



Morphological Characters, Occurrence and Distribution among Members of the Family Solanaceae in Parts of the Niger Delta Ecological Zone

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ABSTRACT: This study investigated a comparative micro-morphological features of 14 species in the family Solanaceae, using trichome and stomatal complements in delimitation of species and genera within the taxon, family. The genus *Solanum* L. is the largest among the genera in Solanaceae. *Solanum aethiopicum* Linn. *Solanum macrocarpon* Linn. *Solanum torvum* Swartz. *Solanum anomalum* Thonn. *Solanum erianthum* D. Don, are covered with stellate trichomes. While *Solanum nigrum* Linn., *Solanum lycopersicum* Linn., *Solanum incanum* Linn., *Datura* spp., *Schwenckia* spp., *Capsicum* spp., *Physalis* spp. have simple uniseriate trichomes. *S. aethiopicum* Linn. *S. torvum* Swartz. *S. lycopersicum* Linn, and *Physalis micrantha* Linn, revealed higher trichome indices. In most species, these trichomes are not visibly observed with the naked eyes. While in some others such as in *S. torvum* and *S. lycopersicum* the trichomes are observable on the plants. Glandular hairs are also present in Solanaceae. Stomata is amphistomatic, types commonly observed are: anisocytic and anomocytic, while paracytic and tetracytic stomata are sometimes revealed in stem epidermis in Solanaceae. The usefulness of trichome and stomatal complements in species and generic taxa are recommended as pertinent characters for classification in Solanaceae and their density may vary from one ecological zone to another. ©JASEM

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Key words: Solanaceae, *Solanum*, Stomata, trichomes, Complements, Comparative.

INTRODUCTION

Stomata are considered to be one of the major epidermal structures within the leaf organ that have allowed higher plants to adapt to virtually all terrestrial environments on earth, this is made possible by means of adjustment of their size, density and distribution (Zarinkamar, 2006b). An alteration of leaf stomatal density can be used as an indicator of environmental change (Case, 2004). *Solanum roustrum*, the shrubby nightshade, is a thorny perennial with velvet leaves and stems due to dense stellate trichomes present on all over the plant (USDA, 2015). Solanaceae is predominated mostly by anomocytic stomata. Trichome and stomatal complements are necessary diagnostic characters used in identification at species and generic levels. The type of hair can be of diagnostic value at species level, sometimes also at generic level, but rarely at family level (Cutler, 1977). The word 'uniseriate' is really an anatomical term rather than morphological and does not describe the shape. 'Multiseriate' is not unique to trichomes, it could also mean multi layers as in epidermal and hypodermal axial parenchyma (Metcalf and Chalk, 1979).

The present study is aimed at producing a more current and comprehensive taxonomic data involving the micro-morphological characters, their occurrence and distribution among members of the family Solanaceae.

MATERIALS AND METHODS

Study Area: The areas covered were different Localities in Rivers State, Imo State and Abia State parts of the Niger Delta, Nigeria.

Sample Collection: The materials used for this study were collected from both cultivated domestic species and wild species or raised from seeds purchased from the fruit and vegetable markets.

Sample Preparation: Fresh leaves and stems were peeled and bleached using sodium hypochlorite for about 2 minutes following the method of Cutler (1978). For other fresh leaves whose epidermal layers were difficult to peel, chemical frictions or scraping method were used, usually the surface to be examined was placed on a glass slide while the other surface was carefully cleared by flooding with 5% sodium hypochlorite and scraping with cork material

or razor. The cleared epidermal layers obtained were then washed in several changes of distilled water and stained with Alcian blue or safranin and temporarily mounted in aqueous glycerol solution (Cutler, 1978). Photomicrographs were taken from good preparations. Stomatal studies were done from the cleared leaves and stems. The length and width of the stomatal complexes (guard cells) were measured using a calibrated eye piece graticule following the method of Arnold (1973). The stomata observed were viewed with the light microscope and were measured or calculated in unit area using the stomatal index [S.I.] formula as shown below:

$$S.I. = \frac{S}{E + S} \times \frac{100}{1}, \text{ equation 1.}$$

RESULT AND DISCUSSION

Stellate or star-shaped trichomes are observed in plates 1a, 1b, 2a, 2b, figures 1a to 1p and figures 2a to 2d as observed in *S. aethiopicum* Linn. *S. torvum* Swartz. *S. anomalum* Thonn. *S. erianthum* D. Don. respectively. While the simple uniseriate trichomes are observed in plates 3a to 8c and figures 2e to 3r respectively. The studies further revealed the presence of anomocytic, anisocytic, tetracytic, paracytic, stomata. *S. nigrum* is observed with the

Where *S* and *E* mean numbers of stomata and epidermal cells within the particular area under investigation.

