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ARTICLE

Epidermal Studies On Ten Members Of Solanaceae.

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Abstract

The Solanaceae Juss., is a large family many members of the family being prized drug plants. The present study emphasized the importance of epidermal features and their relevance in systematic botany. The observations made in leaf epidermal features of the Solanacean members are important especially as they help to establish interspecific relationships among the ten investigated taxa. Though the quantitative epidermal characters like size of the stomatal complex, stomatal index and stomatal frequency showed marked variation, the qualitative characters were almost the same with only slight variations. This support the grouping of the taxa under the family Solanaceae. The species under the same genus also showed similarities with only small variations.

Keywords:

Introduction

The Solanaceae Juss., is a large family consisting of 147 genera and 3000 species, mostly shrubs or herbs, rarely lianes distributed mainly in the tropical and temperate regions. Many species such as potato (*Solanum tuberosum* L.), egg plant (Solanum melongena), tomato (*Lycopersion esculentam* L.), chilies (*Capsicum annum* L.), tobacco (*Nicotiana tobacum*) and Datura (*Datura stramonium* L.) are cultivated throughout India. The habit of the plant is variable like annual or perennial herbs, shrubs and rarely climbers. Stems are prickly or spinous (Lycium), the spines are modified branches. Many members of the family are prized as drug plants. Atropine from the leaves and roots of Atropa belladona, is used as sedative, stimulant and as an antidot in opium poisoning.

The Solanaceae are known for possessing a diverse range of alkaloids such as the tropane alkaloids (Atropa, Datura, Mandragora, and Brugmansia) including atropine, scopolamine, and hyoscyamine. The family Solanaceae was first mentioned in Dioscorides Codex of A. D. 815, where illustrations of three plants viz. Solanum nigrum, Physalis alkekengi and Mandragora sp. were given (D' Arcy, 1979). Solanaceae was presented as a family by including the group Solanum by Bauhin (1623). The earliest scientific literature describing Solanacean plants in India were made by Garcia (1563). Clarke in 1883 described 14 genera and 42 species which are now delimited under Solanum.

The use of morphological and leaf epidermal features has been found to be of immense interest in taxonomy just like the use of other makers like DNA sequence and chemical compositions (Edeoga and Ikem, 2001; Mbagwu and Edeoga, 2006). An excellent review of the application of morphological features in systematic studies is shown in the works of Okwulehi and Okoli (1999), Edeoga and Eboka (2000) and Stern (2000). Furthermore, the use of leaf epidermal features (epidermal cell, stomata and trichomes) in systematics has become popular and distinctive and have been used as a great taxonomic tool at the levels of family, genus and species. The earliest work on the stomata of Solanaceae are those by Vesque (1889) and Tognini (1897). Trichomes have long been of considerable importance in comparative investigations in angiosperms. The trichomes of Solanaceae were studied and members were grouped as species with branchlet hairs and those with stellate hairs by Dunal in 1852. A systematic account of hair morphology in Solanum was given by Seithe (1979), Ogg et al. (1981). Organographic study of trichomes in the family Solanaceae was done by Adedeji et al. (2007).

Taxonomists have so far relied only on the external conventional taxonomic data for grouping plants in various tribes and genera. Along with the vegetative morphology, epidermal morphology also characters that can be considered as important criteria in taxonomic evaluations. The present study describes the leaf epidermal characters of ten members of Solanaceae. It also assesses the relevance of and discusses the extent to which leaf epidermal features might be utilized in the systematic consideration of the ten members in Solanaceae.

Materials and Methods

The present study was carried out in ten plants belonging

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to the family Solanaceae. The plants were collected from different localities in Thiruvananthapuram.

Solanum nigrum, L.
Solanum torvum, Swartz.
Solanum melongena, L. cultivar-1
Solanum melongena, L. cultivar-2
Lycopersicon esculentum, Miller.
Capsicum annuum, L.
Capsicum fruitescens, L.
Capsicum cultivar
Datura metel, L.
Brugmansia sp.

The collected plants were identified and its morphological characters were recorded.

Foliar epidermal studies were carried out on all the 15 plants followed by the methodology standardized by Ahmed (1964). The mechanical scratching method was used for obtaining the peels. Epidermal peelings were taken from both the upper and lower surfaces of the fresh leaves, using a sharp razor blade. The peelings were then washed in distilled water and then stained in aqueous 1% safranin for 2 minutes. The excess stain was washed away with distilled water. The peelings were then mounted in 50% glycerine, sealed using wax and observed under a Binocular Research Microscope.

