



Morphological and Anatomical Studies on *Trichosanthes cucumerina* L. (Cucurbitaceae)

C. Ekeke^{1*} and Josephine U. Agogbua¹

¹Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Authors CE and JUA designed the study. Author CE performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2018/44982

Editor(s):

- (1) Dr. Surendra Singh Bargali, Professor, Department of Botany, DSB Campus, Kumaun University, Nainital, Uttarakhand, India.
(2) Dr. Muhammad Shehzad, Department of Agronomy, Faculty of Agriculture, The University of Poonch Rawalakot, Pakistan.

Reviewers:

- (1) Habu Saleh Hamisu, National Horticultural Research Institute, Nigeria.
(2) Joseph Onyango Gweyi, Kenyatta University, Kenya.
(3) Suelen Alves Vianna, Instituto Agronômico de Campinas, Brazil.
Complete Peer review History: <http://www.sciencedomain.org/review-history/27958>

Original Research Article

Received 12 October 2018
Accepted 11 December 2018
Published 24 December 2018

ABSTRACT

Studies on morphological, anatomical and proximate characteristics of *Trichosanthes cucumerina* L. (Cucurbitaceae) was carried out using morphological observation and microtomy in order to determine the relationship between this species and other cucurbits and complement the existing data on the taxon. *T. cucumerina* is a climber that grows up to 30m tall. The leaves are persistent partly ovate, trilobate to heptalobate, slightly hairy to densely hairy with glandular trichomes and non-glandular trichomes (2–5 celled, with a prominent flattened disk of two rows of cells). Tendril bifid, ovary consists of 3 syncarpous carpels and fruits 23.0 – 56.4 cm long. The species is hypostomatic with mainly anomocytic and tetracytic stomata and the epidermal cells appeared irregular in shape. Stem, peduncle, and tendril were angled with 5 – 13 bicollateral vascular bundles in open rings. The petiole and the midrib comprised 1 – 3 accessory vascular bundles. The sclerenchymatous cells were continuous or non-continuous. The tendril and stem have hollow pith. The similarity in morphological and anatomical features of this species and other members of cucurbits depicts taxonomic and evolutionary relationship among them, however; the type of trichomes we observed suggests that this species could be *T. cucumerina* var. *anguina* and not *T. cucumerina*. Further studies using electron microscope is therefore needed to affirm this finding.

*Corresponding author: E-mail: ekeke.uche@uniport.edu.ng;

Keywords: *Trichosanthes cucumerina*; Trichome; syncarpous carpels; bicollateral; vascular bundles; hypostomatic.

1. INTRODUCTION

Trichosanthes cucumerina L. belongs to the subtribe Trichosanthinae of the tribe Trichosantheae of subfamily Cucurbitaceae [1,2] and family Cucurbitaceae. *Trichosanthes* are widely distributed in the tropics and warm temperate regions of South, Southeast and East Asia, central South America, Madagascar and Africa [3]. The wild species of *Trichosanthes* are restricted to southern and eastern Asia, tropical Australia, and Fiji, while India or the Indo-Malayan region is considered the center of origin (De Candolle, 1882 in Bharathi et al. [4] or may be indigenous to India [5]. The family comprises mainly of climbers with about 118 - 130 genera and 800 - 825 species [2,6] and indigenous to Asia [7]. In West Africa, Cucurbitaceae has 24 genera and 54 species [8] and in Nigeria 41 species in 21 genera, have been documented and they are either cultivated or wild species [8,9] and most of these species are unexploited [10]. *T. cucumerina* roots and seeds are anthelmintic and applied for the cure of biliousness and syphilis [11]. Also, the boiled leaf paste is applied to cancerous tissues [12]. The delimitation of a number of *Trichosanthes* L. species is still problematic, which is partly due to their dioecy (either male or female plant known) [13]. However, [14] has used trichome types and characteristics to delimit this species.

