

## MICRO-MORPHOLOGICAL STUDY OF THREE MEMBERS OF GENUS *Plectranthus* L. (LAMIACEAE) IN NIGERIA

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### ABSTRACT

Micro-morphological studies of three members of the Genus *Plectranthus* L. (Lamiaceae) in Nigeria were conducted to investigate the anatomical characteristics of taxonomic importance. The following plant samples were collected from various locations in Southwestern Nigeria, namely *Plectranthus aegyptiacus* (Forssk.) C. Chr., *Plectranthus esculentus* N.E.Br. and *Plectranthus monostachyus* (P. Beauv.) B. J. Pollard. The anatomical study of the lamina epidermis, venation pattern and petiole were performed. The Single Linkage Cluster Analysis (SLCA) and one-way Analysis of Variance (ANOVA) with the Duncan Multiple Range Test (DMRT) were used to analyze the parameters, and photomicrographs were employed to document the observations. Foliar epidermal characteristics such as epidermal cell shape, anticlinal wall pattern, stomata types, trichome types and ergastic substances are essential in delimiting the species. The identification of numerous starch grains delimits *P. monostachyus* from the other species, a straight anticlinal wall pattern delimits *P. esculentus*, and the presence of abundant crystal sands delimits *P. aegyptiacus*. Quantitatively, stomata index (S.I.) and trichome length for both adaxial and abaxial surfaces were significantly different ( $P \leq 0.05$ ) among the species. The venation pattern of the studied plant samples also revealed specific characteristics. Irregular vein spacing, eucamptodromous secondary vein category and polygonal areole shape delimit *P. esculentus* from the other species.

**Keywords:** Lamiaceae, *Plectranthus*, Taxonomy, Epidermis, Stomata

### INTRODUCTION

The Genus *Plectranthus* is one of the largest genera of Lamiaceae in the subfamily Nepetoideae, tribe Ocimeae, and subtribe Plectranthinae (Codd, 1985). The name *Plectranthus* was derived from two Greek words: “*Plektron*” and ‘*anthos*’ which mean ‘spur’ and ‘flower’ respectively, about its flower's shape, which is ‘spur-shaped flower’ possessed by some members of the Genus (Codd, 1985). It comprises about 300 species, and is found in tropical and warm regions globally (Retief, 2000; Suddee *et al.*, 2004). It is difficult to recognize some species in this Genus due to their morphological similarities. This observation leads to confusion in the taxonomy of the group (as seen in *Coleus*, in which several names have been assigned to the same species, making a review of their ethnobotanical uses difficult) (Paton *et al.*, 2004). Economically, some *Plectranthus* species serve as ornamentals and are of interest in horticulture, while others serve as food, fodder and flavouring. There are four edible tuber crops in the Genus, namely: *P. esculentus* (African Potato), *P. rotundifolius* (Madagascar Potato), *P. edulis* (Ethiopian Potato) and *P. parviflorus* (Sudan Potato) (Codd, 1985). Some are employed in traditional medicine to cure diseases such as sores

and headaches (Bown, 1995). Members of this Genus are of great interest in ethnobotany, which is the basis for natural product research. Some species are used to make carpets or groundcover and rockeries (Lukhoba *et al.*, 2006). Others serve as vermicides, antiseptics and purgatives (Marques *et al.*, 2012). Despite the commercial value of the members of the Genus *Plectranthus*, the taxonomy of the Genus is unclear. *Solenostemon monostachyus* was recently moved into the Genus *Plectranthus* by Pollard and Paton (2001). This recent realignment in the Genus is an indication of taxonomic conflict. There is a need for a comprehensive study aimed at identifying and resolving some of the taxonomic discrepancies in the Genus. Understanding the micro-morphological traits of the members of the Genus can provide useful information in solving this taxonomic problem.

The work aimed to study the micro-morphological characters (anatomical traits) of three species of *Plectranthus* and to establish anatomical differences and similarities.

### MATERIALS AND METHODS

#### Sample collection

A preliminary study of the Genus *Plectranthus* was

conducted at four different herbaria, i.e., IFE herbarium, University of Ibadan (UI) herbarium, University of Jos (UNIJOS) herbarium and Forestry Research Institute of Nigeria (FRIN). The book on the Flora of West Tropical Africa (Hutchinson and Dalziel, 1968) was also consulted. The samples were collected from different locations within Southwestern Nigeria. Samples collected and their coordinates are as follows: *Plectranthus aegyptiacus* 7°55.52'N 4°33.986'E, *Plectranthus esculentus* 9°50'14.065N 7°45.722'E, and *Plectranthus monostachyus* 7°314.118'N 4°31.417'E.