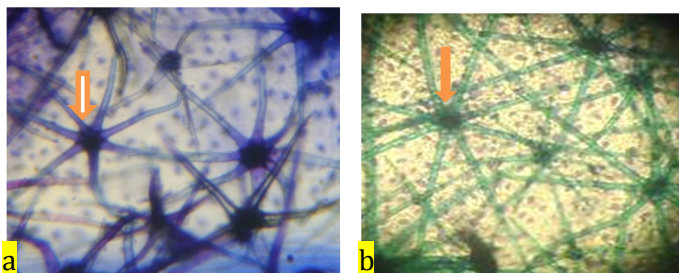
The same formula was applicable for the calculation of trichome index (T.I.), in this case, trichome (T)

$$\text{was used instead of stomata: } T.I. = \frac{T}{E + T} \times \frac{100}{1},$$

equation 2.

Statistical Analysis: The mean \pm standard deviation for trichome and stomatal characteristics of Solanaceae studied was done.

are revealed in the genera: *Solanum* (*S. nigrum* Linn. *S. incanum* Linn. *S. lycopersicum* Linn.), *Datura*, *Schwenckia*, *Physalis*, *Capsicum* etc. The simple or non-stellate trichomes are more universally distributed in Solanaceae than the stellate types. The simple uniseriate and multiseriate trichomes are revealed highest stomatal index among the species studied. (Table 1). *S. aethiopicum*, *S. torvum*, *S. lycopersicum* and *Physalis micrantha* showed higher trichome indices than others. (Table 2)



Arrows revealed stellate trichomes

Plates 1a: *S. aethiopicum* Linn. Adaxial foliar epidermis with numerous stellate trichomes. 1b: *S. torvum* Swartz. Adaxial foliar epidermis with high density of stellate trichomes. Morphologically, most members of the genus '*Solanum*' with rough lamellae possess stellate trichomes, it is envisaged that the numerous dense nature of the hairs is the reason for the leaf texture, as also supported by (USDA, 2015).

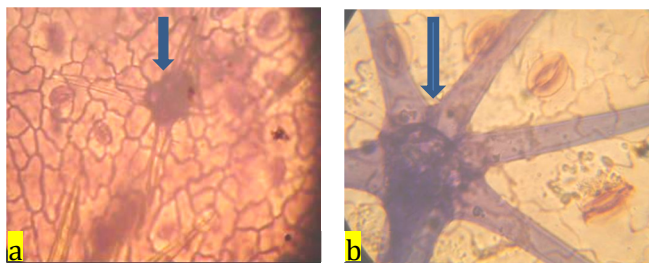


Plate 2a: *S. torvum* Swartz. Abaxial foliar epidermis with less trichome density. 2b: *S. macrocarpon* Linn. abaxial foliar epidermis with 6 branched stellate trichome. Arrows revealed stellate trichomes. *Solanum* species observed with stellate trichomes possessed basically anisocytic and anomocytic stomata. The number of the branches may differ within a given species, (See figures 1 and 2a to 2d). There were varying degrees of stomatal and trichome densities on the adaxial and abaxial foliar surfaces of the species.