Among the Cucurbitaceae, different authors have demonstrated the importance of morphological and anatomical features in their classification [8,9,15,16]. Ekeke et al. [16] reported the importance of tendril and fruit stalk anatomy in the Cucurbit taxonomy Aguoru and Okoli [17] reported the petiole and stem anatomy of West African species of Lecythidaceae and *Momordica* L. Other workers [15,18] reported the root, stem and leaf anatomy and morphology of the genus *Citrullus* Schrad. ex Eckl. & Zeyh., *Cucumis* L., *Cucurbita* L., and *Cucumeropsis* Naud. in Nigeria and Aguoru et al. [19] reported the morphology and anatomy of *Zehneria* Endl. Despite these enormous work on members of Cucurbitaceae, there is little information on the morphological and anatomical description of *T. cucumerina*. Therefore, this work focuses on the morphological and anatomical description of this species to improve its delimitation.

2. MATERIALS AND METHODS

2.1 Plant Material

Fresh plant materials of *T. cucumerina* growing at the University of Port Harcourt Center Ecological Studies and four other localities in Nigeria were collected processed and preserved for this study.

2.2 Morphological Studies

Standard morphological descriptors for Cucurbits germplasm prepared by The International Plant Genetic Resources Institute (IPGRI) Italy, were used to score vegetative and inflorescence characters (IPGRI, 2003). Morphology of the leaf, inflorescence, and fruits of 10 individuals from the four geopolitical zone (South-East, South-South, South-West North Central) in Nigeria was recorded by photography.

2.3 Epidermal Studies

Foliar materials for epidermal studies were collected from fresh plants growing at the Center. The adaxial and abaxial epidermal peels were obtained using sharply pointed forceps or razor blade. Peels were stained with 1% safranin O and rinsed with distilled water to remove excess stain and then mounted in a drop of pure glycerol on clean glass slides. A cover glass was placed over the drop and sealed with nail varnish to prevent dehydration [20]. The epidermal characteristics such as anticlinal cell wall pattern, the arrangement of the epidermal cells, trichome types and shape of epidermal cells were described. The stomatal types were described accordingly [21,22].

2.4 Stem and Petiole Anatomical Studies

Specimens for anatomical analysis (stem, Petiole, tendril, flower stalk, midrib, and peduncle) were obtained fresh from matured plants and fixed in FAA for 12 hours. They were dehydrated, transferred to 70% ethanol and kept at room temperature until required. The stem and petiole were hand sectioned using sharp razor blades [20]. The sections were stained in 1% safranin O and counter stained in Alcian blue for two minutes, viewed and micro-photographed using a photomicroscope (T340B-LED-5M).

3. RESULTS

3.1 Morphological Characteristics

T. cucumerina is a climber which grows up to 30m tall. The leaves are persistent partly ovate, trilobate to heptalobate (Figs. 1b and 1c), 10.5 – 28.6 m long, 8.4 – 23.1 cm wide, leaf base deeply lobed, central leaf narrowly oblong, adaxial surface slightly hairy and the abaxial surface densely hairy and margin spiny. The petiole is hairy and 3.0 – 14.2 cm long. Tendril bifid, fruit 23 – 56.4 cm long, un-ripped/immature fruits whitish to ash (Fig. 1a) with green stripes and yellow when ripped (Fig. 1e) with red edible pulp (Fig. 1f). The seeds are ash in colour with an average size of 6.82 x 13.25 mm (Fig. 1g).

3.2 Epidermal Characteristics

T. cucumerina is hypostomatic and have epidermal cells on both adaxial and abaxial leaf surfaces are irregular in shape, anticlinal cell wall

sinus or undulating (Figs. 2a and 2b). The stomata types are mainly anomocytic and tetracytic and occur only on the abaxial surface (Fig. 2b). Two (2) trichome types namely; glandular trichomes (Figs. 3a, 3b, 3c and 3d) and non-glandular trichomes (Figs. 3e and 3f) were observed on both abaxial and adaxial surfaces of *T. cucumerina* and 2–5 celled with prominent flattened disk of two rows of cells (Figs. 3g and 3h).

