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Taxonomic Significance of the Vegetative Anatomy of Five Species in the Family Malvaceae in Rivers State, Nigeria

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Abstract: *This study investigated the leaf foliar epidermal features of five species in the family Malvaceae. The five species studied were Hibiscus rosa- sinensis, Abelmoschus esculentus, Abelmoschus caillei, Sida acuta and Sida rhombifolia. The Malvaceae family consists of herbs, shrubs or lianas although there are some trees. The aim of this study was to investigate the foliar epidermal anatomy of five species belonging to three genera of the Malvaceae family with the view to finding additional characters of taxonomic importance for the delimitation of the family and to further enhance the understanding of the taxonomic relationships in the genera. Foliar epidermal peels were obtained by standard methods, and examined using a light microscope with photographs taken using a micrograph unit. The results indicated that patterns of the epidermal cell walls were undulating, sinuous and waxy and the shapes were predominantly polygonal to irregular. Leaves were amphistomatic except in H. rosa sinensis and S. rhombifolia. Six stomatal types (Anisocytic, anomocytic, diacytic, amphepericytic, paracytic, anomalous stomata) were identified in the species and were considered taxonomically diagnostic in delimiting the species. Anisocytic and anomocytic stomata were present in almost all the species. Stomatal index was highest in S. acuta and lowest in A. esculentus. Unicellular and granular trichomes were observed in all the studied species except in A. caillei and S. rhombifolia. Stellate trichomes were observed in S. acuta only. Druse crystals were present on the adaxial surfaces of H. rosa sinensis and S. acuta and on the abaxial surfaces of A. caillei and A. esculentus. The results obtained in the study could be used as diagnostic tools for delimiting the species*

Keywords—*Abelmoschus*; Druse crystals; Foliar Epidermis; *Hibiscus*; Malvaceae; *Sida*; Stomata; Trichomes

1. INTRODUCTION

The family Malvaceae family consists of about 85 genera and 1500 species [1]. The family is cosmopolitan in distribution with most of the species confined to the tropics and subtropics. Thirteen (13) genera and 78 species have been recorded in West Africa [2]. *Hibiscus* is the largest genus in terms of number with about 300 species [3] and *Hibiscus rosa-sinensis* L. is the most popular species while *Abelmoschus sp* is a common vegetable in Nigeria.

Members of the family are mostly herbs, shrubs, lianas or trees [4]. They can easily be recognized in the field by their funnel shaped flower with five separate petals and a distinct column of stamens surrounding the pistil. Their leaves are alternate with well developed stipules, petiolate with palmate venation [5]. A characteristic feature of the family is the presence of a natural gump (mucilage, pectin and asparagines) which gives them a slimy texture when crushed. This feature is pronounced even in the dry desert species.

Owing to the high fiber content, the Malvaceae family is of great economic importance throughout the world. Nearly all genera can produce some kind of fibres. The genus *Gossypium* is the source of the commercial cotton. After the removal of fiber, cotton seeds are used as fodder to feed cattle and the seed oil used for edible purposes while the oil cake is useful as good organic manure. Okro, *A. esculentus* (L) Moench, *A. manihot, A. callei* (A.Chev.) Stevels, *Hibiscus sabdariffa* are eaten as vegetable in all the parts of the country. *Urena lobata, Hibiscus tiliaceus, Thespesia populnea* are good sources of wood and fiber. The roots of *Sida cordata* and *Hibiscus hispidissimus* are used in the treatment of urinary tract diseases due to their cooling, diuretic and anti-inflammatory properties [6]. Many species are cultivated as ornamentals including the popular *Hibiscus rosa sinensis, H. mutabilis, H. radiata, Abutilon striatum*. Several species of the genera *Sida* and *Abutilon* are common weeds along road sides and equally serve as fodder for sheep and cattles.

Anatomical features are of great taxonomic value as demonstrated by several researchers [7-12] reported that anatomical features are widely used for identification and delegation of correct and satisfactory position in classification as well as for indicating relationship pattern and phylogeny. [13] used anatomical characters as one of the parameters in delimiting the different types of melons in the family Cucurbitaceae. Anatomy has also proved to be useful in the identification of materials that are not accompanied by flora parts or fruit such as commercial samples of medicinal plants [14].