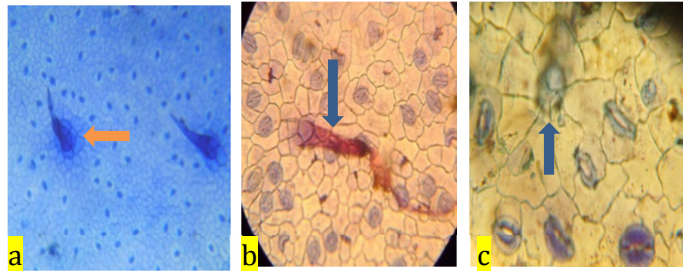


Plate 3a: *S. nigrum* Linn. abaxial foliar epidermis possessed spine-like uniseriate trichomes, (figure 2e). 3b: *Datura metel* Linn. Adaxial foliar epidermis revealed blunt-end uniseriate trichomes. 3c: *Datura metel* Linn. abaxial foliar epidermis. Black arrow showed glandular trichome associated with oil gland. (Figures 2f; 3b; 3e and 3l).

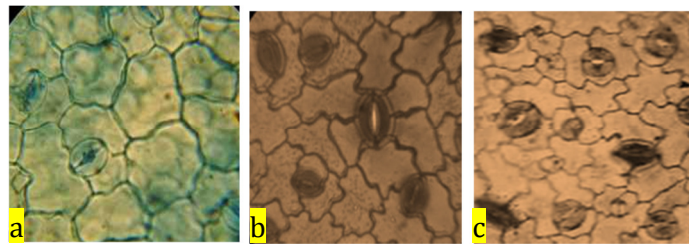


Plate 4a: *S. incanum* Linn. Adaxial foliar epidermis. 4b: *S. incanum* Linn. Abaxial foliar epidermis with anomocytic and anisocytic stomata, 4c: *S. lycopersicum* Linn. Abaxial foliar epidermis. *S. incanum* Linn. And *S. lycopersicum* Linn. are tomentosed with uniseriate trichomes. (See figures 2i, 2g, 3g, 3m and 3p).

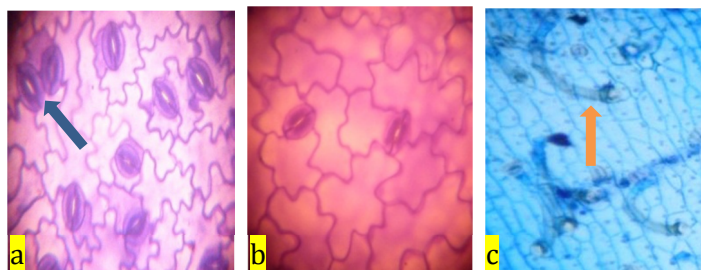


Plate 5a: *Schwenckia americana* Linn. Abaxial foliar epidermis. Black arrow revealed contiguous cells. 5b: *Schwenckia americana* Linn. Adaxial foliar epidermis. 5c: *Schwenckia americana* Linn. Stem epidermis showcased anomocytic stomata. White arrow showed curved hair with bulge head termed covering trichome, which signified a kind of oil secretory function which gave the leaves and stems glossary outlook. (Figure 2q). The presence of tapering trichomes was also discovered in *Schwenckia*, (see figure 3g).

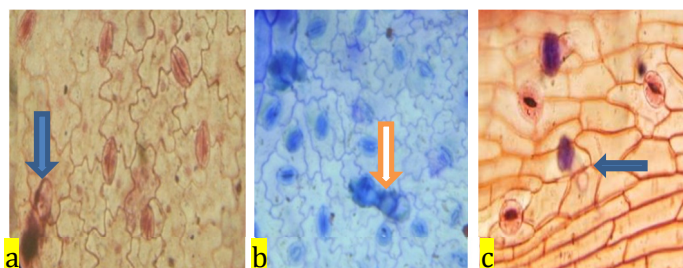


Plate 6a: *Physalis angulata* Linn. Adaxial foliar epidermis. Arrow revealed uniseriate hair. Plate 6b: *Physalis angulata* Linn. Abaxial foliar epidermis. Arrow showed tricellular glandular trichome with bulge ends. (Figures 2h and 3v). Plate 6c: *Physalis angulata* Linn. Stem epidermis. Arrow revealed biseriate trichome. (Figures 2g, 2j, 2r, 3d, 3o, 3q and 3u) commonly found in *Physalis* spp.

