rivers State	Ekeke, C. and Dumbari; 10/11/2014	UPH/V/1294
9	*Coccinia barteri* (Hook. f.) Keay	Aluu Road, Rivers State	Ekeke, C.; 22/10/2014	UPH/V/1278

Table 2: Anatomical characteristics of the friut stalk.

S/N	Species name	Shape of fruit stalk	Number of vascular bundle	Layers of sclerenchyma	Layers of collenchyma	Layers of chlorenchyma	Presnce of crytals	Nature of Epidermis
1	*Momordica charantia*	Triangular	6 (5-large & 1-small)	2-6 continuous	1-6 layer of cells Predominant at the protruded ends	Not distinct from chollenchyma	Druses & prismatic	1-layer, partly oval, elongates periclinally
2	*Zehneria capillacea*	4-angled	4 vascualar bundles	1-3 continuous layers but rarely 1-layer	2-3 layers but rarely 3 layers	1-2 layers but 2-layers at the protruded ends	Absent	1-layer, oval in shape
3	*Lagenaria breviflora*	5-angled	14-18 in 2 or more rings	2-5 continuous layer of cells	3-5 layer of cells	1-3 layer of cells	Absent	1-layer, oval in shape
4	*Cucurbita moschata*	6-angled	6 vascular bundles (5 large and 1 small ones)	Sclerenchyma formed continuous ring with 2-6 layers	1-6 layer of cells Predominant at the protruded ends	Not distinct from collenchyma. 2-3 layers	Druses & prismatic crystals.	1-layer, partly oval, elongates periclinally
5	*Luffa aegyptiaca*	Spherical or oval	10-16 Large bicollateral bundles in concentric ring	Discontinuous ring with 4-6 layers of cells.	3-4 layer of cells	4-6 layer of cells	Absent	1-layer, oval and elongates periclinally
6	*Zehneria scabra*	Spherical or Oval	5-7 vascular bundle a closed concentric ring	1-4 layers of discontinuous cells	2-3 layers but rarely 3-layers	Not distinct from chollenchyma	Absent	1-layer, elongates periclinally
7	*Telfairia occidentalis*	Irregular	20–22 in 2 or more rings extends beyond the sclerenchyma ring	Discontinuous ring with 5-8 layers of cells.	2-4 layers	1-2 layers	Absent	1-layer, oval and elongates anticlinally
8	*Cucumis sativus*	Spherical or oval	7-10 in concentric ring	3-5 discontiuous layer of cells	3-6 layer of cells	4-8 layer of cells	Absent	1-layer, oval , elongates periclinally
9	*Coccinia barteri*	Oval or spherical	11-15 (rarely 15) in concentric ring	2-4 discontiuous layer of cells	2-5 layer of cells	4-7 layer of cells but rarely 7	Absent	1-layer, elongates periclinally

Table 3: Anatomical characteristics of the tendrils.

S/N	Species name	Shape of tendril	Number of vascular bundle	Layers of sclerenchyma	Layers of collenchyma	Layers of chlorenchyma	Presnce of crytals	Nature of Epidermis
1	*Momordica charantia*	4-angled	4-vascualar bundles	2-3 continuous layer of cells	2-4 layers, more on the protruded ends	2-3 layers, more on the protruded ends	Druses and primatic	1-layer, oval in shape
2	*Zehneria capillacea*	4-angled (partly rectangular)	4-vascualar bundles at the angles	1-3 continuous layer of cells	2-3 layers prominent at protruded ends	1-3 layers	Druses	1-layer, oval in shape
3	*Cucurbita moschata*	6-angled with hollow pith	6-vascular bundles at the angles	4-6 continuous layer of cells	4-6 layer of cells	3-4 layer of cells	Druses and prismatic crystals	1-layer, elongates periclinally
4	*Luffa aegptiaca*	5-angled	8 vascular bundles (5 bicolateral & 3 small ones)	4-6 continuous layers of cell.	2-5 layers of cell.	2-3 layers of cell.	Absent	1-layer, oval, elongates anticlinally
5	*Lagenaria breviflora*	Partly 5-angled	6 in single ring	3-5 continuous and undulating layer of cells	4-6 layer of cells	2-layer, elongates periclinally	Absent	1-layer, elongates anticlinally
6	*Zehneria scabra*	5-angled with furrow	5-vascular bundles	2-4 continuous layer of cells	2-4 layer of cells	1-3 layer of cells	Druses	1-layer, elongates periclinally
7	*Telfairia occidentalis*	Irreguar with undulating curticle	Concentric ring of 6 (4 large bicolateral and 2 small ones)	3-4 continuous layers of cell.	3-4 layers of cell.	2-3 layers of cell.	Absent	1-layer, oval in shape
8	*Cucumis sativus*	5-angled with furrow	5 (3large & 2 small ones) formoing closed crescent	2-5 continuous layer of cells	2-5 layer of cells	3-4 layer of cells	Absent	1-layer, oval in shape
9	*Coccinia barteri*	Oval or spherical	7-10 in single concentric ring	4-8 continuous and undulating layer of cells	4-5 layer of cells	3-8 layer of cells	Absent	1-layer, oval in shape

DISCUSSION

Different authors have emphasized the use of anatomical and morphological features in the classification of Cucurbitaceae (Hutchinson and Dalziel, 1954; Metcalfe and Chalk, 1950; Jeffrey, 1980, 2005; Agbagwa and Ndukwu, 2004; Okoli, 2013; Ajuru and Okoli, 2013). Also, tendrils have being regarded as simple or compound axillary shoots which vary from species to species and could be used to delimit them (Okoli, 1987; Amonwu and Okoli, 2013). Furthermore, Jean et al. (2008) described the origin and development of tendrils in *Echinocystis lobata* (Cucurbitaceae). Among the Nigerian Cucurbits, little has been done on the species (Jeffrey, 1964). Also, the anatomy of the tendril and fruit stalk of these species is yet to be given attention. Therefore, the present study focuses on the tendril and fruit stalk anatomy of representative members of different genera in Cucurbitaceae and variations among as supplementary data in the systematics of the species studied.