The micromorphological characteristics of foliar epidermis have played an important role in taxonomy from the point of view of a plant systematic. The epidermis possess a number of important diagnostic characters that offer valuable clues for taxonomic identification such as size, shape, distribution of stomata [15], guard and subsidiary cells [16], as well as presence or absence of trichome and their different types and lengths [8]. The presence or absence of foliar appendages is very significant in delimitation of taxa especially at the generic and specific

levels. They could also reflect light and can reduce the rate of transpiration [17].

Foliar anatomical studies in the leaves of different members of the family Malvaceae have been carried out by [11] [18-22]. Foliar trichomes have provided great deal of systematic evidence as demonstrated by [23] in their anatomical investigation of leaves of *Sida* in Uyo, Nigeria. They were able to determine the taxonomic relationship between the *Sida* species as well as provide artificial keys for easy identification of the species.

The distribution of stomata and subsidiary cells (cells surrounding the guard cells that are different from the epidermal cells) on the adaxial and abaxial surfaces of the epidermis is considered as good biosystematics tool. [24] reported thirty one stomata types in vascular plants. Stomatal character is diagnostic in several plant families and as such use in delimitation of such families as shown by various researchers [2,11].

Trichomes are microscopic plant hairs although they can be visible in certain plant families like the Malvaceac and Asteraceae. Their role is to prevent excessive loss of water and also scare herbivores. [25] reported that the morphology of the trichome provided important epidermal feature in delimiting the family Combretaceae.

Calcium carbonate is present in the leaves, stem and roots. They can be the form of raphides, sands, druse and prism and are believed to play the role of storage in plants. Their presence, types and distribution are diagnostic and considered significant tools in biosystematics. [26] highlighted the taxonomic importance of the presence and distribution of druses. [11,24,27,28] reported the presence of druse crystal as taxonomically significant in their study. [29] reported the presence of calcium oxalates in *Dioscorea* starch grain and confirmed their storage roles. Many creditable taxonomic works have been carried out by many researchers in several members of the Malvaceae. In Nigeria, the information characterizing these species are scanty and the morphological approach seem to be predominant especially for the *Abelmoschus* species. This work is therefore focused on the micromorphological parameters of these species to bridge the gaps by providing additional information for taxonomic purpose. authenticated at the department of Plant Science and Biotechnology herbarium in Rivers State University, Rivers state, Nigeria and also, field reference materials and relevant taxonomic literatures were consulted for authentic identification. Voucher specimens were deposited in the Department of Plant Science and Biotechnology herbarium.

2. MATERIALS AND METHODS

2.1 Sample Collection

The five Plant species were collected from different locations in Rivers state. Collected plant specimens were

2.2 Foliar Epidermal Study

The median portion of the leaves of each of the species, which is well expanded, was scrapped following the standard method described by [30] and modified by [31] The transparent epidermal peels from both the adaxial and abaxial surfaces were soaked in distilled water to rehydrate the cells after which they were stained with Safranin O for 3 minutes and later rinsed again in distilled water. The specimens were mounted in dilute glycerine in readiness for microscopic examination, and cover slips placed correctly. These were examined using a light microscope and photomicrographs were taken with a micrograph unit.

Characters observed on the epidermal peels were: the epidermal cell shape, the anticlinal cell wall patterns, stomatal shape and size, Trichome types and presence or absence of druse crystals. To calculate the stomatal area, the length and breadth of 50 stomata from at least five different plant accessions were multiplied. Stomata indices of the adaxial and abaxial surfaces were calculated using the formula:

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

Where S = Number of stomata and E = Number of ordinary epidermal cells plus the subsidiary cells in the same unit area. Photomicrographs of both the adaxial and the abaxial surfaces of the epidermis were taken.

3. RESULTS

Tables 1-5 show the summary of the important quantitative and qualitative foliar epidermal features of the abaxial and adaxial surfaces respectively.

3.1 Abaxial Epidermal Characteristics

In *H. rosa- sinensis*, Stomatal distribution was hypostomatic with Anomocytic, anisocytic and diallelocytic stomata present. Stomatal size was 63.96×33.15µm, stomatal pore was 20.83±0.82µm. The size of guard cells were 57.54±1.24 × 20.03±1.36µm. Stomatal index was 26.89%. Epidermal cells were pentagonal to polygonal and measured 135.88 ± 1.73 × 71.78±0.6 µm. Anticlinal walls were slightly undulating and the thickness of the epidermal wall measured 3.15±0.13µm. Four armed stellate trichome was observed. Druse crystals were present along the veins and even on the trichome on this surface (Tables 1-5).