3.3 Anatomical Characteristics

3.3.1 Male and female flower stalks and peduncle

The male flower stalk is oval in shape, hairy, with 1-layer of an epidermal cell, 4 – 6 layers of parenchymatous cells (cortex) and 10 – 12 vascular bundles in an open ring. The sclerenchymatous cells occurred in patches (non-continuous) around the bicollateral vascular bundles (Figs. 4, 5 and 6). The peduncle was 8-angled with 10 vascular bundles (Fig. 7). The

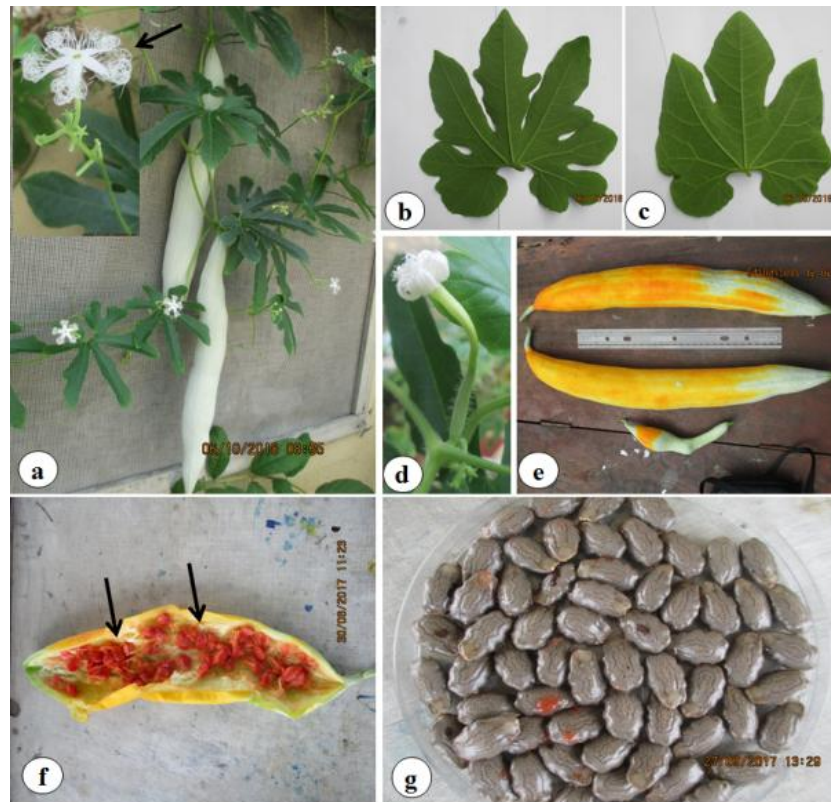


Fig. 1. Morphological characteristics of *T. cucumerina* (a – c) vegetative parts (arrow shows male flower), (d) female flower) and (e – f) ripped fruits (arrows show red edible pulp) and (g) seeds

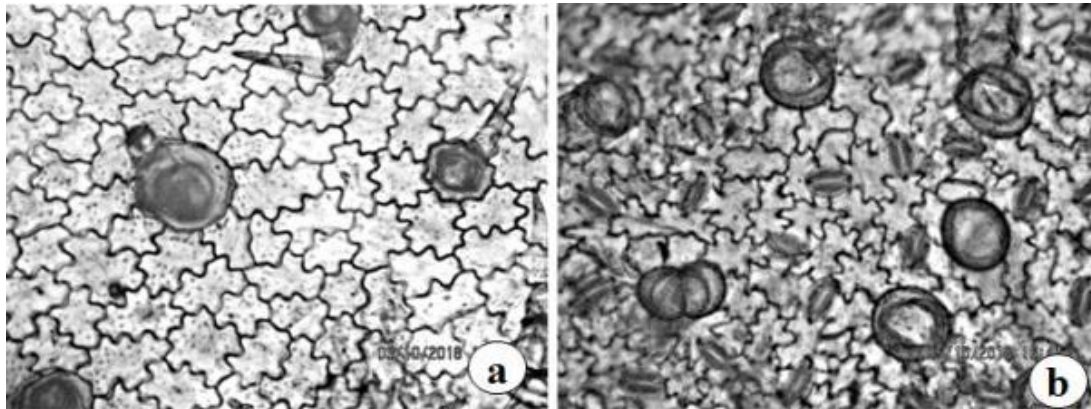


Fig. 2. Epidermal characteristics in *T. cucumerina* (a) upper epidermis and (b) lower epidermis