### Sample preparation

The epidermal layer of the sampled plant was obtained by scraping the leaf surfaces carefully with a new razor blade until the required epidermis was reached. Staining was done with safranin O for about 5 min before mounting. The leaf clearing was carried out by cutting the matured leaves from the median portion of the leaf into a beaker and boiling them in absolute ethanol for 30 min to remove some chlorophyll. The partially cleared leaf was then transferred into 10 g of solid sodium hydroxide per 100 mL water for 30 min for discolouration. The transverse sections of the petiole of each of the species were obtained from the proximal, median and distal regions. The sections were stained with a 10% aqueous solution of Safranin O for 5 min, rinsed severally in water to remove excess stain and counter-stained with Alcian blue for another 5 min to enhance contrast. Then, the sections were passed through a series of ethanol dilutions: 50%, 70%, 80%, 90% and 100%, to enhance dehydration and differentiation, after which they were placed on a clean glass slide with 25 % glycerol solution. The Stomata Index was calculated using the formula:

$$\text{Stomata Index (S.I)} = \frac{S \times 100}{S + E}$$

S= Number of stomata per unit area, E= Number of ordinary epidermal cells and subsidiary cells in the same unit area.

### Microscopic study

Specimens were observed using the light microscope (Leica Dm 500, Germany) under

different power of the objective lenses. Photomicrographs of each slide were obtained, including measurements with linear and square ocular in the standard unit (SI) of micrometre ( $\mu\text{m}$ ).

### Statistical analysis

Data collected from this study were subjected to descriptive statistics and cluster analysis, and their means were tested using the Post Hoc Test (Duncan Multiple Range Test) at Alpha  $\leq$  0.05 level of significance to determine the similarities and variations among the species of the Genus. Photomicrographs of the peels and sections were also obtained.

## RESULTS

### Epidermal Studies

#### *Plectranthus aegyptiacus* (Adaxial) (Plate 1 A1-A3; Tables 1 and 2; Fig. 1)

Epidermal cell shapes are mostly irregular to rectangular; they vary in size from 50  $\mu\text{m}$  to 150  $\mu\text{m}$  in length, with a mean length of  $87.6 \pm 1.46 \mu\text{m}$  and width of  $46.8 \pm 0.45 \mu\text{m}$ . The anticlinal cell wall pattern is wavy to undulating, while periclinal wall patterns are non-striated. Stomata are present, diacytic, with stomata frequency of 1-3 per field of view, and stomata shape is elliptic. The mean stomata length is  $30.4 \pm 0.17 \mu\text{m}$  while the mean stomata width is  $17.5 \pm 0.13 \mu\text{m}$ . Stomata index is 42.87 %. Trichomes were present, largely bicellular and tricellular non-glandular, but rarely unicellular. The mean trichome length is  $451.6 \pm 3.21 \mu\text{m}$ , and crystal sands were observed in this species.

#### *Plectranthus esculentus* (Adaxial) (Plate 1 B1-B3; Tables 1 and 2; Fig. 1)

Epidermal cell shapes are mostly irregular, ranging from rectangular to polygonal occasionally. Epidermal cell sizes range from 50  $\mu\text{m}$  to 125  $\mu\text{m}$  in length. The mean length is  $91.3 \pm 1.23 \mu\text{m}$  and width is  $41.4 \pm 0.37 \mu\text{m}$ . The anticlinal wall pattern is straight, and the periclinal wall pattern is non-striated. Stomata are present, stomata opening is visible, diacytic, with stomata frequency of 3 - 5 per field of view, and stomata shape is elliptic to oval. The mean stomata length is  $34.3 \pm 0.23 \mu\text{m}$ , and the width is  $21.7 \pm 0.16 \mu\text{m}$ . Stomata index is 14.35%. Trichome is present,

non-glandular, mostly multicellular and bicellular. It is rarely unicellular. The mean trichome length is  $277.6 \pm 0.95 \mu\text{m}$ .