In *A. Caillei,* Stomatal distribution was amphistomatic with abundant distribution of stomata. Paracytic stomata was also observed. Stomatal size was 91.73±1.54 x 53.64±3.54; Stomatal pore recorded was 18.49± 0.79 x 11.74± 0.63. The size of guard cells were 81.61±2.27 x 23.40±1.27. Stomatal index was (37.57%). Epidermal cells were polygonal and measured 178.85±5.84 x 55.79±2.61. Anticlinal walls were straight to wavy and the thickness of the epidermal walls measured 2.53±0.20. Oxalate crystals were present (Tables 1-5)

In *A. esculentus,* stomatal distribution was vast and amphistomatic with abundant distribution. Anisocytic, diacytic, paracytic and amphipericytic stomata were observed. Stomatal size was 52.07±3.08 x 37.9 ± 2.52. Stomatal pore recorded 26.32±0.79 x 11.83±0.42. Guard cells measured 69.59±1.02 x 15.54 ±0.74. Stomatal index was 21.01%. Epidermal cells were polygonal and measured 129.49 ±2.04 x 50.81 ±1.36. Anticlinal walls were wavy to undulating, and the thickness of the wall measured 2.77 ±0.17. Unicellular trichome measuring 151.94 x 113.48 was observed with the presence of druse crystals (Tables 1-5)

In *S. acuta* Burm. f., Stomatal distribution was amphistomatic with abundant distribution of stomata. Anisocytic stomata was present together with anomalous stomata. Stomatal size was 42.67 ± 1.17 x 29.71 ±0.57µm while stomatal pore recorded 21.57 ± 1.36 x 7.67. Guard cell size was 29.06 ± 0.88 x 11.34 ± 0.34 µm. Stomatal index was high (41.27%). Epidermal cells were polygonal to irregular and measured 112.55 ±1.83 x 54.47 ±3.79. Anticlinal epidermal walls were wavy and irregular and the thickness of the epidermal wall measured 5.10 ± 0.22 µm. Lengthy unicellular trichomes were abundant; Stellate trichomes were also present. Hydropoten cells and druses were also present (Tables 1-5).

In *S. rhombifolia* L., stomatal distribution was hypostomatic with abundant stomata. Anomocytic and diacytic stomata were observed, with stomatal size of 49.44± 1.86 x 34.87±1. Stomatal pore recorded 31.27±1.58 x 8.71± 0.38 and Stomatal index was 28.90%. Guard cells measured 40.40± 0.76 x 10.13± 0.61. Epidermal cells were polygonal and irregular and measured 72.62± 2.38 x 36.32± 3.71. Anticlinal wall patterns were wavy and irregular. Stellate trichomes and hydropoten cells were also observed. Druses were altogether absent (Tables 1-5).

3.2 Adaxial epidermal characteristics

In *H. rosa- sinensis***,** stomatal distribution was hypostomatic; Anomocytic stomata were observed. Stomatal size was (63.08×41.55) µm while Stomatal pore were unopened and abnormal. Guard cells measured 46.26±2.66 × 23.04±1.61 µm and stomatal index was 1.59%. Epidermal cells were pentagonal to polygonal and measured 122.64±7.87 × 77.51±6.21 µm. Anticlinal walls were straight to curvy. The thickness of the epidermal wall measured 3.74±0.18µm. Unicellular trichome (609.83×664.21) µm was observed, including druse crystals which were present along the veins and even on the trichome (Tables 1-5)

In *A. caillei,* stomatal distribution was amphistomatic with an abundant distribution. Paracytic stomata were observed; Stomatal size was 61.33±2.93 x 45.58± 1.17µm. Stomatal pore recorded 23.31±1.11 x 11.99±0.45. Guard cells size was 49.85±2.82 x 22.96±1.60, and stomatal index was 20.74%. Epidermal cells were polygonal and measured 204.81± 3.43 x 75.71 ±3.50. Anticlinal walls were straight to wavy; The thickness of the epidermal walls measured 4.72±0.43. Glandular trichomes were observed in addition to the presence of oxalate crystals (Tables 1-5)

Stomatal distribution in *A. esculentus* was vast and amphistomatic with abundant distribution. Anisocytic and paracytic stomata were observed, with stomatal size of 3.51±3.21 x 54.72 ±1.17. Stomatal pore was7.49 ±1.95 x 3.73 ±0.22. Guard cells measured 60.51±3.36 x 24.14±2.65 and stomatal index recorded was 24.82%. Epidermal cells were polygonal and measured 230.35±13.17 x 71.05±8.13. Anticlinal walls were wavy to undulating. The thickness of the wall measured 6.00±0.78. Unicellular trichome measuring 151.94 x 113.48 was observed. Druse crystals were present (Tables 1-5)