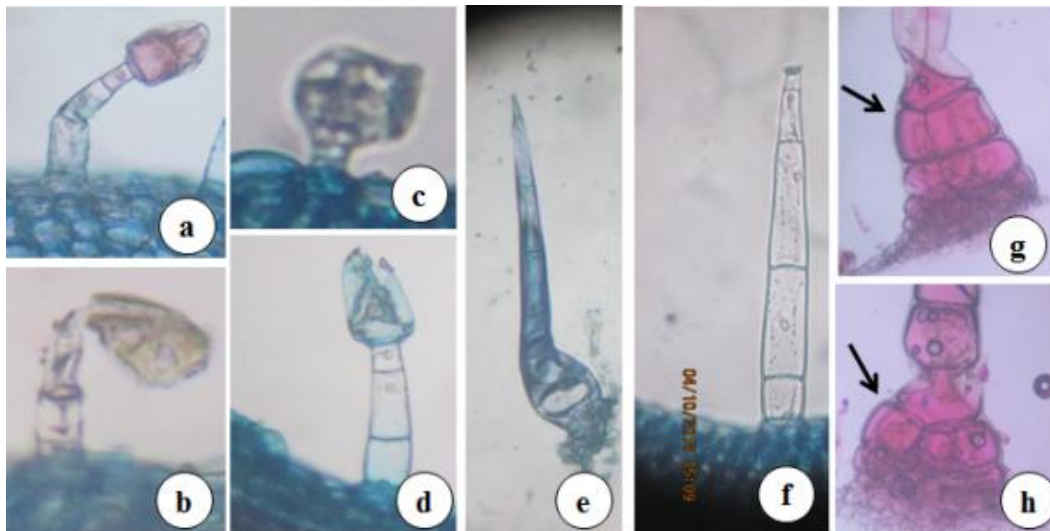


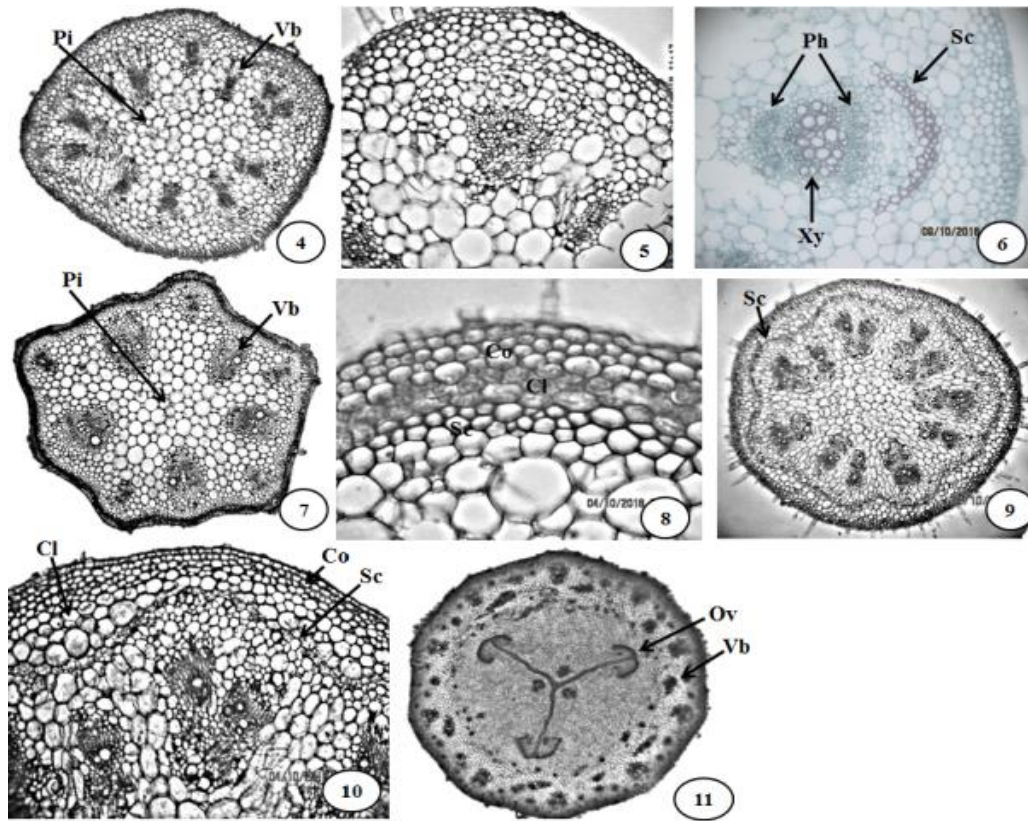
Fig. 3. Trichome types observed in *T. cucumerina* (a – d) glandular trichomes, (e – f) non-glandular trichomes and (g – h) disk at the base of the trichomes