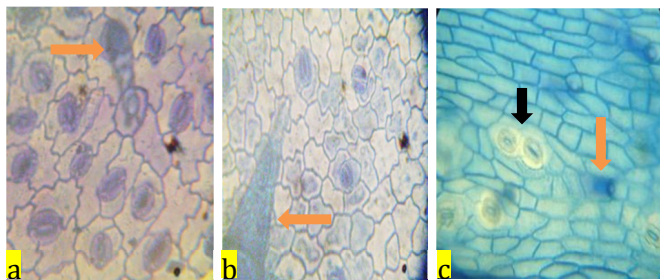


Plate 7a: *Capsicum frutescens* Linn. Abaxial foliar epidermis, arrow revealed clavate trichome. (See figures 2g, 2m and 2r). Plate 7b: *Capsicum frutescens* Linn. Adaxial foliar epidermis with conical trichome. Plate 7c: *Capsicum frutescens* Linn. Stem epidermis. (Figure 2p) Black arrow showed contiguous cells (see figure 4c), while the brown arrow indicated glandular trichome believed to contain capsaicin.

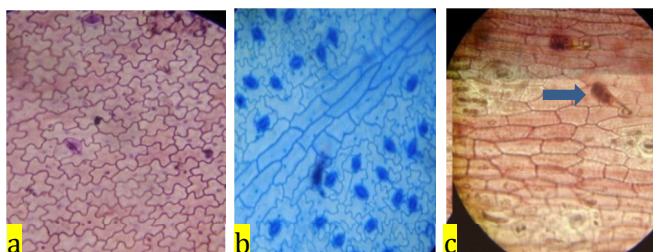
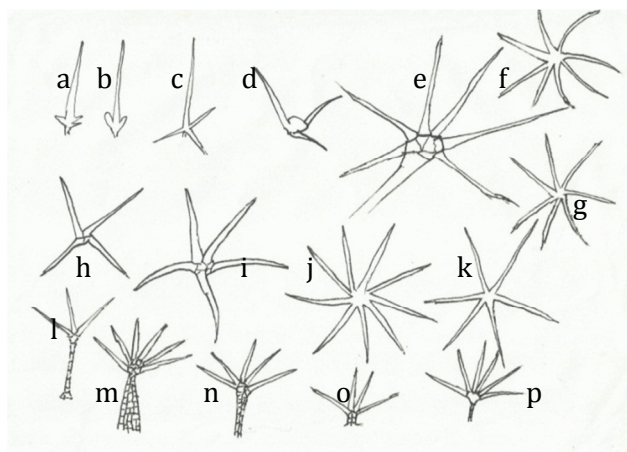


Plate 8a: *Capsicum annum* Linn Adaxial foliar epidermis. 8b: *Capsicum annum* Linn Abaxial foliar epidermis. 8c: *Capsicum annum* Linn Stem epidermis. Arrow showed biseriate clavate trichome. (See Figures: 3c, 3f, 3j, 3k, 3r and 3s). The average number of stomata in the lower epidermis is more numerous than as observed in the upper epidermis.



10µm to 150µm

Figure 1: Stellate trichomes in Solanaceae. 1a to 1d are prominently present during the early growth stage or primary phase of development observed with two (2), three (3) or Four (4) short miniature branched stellates.

While 1e to 1p revealed stellate trichomes found regularly during secondary growth phase. Figures 1m to 1o showed multiseriate stalked stellate trichomes.

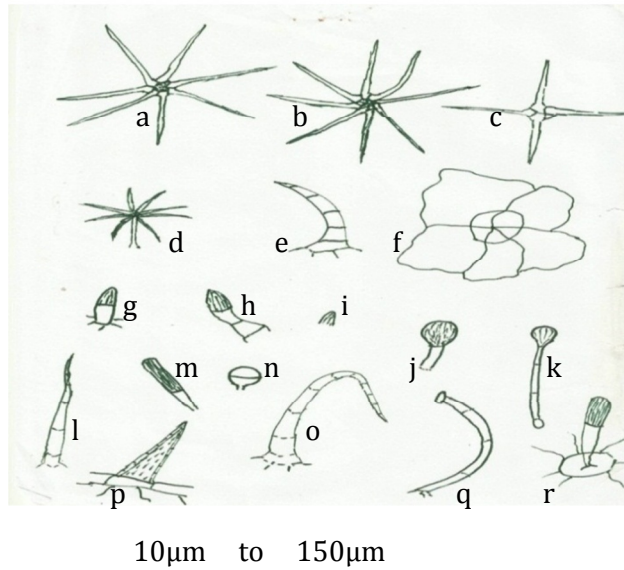


Figure 2: Stellate trichomes in Solanaceae. 2a to 2d. While 2e revealed Spine-like trichome in *S. nigrum* Linn. 2f: Glandular trichome in Solanaceae. 2g to 2r: Simple uniseriate trichomes in Solanaceae.