In *S. acuta,* stomatal distribution was amphistomatic with abundant distribution. Anisocytic stomata were present. Stomata size was 47.63 ± 2.29 x 22.12±0.46 µm. Stomatal pore recorded 13.55 ± 0.35 x 3.28 ± 0.11 µm. Guard cell size was also 36.90 ± 1.55 x 12.06 ± 0.49 µm. Stomatal index was 28.36%. Epidermal cells were polygonal to irregular and measured 112.93 ±2.17 x 24.19±1.66. Anticlinal epidermal walls were wavy and Irregular, and the thickness of the epidermal wall measured 3.20± 0.24 on the adaxial surface. Lengthy unicellular trichomes were abundant. Stellate trichomes were present. Also, grandular trichomes were observed only on the adaxial surfaces. Hydropoten cells and druses were present (Tables 1-5).

In *S. rhombifolia,* stomatal distribution was hypostomatic. Only diacytic stomata were observed. Stomata size was 48.63±0.5 x 22.43± 0.78. Stomatal pore recorded 21.09± 0.71 x 2.97± 0.06. Stomatal index was 10.20%. Guard cell measured 35.70± 0.82 x 12.16± 0.36. Epidermal cells were polygonal and irregular and measured 141.68± 12.90 x 48.56± 2.77. Anticlinal wall pattern were sinous and irregular.Stellate
trichomes Hydropoten cells were observed (Tables 1-5)

Table 1 Foliar epidermal features of the studied species

Species	Stomatal size (µm) Min (Mean±S.E) Ma	Stomatal Pore (µm) Min (Mean±S.E) Ma

	Abaxial (LxB)	Adaxial (LxB)	Abaxial (LxB)	Adaxial (LxB)
H. rosa Sinensis	59.72(63.96± 1.64)69.27 x29.93(33.15± 1.20)36.21	58.82(63.08± 1.33)67.7 x 27.11(41.55± 3.87)46.72	18.99(20.83± 0.82)23.89 x 5.29(6.69± 0.46)8.35	Closed
A. esculentus	43.48(52.07± 3.08)64.32 x 32.22(37.9± 2.52)43.81	66.99(73.51± 3.21)87.33 x51.21(54.72± 1.17)58.83	23.29(26.32± 0.79)27.89 x10.11(11.83± 0.42)12.02	31.27(37.49± 1.95)42.23 x 3.19(3.73± 0.22)4.62
A. caillei	87.39(91.73± 1.54)97.39 x39.42(53.64± 3.54)61.07	54.63(61.23± 2.91)73.29 x42.33(45.58± 1.17)49.62	15.93(18.49± 0.79)21.2 x 9.73(11.74± 0.63)14.11	20.09(23.31± 1.11)26.71 x 10.38(11.99± 0.45)13.41
S. acuta	39.78(42.67± 1.17)47.42 x28.31(29.71± 0.75)31.47	38.21(47.63± 2.29)53.09 x20.98(22.12± 0.46)	17.43(21.57± 1.36)26.21 x 4.63(7.67± 1.16)11.93	12.11(13.55± 0.35)14.28 x 3.11(3.28± 0.11)3.78
S. rhombifolia	41.79(49.44± 1.86)52.89 x30.41(34.87± 1.19)37.80	46.97(48.63± 0.51)50.32 x19.83(22.43± 0.78)23.29	25.71(31.27± 1.58)34.11 x 7.36(8.71± 0.38)9.49	18.35(21.09± 0.71)23.29 x 2.73(2.97± 0.06)3.12