The findings of this work revealed the presence of bicollateral vascular bundles in the tendrils and fruit stalks of the species. This character is consistent among the genera studied and has been noted by different authors in Cucurbitaceae (Hutchinson and Dalziel, 1954; Metcalfe and Chalk, 1950; Jeffrey, 1980, 2005; Agbagwa and Ndukwu, 2004; Okoli, 2013; Ajuru and Okoli, 2013). This is inline with the works of Hutchinson and Dalziel (1954) and supports the placing of the species in different genera and the family by Hutchinson and Dalziel. Also, among the species studied, there is the presence of continuous and discontinuous layers of sclerenchyma in the fruit stalk but in the tendrils, only continuous layers were observed. The presence of continuous layer of sclerenchymatuous cells in the tendril could be attributed to the fact that the tendril is used for anchorage and therefore needs to be strong enough to sustain the weight of the plant including the fruits especially when climbing. The sclerenchymatous layer of cells varied from species to species. This character was found to be diagnostic among the representative members of genera studied. In the fruit stalk for instance, *M. charantia, Z. capillacea, L. breviflora,* and *C. moschata* have continuous sclerenchymatous layer of cell while in *C. moschata, L. aegyptiaca, Z. scabra, T. occidentalis, C. sativus* and *C. coccinia* it is discontinuous. This observation conforms with the findings of Metcalfe and Chalk (1950) who noted the continuous and discontinuous nature of the sclerenchyma cells in the stem and petiole but in contrast with their observation in the tendril of the Cucurbitaceae.

It is worthy noting that in the tendrils of all the species studied, the collenchyma cells were distinguishable from the chlorenchyma cells. However, in the fruit stalk, the collenchyma and chlorenchyma were not distinct in *M. charantia, C. moschata* and *Z. scabra*. Also, the epidermal cells in the species has 1-layer and predominantly oval in shape but the pattern of elongation was fairly different. For instance, in the friut stalk, *M. charantia, C. moschata, L. aegytiaca, Z. scabra, C. sativus* and *C. barteri* have periclinally elongated cells while in *T. occidentalis* it is anticlinally elongated. Also, in the tendril, the epidermal cells of *C.moschata* and *Z. scabra* were periclinally elongated while in *T. occidentalis* and *L. aegytiaca* it is anticlinally elongated.

The vascular bundles formed single concentric ring in the tendrils of all the species investigated. However, in the fruit stalk they formed 1-3 concentric rings. Also, the number of vacular bundles and sizes varied from one species to the other. These differences could be used to delimit the species. For example, in the tendril, the variation in the vascular include; *M. charantia* 4, *Z. capillacea* 4, *C. moschata,* 6, *L. aegptiaca* 8 (5 large bicolateral and 3 small ones), *L. breviflora* 6, *Z. scabra* 5, *T. occidentalis* 6 (4 large bicolateral and 2 small ones), *C. sativus* 5 (3 large bicolateral and 2 small ones) and *C. barteri* 7-10 vacular bundles. Furthermore, in the fruit stalk of *M. charantia, Z. capillacea* and *C. moschata,* the number of vascular bundles was constant numbering 6, 4 and 6 respectively. *L. breviflora* has 14 – 18 vascular bundles in 2 or more rings, *L. aegptiaca* has 10 – 16 vascular bundles in a single ring, *Z. scabra* 5 – 7 vascular bundles in a sinlge ring, *T.*

occidentalis 20 – 22 vascular bundles in 2 or more rings, *C. sativus* 7 – 10 vascular bundles in single ring and *C. barteria* has 11 – 15 vascular bundles (rarely 15) in a ring. These arrangement of the vacular bundles are peripheral n the tendrils of all the species studied but in the fruit stalk, they are partly peripheral in *L. breviflora, T. occidentalis* and *C. moschata* and central in *Z. scabra* and *C. barteri.* This kind of vascular bundle arrangement has reported in some species of cucurbits (Klusener, 1998; Ishimaru et al., 2007). Similar studies (Metcalfe and Chalk, 1950; Sensarma, 1956; Jeffrey, 1980; Agbagwa and Ndukwu, 2004; Jeffrey, 2005; Omar, 2009; Okoli, 2013; Ajuru and Okoli, 2013; Amonwu and Okoli, 2013) have shown this kind of variations in stem, petiole, midrib and tendril on species from this family. Metcalfe and Chalk (1950) noted the occurrence of vascular inserts in an almost closed crescent or circle in *Bryonia,* proprate in C*ucumis* and *Cucurbita,* separate in *Lagenaria* nd *Luffa* but slightly more open in *Alsunitra* in the petiole of these genera.

Conclusion

In the study, the anatomy of the tendril and fruit stalk of nine (9) species representing 8 genera of Cucurbits in Nigeria has been carried out. This work presents the first comprehensive report on the anatomy of fruit stalk and tendril of these species from Nigeria. The findings showed that there are similarities and variations in the shape, number and size of vascular bundles, nature of epidermis, layers and nature of sclerenchymatuous, collechymatuous and chlorenchymatuous cells in the fruit stalk and tendril could be used to delimit the species of Cucurbitaceae in Nigeria.

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