The following epidermal characters were studied:-

Shape of the epidermal cell
Nature of the epidermal cell
Distribution of stomata
Type of stomata
Number of subsidiary cells
Size of the stomatal complex(length and breadth in μm)
Stomatal frequency
Stomatal index
Stomatal abnormalities
Type of trichome

The frequency of stomata was calculated as the number of stomata/unit area (10x X 40x field of the Binocular Research Microscope). The length and breadth of the stomatal complex were measured using an Ocular Micrometer. All the observations measurements were taken from an average from a sample size of 25 for each parameter.

The stomatal index was calculated using the formula,

$$S1=(S/(S+E))*100$$

where E is the number of epidermal cells/unit area and S is the number of stomata in the same area. Photomicrographs of the stomata were taken using a Leica DM 500 Research Microscope.

Results

Foliar epidermal characters of ten members of Solanaceae were analysed in the present study. Among the ten epidermal characters analysed, data regarding size of the stomatal complex is represented in Table 1. Qualitative epidermal characters like shape of the epidermal cell, nature of the epidermal cell, distribution of stomata, type of stomata, number of subsidiary cells and stomatal abnormalities are represented in Table 2. The stomatal frequency and stomatal index are briefed in Table 3. The nature of trichome is given in Table 4. The morphological description and the epidermal characters analysed in the ten members of Solanaceae are detailed below.

Solanum nigrum, L.

A variable annual erect herb with simple glabrous, toothed, ovate, exstipulate leaves (Fig 1.). Flowers are small, white, ebractate, hermaphrodite, complete, pentamerous, slightly zygomorphic due to oblique position of the carpels, cyclic, hypogynous in extra axillary, sub-umbellate, 3-8 flowered cymes. Calyx five-lobed, gamosepalous, persistent, valvate; corolla five-lobed gamapetalous, rotate, white, imbricate; stamens five, epipetalous, filaments short and basally hairy, anthers oblong, connivent, basifixed, dehiscence by apical pores; gynoecium is bicarpellary, syncarpous, bilocular, carpels placed obliquely in relation to mother axis, posterior carpel towards right, superior, ovules numerous per locule, axile placentation, placenta swollen and oblique, style hairy at base, apically transformed into a lobulate stigma. Berries globose, juicy, purplish black and bitter in taste with a saucer like persistent calyx.

Epidermal characters:

Leaves hypostomatic; upper epidermal cells irregular with highly sinuous walls; lower epidermis with abundant anisocytic stomata; subsidiary cells 4; lower epidermal cells irregular with highly sinuous walls (Fig. 2.); stomatal complex 53.33μm x 41.66μm; stomatal frequency 374; stomatal index 61.2. Upper epidermis showed multicellular finger hairs (Fig. 3.). The lower epidermis showed long stellate hairs (Fig. 4.).

Solanum torvum, Swartz.

A tomentose shrub with prickly stem (Fig. 5.); leaves ovate and lobed, tomentose with prickles especially on the under surface near the midrib; small white flowers with long pedicels in extra axillary corymbose denser cymes; calyx five-lobed, gamosepalous, persistent, valvate; corolla five-lobed gamopetalous, rotate, white, imbricate; stamens five, epipetalous, filaments short; carpels minutewith green stigma; berry globose and green, seeds circular and smooth.

Epidermal characters:

Leaves amphistomatic; anisocytic stomata with three subsidiary cells on the upper surface; epidermal cells irregular with moderately sinuous walls (Fig. 6.); stomatal complex

23.33µm x 22.5; stomatal frequency 101, stomatal index 22. Lower epidermal cells with both anomocytic and anisocytic stomata; subsidiary cells 3-4; epidermal cells irregular with highly sinuous walls (Fig. 7.); stomatal complex 33.45µm x 26.5, stomatal frequency 690, stomatal index 53.7.

The epidermis is characterized by large number of attractive stellate hairs on both sides, with lesser number of hairs on the upper epidermis than that in the lower surface (Fig. 8.).

Solanum melongena L. cultivar-1

An erect herb covered by soft hairs, more in younger parts; leaves large parsely green, velvety elliptic, lobed with acute apex and cordate base; flowers blue solitary or segregated in to cymes with the lowest only fertile; anthers yellow in colour with short filaments; carpel shorter than the anther; stigma white in colour; berry glabrous white, yellow or dark purple; commonly referred to as the Egg plant or the Brinjal (Fig. 9.)