***Plectranthus monostachyus* (Adaxial)** (Plate 1 C1-C4; Tables 1 and 2; Fig 1)

Epidermal cells are mostly irregular, and the anticlinal wall patterns are undulating to sinuous, while the periclinal wall pattern is non-striated. The cell sizes vary from  $45 \mu\text{m}$  to  $135 \mu\text{m}$  in length, with a mean length of  $98.40 \pm 1.86 \mu\text{m}$  and a mean width of  $49.3 \pm 0.56 \mu\text{m}$ . Stomata are present, diacytic, randomly distributed with 2-5 stomata frequency per field of view, stomata shape oval, mean length and width are  $31.50 \pm 0.21 \mu\text{m}$  and  $20.35 \pm 0.27 \mu\text{m}$ , respectively. The stomata index is 20%. Trichomes present, non-glandular, mostly unicellular and few bicellular, with scale occasionally present. The mean trichome length is  $84.45 \pm 1.81 \mu\text{m}$ . Starch grains were identified.

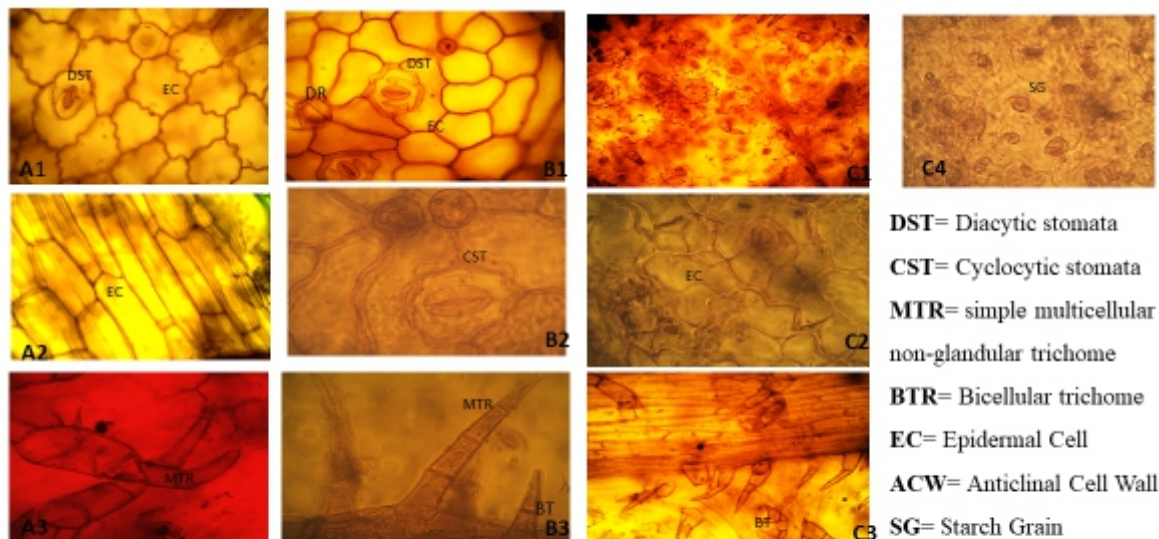
***Plectranthus aegyptiacus* (Abaxial)** (Plate 2 D1-D3; Tables 1 and 2; Fig. 1)

Epidermal cell shapes are irregular, i.e., rectangular to pentagonal. Epidermal cell sizes range from  $45 \mu\text{m}$  to  $115 \mu\text{m}$  in length. The average length is  $86.5 \pm 1.15 \mu\text{m}$ , and the average width is about  $33.4 \pm 0.32 \mu\text{m}$ . Anticlinal wall

patterns are straight, wavy to undulating, while periclinal wall patterns are non-striated. Stomata are present and are of diacytic type, evenly distributed with stomata frequency of 4-10 per field of view. Stomata shape is elliptic to oval. The mean stomata length is  $34.15 \pm 0.20 \mu\text{m}$  and width is  $20.4 \pm 0.21 \mu\text{m}$ ; stomata index is 69.23%. Trichomes are present and are largely tricellular non-glandular. The mean trichome length is  $372.6 \pm 1.60 \mu\text{m}$ .

***Plectranthus esculentus* (Abaxial)** (Plate 2 E1-E3; Tables 1 and 2; Fig. 1)

Epidermal cell shapes are irregular, rectangular to polygonal, and each cell size varies from  $52.5 \mu\text{m}$  to  $122.5 \mu\text{m}$  in length, with a mean length of  $85.95 \pm 1.16 \mu\text{m}$  and mean width of  $48.1 \pm 0.51 \mu\text{m}$ . The anticlinal wall pattern is straight, while the periclinal wall is non-striated. Stomata are present, moderately distributed, with stomata frequency of 3-5 per field of view. The stomata type is cyclocytic (subsidiary cell formed one narrow ring around the guard cells), stomata shape is oval to elliptic, the mean length of stomata is  $34.5 \pm 0.18 \mu\text{m}$ , while the width is  $21.25 \pm 0.17 \mu\text{m}$ . Stomata index is 14.29%. Trichomes are present, bicellular and multicellular non-glandular, and the average length of trichomes is  $203.8 \pm 0.80 \mu\text{m}$ . Cell inclusions are druses.