Min= Minimum, S.E= Standard error, Ma= Maximum, L= Length, B= Breadth

Table 2 Foliar epidermal features of the studied species continued

Species	Stomatal number		Epidermal cells number		Epidermal Cells (µm) Min (Mean±S.E) Ma	
	Ab	Ad	Ab	Ad	Abaxial (LxB)	Adaxial (LxB)
H. rosa Sinensis	32	4	87	141	129.83(135.88± 1.73)141.62 x 69.83(71.78± 0.67)74.62	102.42(122.64± 7.87)148.09 x 59(77.51± 6.21)98.86
A. esculentus	27	24	98	74	123.49(129.49± 2.04)137.17 x 46.97(50.81± 1.36)54.11	204.78(230.35± 13.17)279.88 x 38.24(71.05± 8.13)90.81
A. caillei	27	18	46	68	163.12(178.85± 5.84)201.62 x 49.21(55.79± 2.61)64.11	193.42(204.81± 3.43)211.75 x62.42((75.71± 3.50)83.41
S. acuta	71	71	72	181	106.33(112.55± 1.83)117.01 x 43.33(54.47± 3.79)67.58	103.89(112.93± 2.17)117.68 x 19.4(24.19± 1.55)29.38
S. rhombifolia	33	9	82	77	65.23(72.62± 2.36)81.02 x 21.9(36.32± 3.71)47.55	107.33(141.68± 12.90)187.5 x 38.43(48.56± 2.77)57.86

Min= Minimum, S.E= Standard error, Ma= Maximum, L= Length, B= Breadth

Table 3 Foliar epidermal features of the studied species continued

Species	Epidermal wall thickness (µm) Min (Mean±S.E) Ma	Stomatal index (%)	Guard cells (µm) Min (Mean±S.E) Ma

	Abaxial	Adaxial	Ab	Ad	Abaxial	Adaxial
H. rosa sinensis	2.87(3.15± 0.13)3.72	2.67(3.74± 0.18)3.78	26.89	1.5	53.39(57.54± 1.24)60.91 x15.11(20.03± 1.36)22.82	39.71(46.26± 2.66)47.25
					X15.11(20.03± 1.36)22.82	20.86(23.04± 1.61)30.22
A. esculentus	2.07(2.77± 0.17)3.11	4.07(6.00± 0.78)9.24	21.01	24.82	66.59(69.59± 1.02)71.28	52.49(60.51± 3.36)70.57
					X14.21(15.54± 0.74)18.71	x17.38(24.14± 2.65)31.28
A. caillei	2(2.53± 0.20)3.07	3.05(4.72± 0.43)6.03	37.57	20.74	72.13(81.16± 2.27)83.47	41.68(49.85± 2.82)61.01
					X20.09(23.40± 1.27)27.21	x19.48(22.96± 1.60)29.48
S. acuta	4.29(5.10± 0.22)5.34	2.49(3.20± 0.24)4.11	41.27	28.36	26.22(29.06± 0.88)31.22	32.42(36.90± 1.55)41.28
					X10.07(11.34± 0.34)12.11	x10.43(12.06± 0.49)13.62
S. rhombifolia	1.98(2.38± 0.18)3.13	3.02(3.79± 0.34)5.21	28.9	10.2	38.06(40.40± 0.76)42.82	32.82(35.70± 0.82)37.84
					X 7.98(10.13± 0.61)12.31	X 10.86(12.16± 0.36)13.15

Min= Minimum, S.E= Standard error, Ma= Maximum, L= Length, B= Breadth

Table 4 Foliar epidermal features of the studied species continued

Species	**Epidermal cell wall shape**		**Epidermal cell wall pattern**		**Stomatal Distribution**
	Abaxial	**Adaxial**	**Abaxial**	**Adaxial**	
H. rosa sinensis	Polygonal	Polygonal	Curve, straight	undulating, straight	Hypostomatic
A. esculentus	Polygonal	Polygonal	Undulating	Wavy	Amphistomatic
A. caillei	Polygonal	Polygonal	Undulating	undulating	Amphistomatic
S. acuta	Irregular	Irregular	Wavy	Sinous	Amphistomatic
S. rhombifolia	Polygonal ,Irregular	Polygonal ,Irregular	Wavy	wavy, sinuous	Hypostomatic

Table 5 Stomatal types and their occurrence in the studied species

Species	**Leaf surface**	**Anisocytic**	**Anomocytic**	**Diacytic**	**Paracytic**	**Diallelocytic**	**Amphipericytic**	**Anomalous**
H. rosa sinensis	**Ab** **Ad**	+ +	+ -	-- -	- -	+ -	- -	- +
A. Caillei	**Ab** **Ab**	- -	- -	- -	+ +	- -	- -	- -
A. esculentus	**Ab** **Ad**	+ +	- -	+ -	+ +	- -	+ -	- -
S. acuta	**Ab** **Ad**	+ +	+ -	- -	- -	- -	- -	+ -