cortex comprised 5 – 6 layers of parenchymatous cells and 1 – 2 continuous layers of sclerenchymatous cells (Fig. 8). The female flower stalk is hairy, has 12 – 13 vascular bundles in an open ring (Fig. 9) and 2 – 3 non-continuous layers of sclerenchymatous cells (Fig. 10). The ovary consists of 3 syncarpous carpels with completely inferior or half-inferior ovary (Fig. 11).

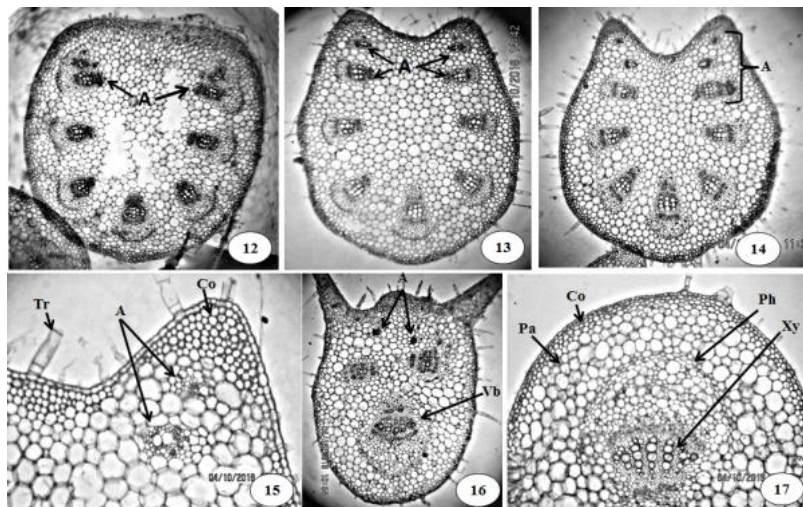
3.3.2 Petiole and midrib

The petiole comprised 5 – vascular bundles in an open arc with 1 – 3 accessory vascular bundles depending on the part of the petiole sectioned or studied. At the base of the leaf or towards the

attachment to the stem it has one dividing accessory vascular bundle (Fig. 12), at median portion two accessory vascular bundles (Fig. 13) and at the distal portion or base of the leaf it has 3 - accessory vascular bundles (Fig. 14). The adaxial cuticle of the basal portion of the petiole is flat while at the median and distal portion it has V-shape. The midrib has 3 – vascular bundles with one accessory vascular bundle (Fig. 16). The edges of the petiole have 3 – 9 layers of collenchyma (Fig. 15). This feature helps in to strengthen the petiole to hold the leaf in position for photosynthesis. The adaxial cuticle of the midrib is slightly elevated and the abaxial parenchymatous cell has 6 – 10 layers (Fig. 17).