Epidermal characters

Leaves amphistomatic; upper epidermal stomata anisocytic; epidermal cells irregular and slightly sinuous; subsidiary cells three (Fig. 10.); stomatal complex 25.0µm x 30.8; stomatal frequency 108 and stomata index 20 respectively. Lower epidermis with anisocytic stomata surrounded by three subsidiary cells; stomatal complex 30.33µm x 32.5; irregular epidermal cells with slightly sinuous walls; stomatal frequency 393 and stomata index 33 respectively (Fig. 11.). The epidermis is characterized by large number of attractive stellate hairs on both sides (Fig. 12).

Solanum melongena L. cultivar-2

An erect herb covered by soft hairs, more in younger parts (Fig. 13); leaves large parsely green, velvety elliptic, lobed with acute apex and cordate base; flowers blue solitary or segregated in to cymes with the lowest only fertile; anthers yellow in colour with short filaments; carpel shorter than the anther; stigma white in colour; berry long green.

Epidermal characters

Leaves amphistomatic; upper epidermal stomata anisocytic; epidermal cells irregular and moderately sinuous; subsidiary cells three; stomatal complex 20.7µm x 22.7µm; stomatal frequency 177 and stomata index 27 respec tively (Fig. 14). Lower epidermis with anisocytic stomata surrounded by three subsidiary cells; stomatal complex 30.8 µm x 31.1µm; irregular epidermal cells with highly sinuous walls ; stomatal frequency 535 and stomata index 36 respectively (Fig. 15). The upper epidermis has multicellular finger hairs (Fig. 16.) and the lower epidermis is characterized by large number of attractive stellate hairs (Fig. 17).

Lycopersicon esculentum, Miller.

A tall pubescent herb with spinach green pinnately lobed leaves; chartaceous and lobed with acute apices and cordate unequal bases, lobes triangular; flowers small yellow in peduncled cymes; anthers yellow; carpels very small with green stigma; berry globose shining red and juicy with many compressed seeds ; commonly known as 'tomato' (Fig. 18).

Epidermal characters

Amphistomatic leaves with both anomocytic and anisocytic upper stomata; subsidiary cells 3-4; irregular and moderately sinuous epidermal cells; stomatal complex 32.5µm x 25µm; stomatal frequency 191 and stomatal index 20.3 respectively (Fig. 19). Anomocytic stomata surrounded by four subsidiary cells on the lower epidermis; epidermal cells irregular and highly sinuous; stomatal complex 40 µm x 40µm; stomatal frequency 588 and stomatal index 67.1 respectively (Fig. 20). Multicellular finger hairs were present on both sides (Fig. 21).

Capsicum annuum, L.

A shrubby perennial plant with angular branches bearing thin lanceolate, acuminate, wrinkled, and pubescent leaves. Spinach green, narrow oblong, chartaceous and entire leaves - acuminate apices and decurrent bases; Flowers solitary, corolla small and white; anther green, filaments short; stigma white. Berry pendant large, elongate, green, curved, red orange when ripe; referred widely as the 'chilly' (Fig. 22).

Epidermal characters

Amphistomatic leaves with irregular and highly sinuous upper epidermal cells; stomata anomocytic; subsidiary cells four; stomatal complex 28.33µm x 21.1µm ; stomatal frequency 148 and stomatal index 25.1 (Fig. 23). Lower epidermal cells irregular and slightly sinuous ; stomata anomocytic and surrounded by 3-4 subsidiary cells (Fig. 24); stomatal complex 55.9µm x 55.9µm; stomatal frequency 65.5 and stomatal index 282. The upper epidermis and lower epidermis showed multicellular finger hairs (Fig. 25).

Capsicum fruitescens L.

A spreading shrub with thin and broadly ovate leaves (Fig. 26.). The stem is herbaceous, erect and hairy; leaves are alternate, opposite in flora region, simple and estipulate. Flowers white or greenish white with pedicels; solitary or two to three together. The placentation is axile, ovules are numerous, style single terminating in a bilabed stigma. Fruit is a berry, elongate and red when ripe and the seed are minute endospermic with a straight or curved embryo.

Epidermal characters

Leaf hypostomatic with upper epidermal cells irregular and slightly sinuous. Lower epidermis with anisocytic stomata; subsidiary cells three; epidermal cells irregular with moderately sinuous walls (Fig. 27); stomatal complex 59.6µm x 45.73µm; stomatal frequency 370 and stomatal index 20.6. Upper epidermis shows unicellular finger hairs (Fig. 28) and lower epidermis shows multicellular finger hairs (Fig. 29).

Capsicum cultivar

A shrub bearing oblong leaves with unequal bases; leaves spinach green,oblong ,chartaceous and entire with acute apices and acute-unequal bases; small violet flowers in groups of two to three; green anthers; carpels very small with violet stigma; berries inflated, straight and violet in colour with tapering tips (Fig. 30).