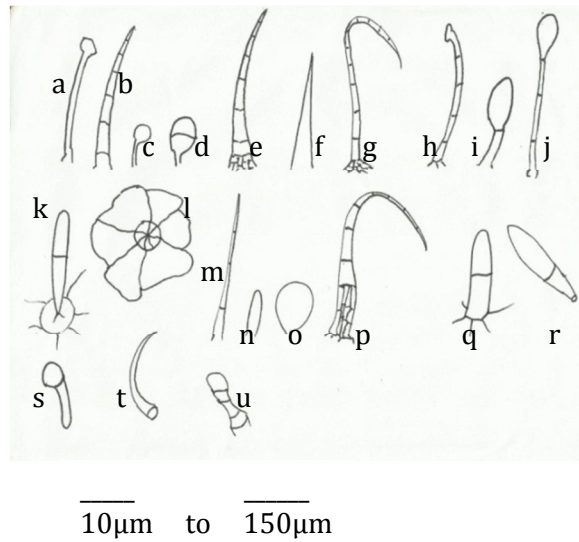


Fig 3: Simple uniseriate trichome complements in Solanaceae. 3a and 3h are covering trichomes unique to *Schwenckia americana* along with 3g which is a tapering trichome, 3b; 3e, and 3l were observed in *Datura metel*. 3c, 3f, 3j, 3k, 3r and 3s were revealed in *Capsicum* spp., 3g, 3m and 3p showed in *Solanum lycopersicum*, while 3d, 3o, 3q and 3u were found present in *Physalis* species.

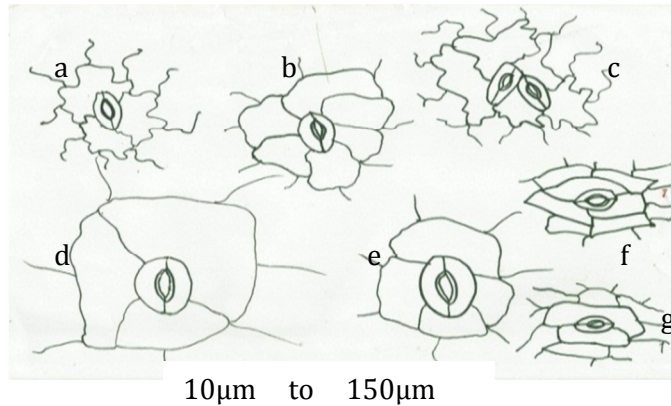


Fig 4: Stomatal types in Solanaceae. 4a to 4b: Anomocytic; 4c: contiguous cells; 4d to 4e: anisocytic; 4f: anomocytic; 4g: paracytic stoma. Paracytic stomata observed in stem epidermis but not as common as anomocytic and anisocytic stomata.

Table 1: Stomatal Indices of some Members of Solanaceae within the Niger Delta Eco zone, Nigeria