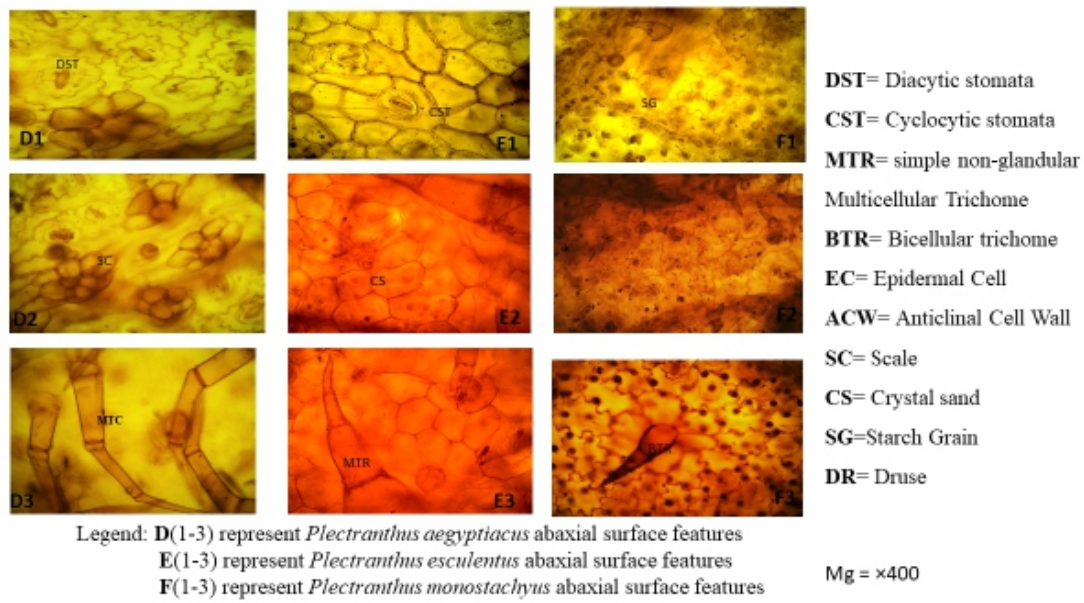


Legend: A(1-3) represent *Plectranthus aegyptiacus* adaxial surface features  
 B(1-3) represent *Plectranthus esculentus* adaxial surface features  
 C(1-4) represent *Plectranthus monostachyus* adaxial surface features

DST= Diacytic stomata  
 CST= Cyclocytic stomata  
 MTR= simple multicellular non-glandular trichome  
 BTR= Bicellular trichome  
 EC= Epidermal Cell  
 ACW= Anticlinal Cell Wall  
 SG= Starch Grain

DR= Druse  
 Mg =  $\times 400$

**Plate 1: shows the Lamina Epidermal features of adaxial surface of the species studied**



**Plate 2:** Shows the Lamina Epidermal features of abaxial surface of the Species studied

***Plectranthus monostachyus* (Abaxial)** (Plate 2 F1-F3; Tables 1 and 2; Fig. 1)

Epidermal cells are irregular to rectangular occasionally polygonal. Anticlinal wall patterns are wavy to undulating while the periclinal wall patterns are non-striated. The epidermal cells have a mean length of  $81.5 \pm 1.24 \mu\text{m}$  and a mean breadth of  $45.4 \pm 0.44 \mu\text{m}$ . Stomata are present,

diacytic, and randomly distributed; stomata frequency is 2-5 per field of view. Stomata shape is elliptic to oval with a mean length of  $31.3 \pm 0.24 \mu\text{m}$  and mean width of  $20.35 \pm 0.28 \mu\text{m}$ . Stomata index is 20 %. Trichomes present are largely unicellular, with few bicellular, non-glandular trichomes. The trichomes have a mean length of  $89.6 \pm 2.08 \mu\text{m}$ . Starch grains were identified.