Figs. 4 – 11. Floral anatomical features of *T. cucurmerina* (4 – 5) male flower stalk, (6) bicollateral vascular bundle, (7 – 8) penduncle, (9 – 10) female flower stalk and (11) ovary. (Co – Collenchyma, Sc – Sclerenchyma, Vb – Vascular bundle, Cl – Chlorenchyma, Xy – Xylem, Ph – Phloem, Pi – Pith)



Figs. 12 – 17. Anatomy of petiole and midrib in *T. cucurmerina* leaf (12) base of the petiole, (13) median of the petiole, (14) petiole of the distal, (16 – 17) midrib, Co – Collenchyma, Sc – Sclerenchyma, Vb – Vascular bundle, Cl – Chlorenchyma, Xy – Xylem, Ph – Phloem, A – accessory vascular bundle, Tr – trichome, Pa – Parenchymatous cells.

3.3.3 Tendril and stem

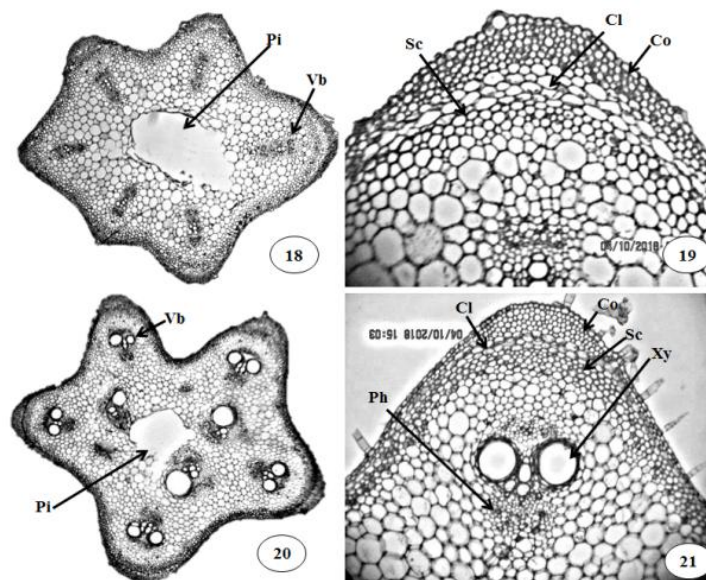
The tendril is 6-angled with 6-vascular bundles, hollow pith and 2 – 4 layers of sclerenchymatous cells (Fig. 18). The edge of the angles has 4 – 8 layers of collenchyma and 2 - 4 layers of chlorenchyma (Fig. 19). The stem is 5-angled with 8-vascular bundles and 2 small ones (6 at the peripheral region and 5 towards the pith), hollow pith, 4 – 7 layers of sclerenchymatous cells and large xylem cells (Figs. 20 and 21).

4. DISCUSSION

Morphological characters among all the Cucurbitaceae species had been reported by Hutchinson and Dalziel [8]. Since *T. cucumerina* was not indigenous to West Africa, it was described by Hutchinson and Dalziel [8]. Despite this, the morphological attributes of this species confirmed that it belongs to Cucurbitaceae. Also, the morphological result corroborates with the description by Jeffrey [1]. Some morphological characters which were common and similar to the previous reports were the leaf type, leaf apex, leaf shape, phyllotaxy, leaf base, fruit type, fruit colour, fruit shape, nature of tendril and seed arrangement.