UPH Reference No	Solanaceae	Adaxial(Upper) Foliar Surface				Abaxial(Lower) Foliar Surface			
		No of Stomatal Cells	No of Epidermal Cells	Stomatal Index (SI)	Stomatal Type	No of Stomatal Cells	No of Epidermal Cells	Stomatal Index (SI)	Stomatal Type
CW001	<i>Solanum aethiopicum</i> Linn.	45	155	22.50%	Anisocytic	75	235	24.19%	Anisocytic
CW002	<i>Solanum nigrum</i> Linn.	47	105	30.92%	Anisocytic	96	409	19.01 %	Anisocytic
CW003	<i>Solanum torvum</i> Sw.	30	212	12.40%	Anisocytic	38	168	18.45%	Anisocytic
CW004	<i>Solanum macrocarpon</i> Linn.	67	221	23.26%	Anisocytic	90	370	19.57%	Anisocytic
CW005	<i>Solanum anomalum</i> Thonn.	60	242	19.86%	Anisocytic	90	370	19.57%	Anisocytic
CW006	<i>Solanum incanum</i> Linn.	98	305	24.32%	Anisocytic	98	305	24.32%	Anisocytic
CW007	<i>Solanum erianthum</i> D. Don.	70	295	19.18%	Anisocytic	98	295	24.94%	Anisocytic
CW008	<i>Solanum lycopersicum</i> Linn.	55	230	19.30%	Anisocytic	44	180	19.64%	Anisocytic
CW009	<i>Datura metel</i> Linn.	30	103	22.56%	Anisocytic	15	80	15.79%	Anisocytic
CW010	<i>Schwenkia americana</i> Linn.	3	45	6.25%	Anomocytic	15	45	25.00%	Anomocytic
CW011	<i>Physalis angulata</i> Linn.	15	95	13.64%	Anomocytic	20	80	20.00%	Anomocytic
CW012	<i>Physalis micrantha</i> Linn.	18	98	15.52%	Anomocytic	25	96	20.66%	Anomocytic
CW013	<i>Capsicum frutescens</i> Linn.	5	78	6.02%	Anomocytic	18	118	13.24%	Anomocytic
CW014	<i>Capsicum annum</i> Linn.	5	78	6.02 %	Anomocytic	41	117	25.95%	Anomocytic

Table 2: Trichome Indices of some Members of Solanaceae within the Niger Delta Eco zone, Nigeria

UPH Reference No	Solanaceae	Adaxial(Upper) Foliar Surface				Abaxial(Lower) Foliar Surface			
		No of Trichomes Cells	No of Epidermal Cells	Trichome Index (SI)	Trichome Type	No of Trichomes Cells	No of Epidermal Cells	Tirchome Index (SI)	Trichome Type
CW001	<i>Solanum aethiopicum</i> Linn.	155	325	32.29%	Stellate	125	330	27.47%	Stellate
CW002	<i>Solanum nigrum</i> Linn.	5	250	01.96%	Uniseriate	96	545	15.97 %	Uniseriate
CW003	<i>Solanum torvum</i> Sw.	115	309	27.12%	Stellate	85	301	22.02%	Stellate
CW004	<i>Solanum macrocarpon</i> Linn.	39	285	12.04%	Stellate	31	291	09.63%	Stellate
CW005	<i>Solanum anomalum</i> Thonn.	25	302	07.65%	Stellate	20	425	04.49%	Stellate
CW006	<i>Solanum incanum</i> Linn.	10	410	02.38%	Uniseriate	08	420	01.87%	Uniseriate
CW007	<i>Solanum erianthum</i> D. Don.	20	390	04.88%	Stellate	28	382	06.83%	Stellate
CW008	<i>Solanum lycopersicum</i> Linn.	115	308	27.19%	Uniseriate	70	290	19.44%	Uniseriate
CW009	<i>Datura metel</i> Linn.	10	350	02.94%	Uniseriate	15	250	05.66%	Uniseriate
CW010	<i>Schwenckia americana</i> Linn.	30	300	09.09%	Uniseriate	30	320	08.57%	Uniseriate
CW011	<i>Physalis angulata</i> Linn.	3	250	01.19%	Uniseriate	4	300	01.32%	Uniseriate
CW012	<i>Physalis micrantha</i> Linn.	51	400	11.31%	Uniseriate	203	530	27.69%	Uniseriate
CW013	<i>Capsicum frutescens</i> Linn.	10	325	02.99%	Uniseriate	30	335	08.22%	Uniseriate
CW014	<i>Capsicum annum</i> Linn.	5	315	01.61%	Uniseriate	25	300	07.69%	Uniseriate

Table 3: Stomatal Characteristics of some Members of Solanaceae in Parts of the Niger Delta Ecozone, Nigeria.