**Table 1:** Qualitative characters of foliar anatomical features of both adaxial and abaxial surfaces of the species

Features Species	Surface	Epidermal cell shape	Anticlinal wall	Stomata Type/ Shape	Trichome Type	Cell inclusion
<i>Plectranthus aegyptiacus</i>	Ad	Irregular to Rectangular	Wavy to Undulating	Diacytic / Oval or Elliptic	Bicellular and Tricellular non-glandular, rarely Unicellular	Crystal sand
	Ab	Irregular to Rectangular	Wavy to Undulating	Diacytic / Oval or Elliptic	Tricellular non-glandular	None
<i>Plectranthus esculentus</i>	Ad	Polygonal	Straight	Diacytic / Circular	Bicellular and Tricellular non-glandular, rarely Unicellular	None
	Ab	Polygonal	Straight	Cyclocytic/ Circular	Bicellular and Multicellular non-glandular	Druses
<i>Plectranthus monostachyus</i>	Ad	Mostly irregular	Undulating/ Sinuous	Diacytic / Oval	Unicellular and Bicellular non-glandular; Scales	starch grains
	Ab	Irregular occasionally polygonal	Wavy to Undulating	Diacytic / Oval or Elliptic	Unicellular and Bicellular non-glandular	starch grains

Key: Ad - Adaxial; Ab - Abaxial

**Table 2:** Means of foliar anatomical features of adaxial and abaxial surfaces of the three species

Species Characters	Surface	<i>P. aegyptiacus</i> ( $\mu\text{m}$ )	<i>P. esculentus</i> ( $\mu\text{m}$ )	<i>P. monostachyus</i> ( $\mu\text{m}$ )
Epidermal Cell Length (ECL)	Ad	87.6 $\pm$ 1.46 <sup>b</sup>	91.3 $\pm$ 1.23 <sup>b</sup>	98.4 $\pm$ 1.86 <sup>a</sup>
	Ab	86.5 $\pm$ 1.15 <sup>a</sup>	85.95 $\pm$ 1.16 <sup>a</sup>	81.5 $\pm$ 1.24 <sup>b</sup>
Epidermal Cell Width (ECW)	Ad	46.8 $\pm$ 0.45 <sup>b</sup>	41.4 $\pm$ 0.37 <sup>c</sup>	49.3 $\pm$ 0.56 <sup>a</sup>
	Ab	33.4 $\pm$ 0.32 <sup>c</sup>	48.1 $\pm$ 0.51 <sup>a</sup>	45.4 $\pm$ 0.44 <sup>b</sup>
Stomata Length (SL)	Ad	30.4 $\pm$ 0.17 <sup>b</sup>	34.3 $\pm$ 0.23 <sup>a</sup>	31.5 $\pm$ 0.21 <sup>b</sup>
	Ab	34.2 $\pm$ 0.20 <sup>a</sup>	34.5 $\pm$ 0.18 <sup>a</sup>	31.3 $\pm$ 0.24 <sup>b</sup>
Stomata Breadth (SB)	Ad	17.5 $\pm$ 0.13 <sup>b</sup>	21.7 $\pm$ 0.16 <sup>a</sup>	20.4 $\pm$ 0.24 <sup>a</sup>
	Ab	20.4 $\pm$ 0.21 <sup>a</sup>	21.3 $\pm$ 0.17 <sup>a</sup>	20.4 $\pm$ 0.27 <sup>a</sup>
Stomata Index (SI)	Ad	42.87 % <sup>a</sup>	14.35 % <sup>c</sup>	20 % <sup>b</sup>
	Ab	69.23 % <sup>a</sup>	14.29 %	20 % <sup>b</sup>
Trichome Length (TL)	Ad	451.6 $\pm$ 3.21 <sup>a</sup>	277.6 $\pm$ 0.95 <sup>b</sup>	84.5 $\pm$ 1.81 <sup>c</sup>
	Ab	372.6 $\pm$ 1.60 <sup>b</sup>	203.8 $\pm$ 0.80 <sup>b</sup>	89.6 $\pm$ 2.08 <sup>c</sup>
Stomata Count (SC)	Ad	1-3 per field <sup>c</sup>	3-5 per field <sup>b</sup>	2-5 per field <sup>a</sup>
	Ab	4-10 per field <sup>a</sup>	3-5 per field <sup>b</sup>	2-5 per field <sup>c</sup>

Means with the same alphabets across the row are not significantly different at  $P \leq 0.05$  while those with different letters are significantly different. **Ad**- Adaxial and **Ab**- Abaxial

### Venation Pattern Studies

***Plectranthus aegyptiacus*** (Plate 3 G1; Table 3)  
The primary vein category is pinnate, the secondary vein category is semi-craspedodromous, and vein spacing is uniform. The vein angle is acute, and the inter-secondary vein is weak. The areole development of this species is imperfect, with a mean length of  $0.96 \pm 1.41$  and breadth of  $0.63 \pm 0.16$  mm. Areole shape is quadrangular; the veinlet ending ranges from 1 to 2 in number per areole; they are singly diverged.