The application of epidermal features in delimiting flowering plants have been emphasized by many authors

[9,14,15,16,19,21,23,24]. The epidermal characteristics in Cucurbitaceae vary from polygonal to irregular in shape; straight, curved or undulating anticlinal cell wall pattern and species could be mainly amphistomatic with isotricytic, tetracytic and anomocytic stomata. Agogbua et al. [19] reported that *Zehneria* species have straight to undulating anticlinal cell wall pattern with isotricytic, tetracytic and anomocytic stomata. Ajuru et al. [25] and [26] reported similar features in *Citrullus*, *Cucumis*, *Cucurbita*, and *Cucumeropsis* [25]. Also Mohammad and Fahad [14] reported different trichome types such as trichome with thin-walled, irregular in shape and without flattened disk at base, however, some trichomes were slightly conical and end with acute apex in *T. cucumerina*, while trichomes with thin walled, irregular in shape, without flattened disk at base, slightly blunt apex in *T. cucumerina* var. *anguina*, trichomes that are 2–3 celled, with prominent flattened disk of two rows of cells (outer comprises 15–18 celled while inner comprises 7–10 celled) apex ended with pointed tip in *T. dioica*. On the other hand, the trichomes rudimentarily developed, with 8–10 celled flattened base in *T. lepiniana* and trichomes that are 2–3 celled with the well-developed flattened disk at the base, slightly curved at the end with acute apex and are without cystolithic appendages in *T. tricuspidata*. We have also observed similar epidermal features and



Figs. 18 – 21. Tendril and stem anatomy of *T. cucumerina* (18 – 19) tendril and (20 – 21) stem. Note: Co – Collenchyma, Sc – Sclerenchyma, Vb – Vascular bundle, Cl – Chlorenchyma, Xy – Xylem, Ph – Phloem, Pi – Pith)

trichome type in the *Trichosanthes* species in this study addition with glandular trichomes. Based on the trichome types identified in the *Trichosanthes* species studied we suggest that this species occurring in Nigeria is *T. cucumerina* var. *anguina* and not *T. cucumerina*.

Previous studies have also shown that most members of the Cucurbitaceae have angled stem and tendril or even oval or irregular in shape [1,9,16,19]. These authors opined that the layers of sclerechyma cells in the tendrils vary from 1 – 6 forming a continuous ring. Also the collenchyma and chlorenchyma cells found in the stems and tendrils of cucurbits. Our observation was similar to these previous reports and confirms the placement of *T. cucumerina* in Cucurbitaceae.

We observed variation in the number of vascular bundles from the base or proximal end of the petiole, median, and the distal end immediately below the lamina. In dicots similar observations have been made by Metcalfe and Chalk [22] who noted the along the petiole of vascular plants, the number of vascular bundles varies and reported three patterns at the base, median and distal ends. Our observation on the petiolar vascular pattern in *T. cucumerina* was in line with the report of Metcalfe and Chalk [22].