UPH. Reference No.	Name of Taxa	Leaf Surface	$\bar{x} \pm S.D$ Stomata Length (μm)	$\bar{x} \pm S.D$ Stomata Width (μm)	Coefficient of Variation for Length of Stomata	Coefficient of Variation for Width of Stomata
CW001	<i>Solanum aethiopicum</i> Linn.	Adaxial	56 \pm 2.33	36 \pm 1.76	4.16%	5.02%
		Abaxial	54 \pm 1.72	37 \pm 2.24	3.19%	6.09%
CW002	<i>Solanum nigrum</i> Linn.	Adaxial	43 \pm 1.61	32 \pm 1.41	3.74%	4.39%
		Abaxial	45 \pm 1.76	24 \pm 7.57	3.96%	31.54%
CW003	<i>Solanum torvum</i> Sw.	Adaxial	55 \pm 1.76	41 \pm 2.46	3.20%	6.00%
		Abaxial	55 \pm 2.36	36 \pm 1.72	4.29%	4.78%
CW004	<i>Solanum macrocarpon</i> Linn.	Adaxial	59 \pm 2.92	38 \pm 3.06	4.95%	8.06%
		Abaxial	57 \pm 2.74	34 \pm 2.33	4.81%	6.86%
CW005	<i>Solanum anomalum</i> Thonn.	Adaxial	54 \pm 1.72	35 \pm 1.76	3.19%	5.02%
		Abaxial	54 \pm 1.72	35 \pm 1.76	3.19%	5.02%
CW006	<i>Solanum incanum</i> Linn.	Adaxial	67 \pm 2.74	39 \pm 2.92	4.09%	7.49%
		Abaxial	59 \pm 2.46	40 \pm 3.51	4.17%	8.789%
CW007	<i>Solanum erianthum</i> D. Don.	Adaxial	49 \pm 5.97	20 \pm 1.02	12.19%	5.12%
		Abaxial	52 \pm 2.11	33 \pm 6.68	4.05%	2.02%
CW008	<i>Solanum lycopersicum</i> Linn..	Adaxial	69 \pm 3.67	42 \pm 3.44	5.32%	8.20%
		Abaxial	71 \pm 4.83	47 \pm 2.74	6.80%	5.84%
CW009	<i>Datura metel</i> Linn.	Adaxial	136 \pm 10.75	90 \pm 26.67	29.63%	12.60%
		Abaxial	117 \pm 9.49	87 \pm 9.49	8.11%	10.90%

CW010	<i>Schwenckia americana</i> Linn.	Adaxial	134 ± 17.76	89 ± 14.49	13.26%	16.28%
		Abaxial	130 ± 25.82	87 ± 15.67	19.86%	18.01%
CW011	<i>Physalis angulata</i> Linn.	Adaxial	138 ± 11.35	84 ± 11.74	8.23%	13.97%
		Abaxial	103 ± 29.08	72 ± 13.98	28.23%	19.42%
CW012	<i>Physalis micrantha</i> Linn.	Adaxial	112 ± 13.98	59 ± 9.94	12.48%	16.85%
		Abaxial	83 ± 11.60	50 ± 8.17	13.98%	16.34%
CW013	<i>Capsicum frutescens</i> Linn.	Adaxial	133 ± 11.40	86 ± 8.43	8.72%	9.81%
		Abaxial	140 ± 14.14	77 ± 8.23	10.10%	10.69%
CW014	<i>Capsicum annuum</i> Linn.	Adaxial	127 ± 31.98	87 ± 19.75	25.18%	21.71%
		Abaxial	120 ± 18.26	76 ± 12.65	28.56%	16.64%

Conclusion: In Solanaceae, stomatal and trichome complements are used to classify some species to a very great extent. There are both simple uniseriate and multiseriate trichomes. Contiguous cells, glandular trichomes, anomocytic and anisocytic stomata are very common in Solanaceae. Tetracytic and paracytic stomata are also observed in Solanaceae. Stomatal and trichome complements are vital diagnostic characters among species found in genera within any given family of plants. It is obvious that comparative studies among different families of plant may prove very difficult. It is not out of place that with the present day descriptions assigned in micro-morphological studies there may arise in the near future, stomatal and trichome classification that may be acceptable to an appreciable extent.

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