### ***Plectranthus esculentus*** (Plate 3 G2; Table 3)

The primary vein category is pinnate, the secondary vein category is eucamptodromous, the vein spacing is irregular, and the secondary vein angle is acute with a weak inter-secondary vein.

The areoles are well developed, with a mean length of  $0.46 \pm 2.20$  mm and breadth of  $0.33 \pm 1.44$  mm. Areole shape is quadrangular, and veinlet ending ranges from 2 to 3 in number per areole; they are singly diverged, forked or bifurcated.

### ***Plectranthus monostachyus*** (Plate 3 G3; Table 3)

The primary vein category is pinnate, the secondary vein category is semi-craspedodromous, and the vein spacing is uniform. The vein angle is acute with a weak inter-secondary vein. Areoles are well developed, polygonal to rectangular, with a mean length of  $526.4 \pm 0.38$   $\mu\text{m}$  and mean breadth of  $333.2 \pm 1.81$   $\mu\text{m}$ . Veinlet ending ranges from two to four, diverging singly, forked or bifurcated.

### Petiole Anatomical Studies

Only two species out of the three species in this study have petioles. The species with petioles are *Plectranthus aegyptiacus* and *Plectranthus monostachyus*. *Plectranthus esculentus* is apetiolate.

***Plectranthus aegyptiacus*** (Plate 3 H1-H3; Table 4)

**Outline:** The outline in the proximal region is semi-circular, while the median and the distal regions are oval or circular. The cuticle gently undulates and is non-striated. The epidermis is uniseriate. There are simple unicellular trichomes in the proximal region but no trichomes in the other two regions.

**Cortex:** The cortex consists of two types of cells - oval, circular and polygonal-shaped collenchyma cells and polygonal to oval-shaped parenchyma cells.

**Vasculature:** In the proximal region, the number of vascular bundles ranges from 10 to 11, while the median and distal regions have 5 to 7 vascular bundles in the pith region. There are 2 to 3 rib bundles in the proximal region, but none was observed in the median and distal regions. The vascular bundle type is conjoint, collateral. The pith cavity is filled with polygonal to oval

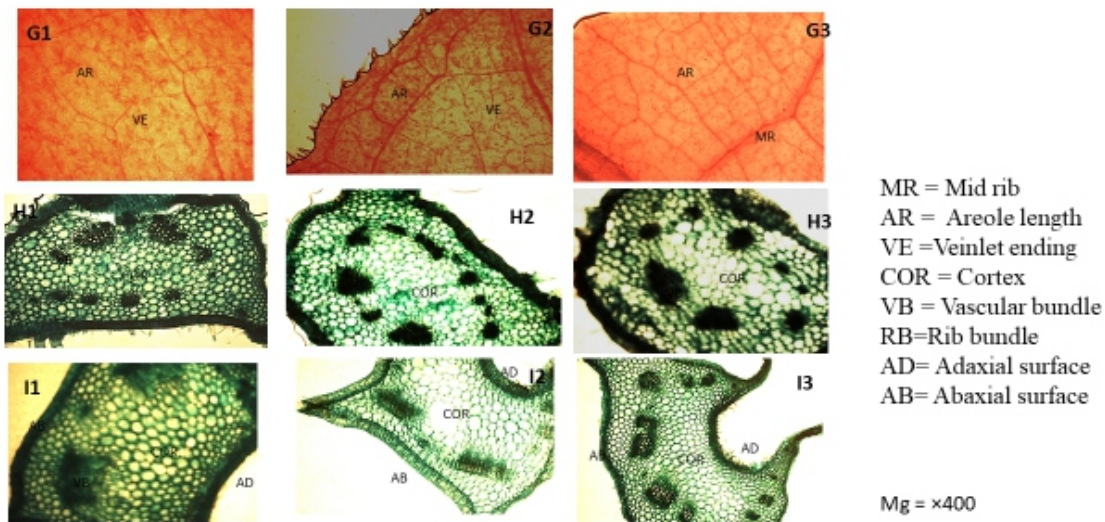
parenchyma cells.