5. CONCLUSION

The species studied display characteristics typical of plants belonging to the family Cucurbitaceae. The similarity in morphological and anatomical features of this species and other members of cucurbits depicts taxonomic and evolutionary relationship among them, however, the type of trichomes we observed suggests that this species could be *T. cucumerina* var. *anguina* and not *T. cucumerina*. Further studies using electron microscope is therefore needed to affirm this assertion.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Jeffrey CA. Review of the Cucurbitaceae. Botanical Journal of the Linnaean Society. 1980;81:233–247.
2. Jeffrey CA. An outline classification of the Cucurbitaceae. In: Bates, D. M. Robinson, R. W. and Jeffrey, C. (eds.). Biology and utilization of the Cucurbitaceae. Cornell University Press Ithaca, NY. 1990;449-463.
3. Sharma OP. Plant taxonomy. Tata McGraw-Hill Publishing Company Limited. New Delhi, India; 2000.
4. Bharathi LK, Behera TK, Sureja AK, Joseph-John K, Wehner TC. Horticultural reviews, Vol. 41, First Edition. Edited by Jules Janick. Published by John Wiley & Sons, Inc. Wiley-Blackwell; 2013.
5. Seshadri VS. Cucurbits. In: T.K. Bose and M.G. Som (eds.), Vegetable crops of India. Naya Prokash, Calcutta. 1986;19.
6. Jeffrey CA. A new system of Cucurbitaceae. Bot. Zh. 2005;90:3332-3335.
7. Sheikh SA, Nowreen J, Md. Ashashan H, Mohammad NI. Cytogenetical and molecular characterization of five commercial varieties in *Trichosanthes anguina* L. *Cytologia*. 2012;77(2):155–162.
8. Hutchinson J, Dalziel JM. Flora of West tropical Africa. Crown Agents, London UK; 1954.
9. Okoli BE. Wild and cultivated cucurbits in Nigeria. Econ. Bot. 1984;38:350-357.
10. Okoli BE. Fluted Pumpkin, Telfairia-The Under-Exploited Golden Treasure. University of Port Harcourt Press, Nigeria; 2013.
11. Ahmed ZU, Hassan MA, Begum ZNT, Khondker M, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA, Haque EU. Encyclopedia of Flora and Fauna of Bangladesh. Angiosperms: Dicotyledons (Balsaminaceae-Euphorbiaceae). Asiatic Society of Bangladesh, Dhaka. 2008;7:546.
12. Rahman MA, Uddin SB, Wilcock CC. Medicinal plants used by Chakma tribe in Hill Tracts districts of Bangladesh. Indian Journal of Traditional Knowledge. 2007;6:508–517.
13. Kanchana P, Raymond VH. Pollen morphology of *Trichosanthes* (Cucurbitaceae), Grana. 2005;44(2):75-90.
14. Mohammad AA, Fahad MAA. Taxonomic significance of trichomes micromorphology in cucurbits. Saudi Journal of Biological Sciences. 2011;18:87–92.
15. Ajuru MG, Okoli BE. The morphological characterization of the melon species in the family Cucurbitaceae Juss., and their Utilization in Nigeria. International Journal of Modern Botany. 2013;3(2):15-19.

16. Ekeke C, Agogbua J, Okoli BE. Comparative anatomy of tendril and fruit stalk in Curcubitaceae Juss. from Nigeria. International Journal of Biological and Chemical Sciences. 2015;9(4):1875–1887.
17. Aguoru CU, Okoli BE. Comparative stem and petiole anatomy of West African species of *Momordica L* (Cucurbitaceae). African Journal of Plant Science. 2012;6(15):403-409.
18. Ajuru MG, Okoli BE. Morphological and Epidermal Studies on Certain Species of *Napoleona P. Beauv.* (Lecythidaceae) in Nigeria. International Journal of Modern Botany. 2012;2(4):115-119.
19. Agogbua J, Ekeke C, Okoli BE. Morpho-anatomical characters of *Zehneria capillacea* (Schumach) C. jeffrey and *Zehneria scabra* (L.F.) sond cucurbitaceae. African Journal of Plant Science. 2015;9(12):457-465.
20. IPGRI. Descriptors for Melon (*Cucumis melo L.*). International Plant Genetic Resources Institute, Rome, Italy; 2003.
21. Ndukwu BC, Okoli BE. Studies on Nigerian *Curcubita moschata*. Nig. J. Bot. 1992;5:18-26.
22. Metcalfe CR, Chalk L. Anatomy of the dicotyledons. 2nd Edn., Clarendon Press, Oxford, UK. 1979;276.
23. Malvey P. Structure, nomenclature and classification of stomata. Acta Botanica Sinica. 2004;44(2):242-252.
24. Metcalfe CR, Chalk L. Anatomy of the dicotyledons. Vol. II. Oxford University Press, Oxford; 1972.
25. Stace CA. The Taxonomic importance of the leaf surfaces. In: Current Concepts in Plant Taxonomy, Heywood, V.H. and D.M. Moore (Eds.). Academic Press, London, Orlando; 1984.
26. Ajuru FWN, Chimamkpa WW. Leaf epidermal characteristics of melons in the family cucurbitaceae Juss. in Nigeria, Agricultural and Bionutritional Research. 2018;2:5-10.

© 2018 Ekeke and Agogbua; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sciencedomain.org/review-history/27958>