S. rhombifolia	**Ab**	-	+	+	-	-	-	-
	Ad	-	-	+	-	-	-	-

+= Present; - =Absent; Ab= Abaxial ; Ad= Adaxial

4. DISCUSSION

Foliar epidermal features proved to be most significant in distinguishing the species as variations were observed in several characters. In the study, three of the species; *A. caillei, A. esculentus* and *S. acuta* were ampistomatic while *H. rosa sinensis* and *S. rhombifolia* were hypostomatic. Six stomatal types were identified among the species. They include; Anisocytic (stomata completely surrounded by only three subsidiary cells, variable in positon and shape but one of the subsidiary cell is distinctly small), anomocytic (stomata completely surrounded by only four or more subsidiary cells variable in size and shape but not differentiated in any way from the normal epidermal cells), diacytic (stomata completely surrounded by a single ring of two cells enclosing the guard cells at right angles to the long axis of the guard cell), amphepericytic (stomata with one cell enclosing both guard cells enclosed by a second single cell), paracytic (stomata with two cells completely enclosing the guard cells with their long axis parallel to the long axis of the guard cells) and anomalous (stomata with irregularity in the distribution of the subsidiary cells or guard cells). These variations in stomata types and distribution were diagnostic in the species. The diagnostic importance of stomata in angiosperm taxonomy has been reported by [32,33]. The present result is similar to that reported by [24] who observed anomocytic stomata as predominant in the species of *Sida* L. [11] opined that it is possible for different types of stomata to occur among the same species. Paracytic stomata were observed only in the *Abelmoschus* species which agrees with the report of [34].

Stomatal index varied greatly among the species and as such is considered useful in delimiting the studied species. The highest stomatal index was recorded in *S. acuta* (41.27%). This result supports [11] statement that stomatal index is independent of the environment or size of leaf surface and thus, serves as a reliable tool for identification.

Epidermal cells were predominantly polygonal in all the studies species. However, irregular shapes were observed in *S. acuta* and *S. rhombifolia.* Anticlinal epidermal wall patterns were straight, curve to undulating in both surfaces of *H.rosa sinensis, A. caillei* and *A. esculentus* but undulating, wavy to sinuous in *S. acuta* and *S. rhombifolia.* [24] also reported undulating epidermal wall pattern in the *Sida* species they studied. They attributed the observations to the site of sample collection. [35] stated that cell wall undulation is a reflection of adequate habitat moisture and the feature equip leaves with greater tensile strength.

The taxonomic implication of foliar trichomes have been emphasized by [19,36,37]. Simple conical unicellular trichomes were observed in *H. rosa sinensis, A. esculentus* and *S. acuta*, while stellate trichomes were observed in both *S. acuta* and *S. rhombifolia.* Glandular trichomes were observed in *A. caillei* only. The longest unicellular trichome (1325.83µm) was recorded in *S. acuta.* [24] also reported stellate and unicellular trichomes in the *Sida* species they studied and also observed the longest in *S. acuta*. Presence or absence of trichomes has been observed to be influenced by the plant's habitat and its frequency and distribution has been helpful in distinguishing sun and shade morphophytes [38]. Trichomes equally serve the function of reducing the rate of transpiration in plants they occur.

Druse crystals have been considered as diagnostic tools for taxonomic studies by [11,26,39] reported that the presence of crystals of calcium carbonate known as druses and their manner of distribution in leaves and flowers were of taxonomic interest in their study of some *Hibiscus* species. In this study, druse crystals were observed in all the species except *S. rhombifolia*. [39] stated that druse crystal could act as herbivore deterrents. They were also thought to stiffen plant tissues in which they occur [40].

Hydropoten cells were observed in *S. acuta* and *S. rhombifolia* only. [24] also observed these 'water drinking' cells in their work and attributed their presence to the fact that the plant species were located along road sides constantly flooded by runoff water from the road. The presence of the hydropoten cells could be used to distinguish the *Sida* genus from the other studied genera.

5. CONCLUSIONS

The foliar epidermal characters of significance in the delimitation of the studied species included type, size and number of stomata, epidermal cell shape, number on both abaxial and adaxial surfaces as well as the epidermal wall pattern. Presence or absence of druse crystals and the type of trichome were also significant. These characters were diagnostic and considered highly significant for delimiting the species at the generic level and less so to determine interspecific relationships. Further evaluation using other taxonomic markers such as phytochemical, phylogenetic and molecular properties is recommended to provide more diagnostic characters.

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