***Plectranthus monostachyus*** (Plate 3 I1-I3; Table 4)

**Outline:** The outlines of the proximal, median and distal regions are rectangular, and the depth of the ventral view (adaxial surface) in the median region (Plate 3 I2) and the distal region varies (Plate 3 I3). The cuticle gently undulates and is non-striated. The epidermis is comprised of uniseriate variously shaped cells and varies from oval circular to polygonal. Simple unicellular trichomes are present in the ventral view of the distal region but absent in the other two regions.

**Cortex:** The cortex is occupied by collenchyma cells of varying shapes, from oval and circular to polygonal. Parenchyma, made up of polygonal to oval, thin-walled cells was also observed.

**Vasculature:** In the proximal region, the vascular bundle ranges from 6 to 7; the vascular bundles in the median region range from 4 to 5 and are partly fused; while in the distal region, there are 10 to 11 vascular bundles in the pith region. Two (2) to 3 rib bundles were observed in the cortex in the three regions. The vascular bundle type is concentric amphicribal.



**Legend:** G(1-3) represent Venation Pattern of the three species (PA, PE & PM) studied

H(1-3) represent Petiole anatomical features of *Plectranthus aegyptiacus* from proximal to distal region

I(1-3) represent Petiole anatomical features of *Plectranthus monostachyus* from proximal to distal region

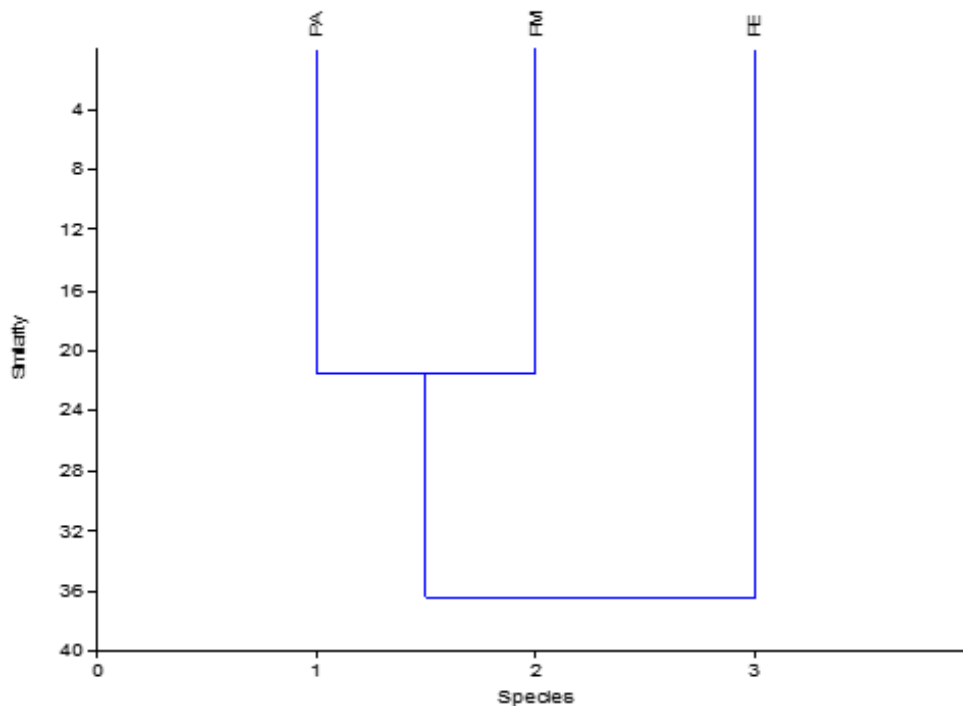
**Plate 3: Shows the Venation Pattern and Petiole Anatomy**

**Table 3:** Summary of the venation pattern of the species studied

Species Character	<i>P. aegyptiacus</i>	<i>P. esculentus</i>	<i>P. monostachyus</i>
<b>Vein angle</b>	Acute	Acute	Acute
<b>1<sup>0</sup> Vein category</b>	Pinnate	Pinnate	Pinnate
<b>2<sup>0</sup> Vein category</b>	Semi craspedodromous	Eucamptodromous	Semi craspedodromous
<b>Vein Spacing</b>	Uniform	Irregular	Uniform
<b>3<sup>0</sup> vein category</b>	Prominent	Not prominent	Prominent
<b>Inter-secondary vein</b>	Weak	Weak	Week
<b>Areole formation</b>	Imperfect	Perfect	Perfect
<b>Areole shape</b>	Quadrangular	Polygonal	Quadrangular
<b>Areole length</b>	0.96 ± 1.41 mm	0.46 ± 2.20 mm	0.53 ± 2.23 mm
<b>Areole breadth</b>	0.63 ± 0.16 mm	0.33 ± 1.44 mm	0.33 ± 1.81 mm
<b>Veinlet ending Number</b>	1-2 per areole	1-3 per areole	2-4 per areole

**Table 4:** Summary of the petiole anatomical features of three regions of *Plectranthus aegyptiacus* and *Plectranthus monostachyus*

Species	Petiole Region	Outline of the region	Layer / Shape of Parenchyma cell	Vascular bundle number and description
<i>Plectranthus aegyptiacus</i>	Proximal	Semicircular	2 -5 layers Polygonal to oval	10 to 11 Conjoint Collateral
	Median	Oval / circular	2-4 layers, Polygonal	8 to 9 Conjoint Collateral
	Distal	Oval / circular	1-3 layers, Polygonal	6 to 7 Conjoint Collateral
<i>Plectranthus monostachyus</i>	Proximal	Rectangular,	1-3 layers, Oval or Polygonal	4, Fused together Concentric, Amphicribal
	Median	Rectangular with slightly hollow ventral view	1-3 layers Circular to Polygonal	5 and joined Concentric, Amphicribal
	Distal	Rectangular with deep hollow ventral view	1-3layers Circular	7 - 8, separated, Concentric, Amphicribal



**Figure 1:** Single Linkage Cluster Analysis (SLCA) of eighteen parameters generated from anatomical of the *Plectranthus* species.

**Legend:**

PA - *Plectranthus aegyptiacus*

PE - *Plectranthus esculentus*

PM - *Plectranthus monostachyus*

**DISCUSSION**

The use of micromorphological traits (anatomical characters) in identification cannot be under-emphasized because they are not affected or altered by environmental factors, and several workers have found them very useful in the classification, identification and delimitation of plants (Arvind *et al.*, 2010; Abdel-Khalik and Karakish, 2016; Arogundade and Adedeji, 2016; Musila *et al.*, 2017; Kalita *et al.*, 2020). The foliar epidermal characteristics such as epidermal cell shape, anticlinal wall, stomata type, trichome types, non-glandular trichome, and scale and ergastic substances are important in delimiting the species studied. The anticlinal wall patterns of the species studied are diagnostic within the Genus in all the species; a wavy to undulating pattern was observed in *P. aegyptiacus*, a straight pattern was seen in *P. esculentus*, while a sinuous pattern was observed in *P. monostachyus*. The presence of irregular epidermal cell shape and undulating or wavy anticlinal wall pattern in *Plectranthus aegyptiacus* contradict the observation of Musila *et*

*al.* (2017), who reported straight anticlinal wall pattern for the species of *Plectranthus*. The three species of *Plectranthus* studied were observed to be amphistomatic, which supports the effectiveness of photosynthesis and transpiration. Stomata type of note in the members of the Genus studied was diacytic except in the abaxial surface of *P. esculentus* where cyclocytic (a situation where one subsidiary cell surrounds the two guard cells) was observed. The stomata index of each species was a diagnostic character for both adaxial and abaxial surfaces and the highest stomata index on both the adaxial and abaxial surfaces was recorded in *P. aegyptiacus* followed by *P. esculentus* and *P. monostachyus*. The longest trichome was observed in *P. aegyptiacus*, and the shortest was observed in *P. monostachyus*. The fact that all the species in this study have trichomes is supported by the assertion of Metcalfe and Chalk (1972) and Kalita *et al.* (2020) that the presence of trichomes is a hallmark among the members of the family Lamiaceae. The venation pattern of the leaves of the species revealed irregular vein spacing,



eucamptodromous secondary vein category and polygonal areole shape for *P. esculentus*, which delimits it from the other species. *P. aegyptiacus* showed an imperfect areole formation. Petiole's anatomical study of the species indicated that the number of vascular bundles decreased from the proximal to the distal region in *P. aegyptiacus*, and increased from the proximal to the distal region in *P. monostachyus*.

The Single Linkage Cluster Analysis (SLCA) revealed a closer relationship between *Plectranthus aegyptiacus* and *Plectranthus monostachyus* as they clustered together with *Plectranthus esculentus* separated from them.

## CONCLUSION

The study revealed some interspecific and intra-generic characters of taxonomic value in the classification of the Genus *Plectranthus*. However, each species also had peculiar diagnostic characteristics that might assist in their identification and delimitation.

## ACKNOWLEDGEMENT

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