Epidermal characters

Amphistomatic leaves with anisocytic upper stomata; subsidiary cells three; epidermal cells irregular and highly sinuous (Fig.31); stomatal complex 38µm x 34µm; stomatal frequency 38 and stomatal index 21.2. Lower epidermis with anomocytic stomata surrounded by four subsidiary cells; epidermal cells irregular and highly sinuous (Fig.32); stomatal complex 35.73µm x 42.4µm ; stomatal frequency 313 and stomatal index 33.33. The upper epidermis and lower epidermis showed multicellular finger hairs (Fig. 33).

Datura metel, L.

A tall shrub supposed to have spread from South America to all other parts of the world; entire plant densely covered with greyish tomentum; leaves spinach green; long, broadly ovate or wide elliptic, chartaceous and serrate, unequal at the base and densely tomentose on both surfaces; long white flowers; calyx very long, inflated, persistent and reflexed in fruit; corolla about twice as long as calyx, whitish and green below; light yellow anthers; white stigma; capsule globose, nodding and covered with long slender spines (Fig. 34).

Epidermal characters

Leaves amphistomatic with anomocytic stomata ; subsidiary cells three; epidermal cells irregular and slightly sinuous (Fig.35); stomatal complex 42.67µm x 25.1µm ; stomatal frequency 99 ; stomatal index 17.3. Lower epidermis with both anisocytic and anomocytic stomata; subsidiary cells three to four ; epidermal cells irregular and highly sinuous (Fig.36); stomatal complex 53.33µm x and 69.3µm ; stomatal frequency 153 and stomatal index 46.1. Both upper and lower epidermis showed multicellular finger hairs (Fig. 37).

Brugmansia sp.

Small tree or bush, often covered with fine hairs in young stems, leaves, flower, and fruit. Flowers giant and drooping, with common name 'Angel's Trumpet' (Fig.38). They are white when open, and turn peach on aging. The leaves alternate, ovate, entire to coarsely toothed. Flowers single, pendent, 5-lobed at tip, trumpet-like or funnel-shaped. The calyx is synsepalous ranging from tubular to deeply cleft. The corolla is sympetalous, actinomorphic, and plicate, reflexed lobes with a long tube. The stamens are dis-

Table 1. Size of the stomatal complex in ten members of Solanaceae

Sl. No	Name of plant	Size of stomatal complex			
		Upper epidermis		lower epidermis	
		length	breadth	length	breadth
1	*Solanum nigrum*	A	A	53.3	41.66
2	*Solanum torvum*	23.33	22.5	33.45	26.5
3	*Solanum melongena C-1*	25	30.8	30.33	32.5
4	*Solanum melongena C-2*	20.7	22.7	30.8	31.1
5	*Lycopersicon esculentum*	32.5	25	40	40
6	*Capsicum annum*	28.33	21.1	55.9	55.9
7	*Capsicum frutescens*	A	A	59.6	45.73
8	*Capsicum cultivar*	38	34	35.73	42.4
9	*Datura metel*	42.67	25.1	53.33	69.3
10	*Brugmansia sp.*	A	A	59.6	45.73

Table 2. Qualitative epidermal characters in ten members of Solanaceae

Characters		*S.nigrum*	*S.torvum*	*S. melongena* C-1	*S. melongena* C-2	*L.esculentum*	*C. annum*	*C. frutescens*	*Capsicum C*	*D. metel*	*Brugmansia*
Distribution of stomata		Hypostomatic	amphistomatic	amphistomatic	amphistomatic	amphistomatic	amphistomatic	Hypostomatic	amphistomatic	amphistomatic	Hypostomatic
Type of stomata	upper	A	Anisocytic	Anisocytic	Anisocytic	anomocytic , anisocytic	Anomocytic	A	Anisocytic	Anomocytic	A
	lower	Anisocytic	anomocytic , anisocytic	Anisocytic	Anisocytic	Anomocytic	Anomocytic	Anisocytic	Anomocytic	anomocytic , anisocytic	anomocytic , anisocytic
Shape of epidermal cell	upper	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular
	lower	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular	Irregular
Nature of cell wall	upper	Highly sinuous	moderately sinuous	slightly sinuous	moderately sinuous	moderately sinuous	Highly sinuous	slightly sinuous	Highly sinuous	slightly sinuous	Highly sinuous
	lower	Highly sinuous	Highly sinuous	slightly sinuous	Highly sinuous	Highly sinuous	slightly sinuous	moderately sinuous	Highly sinuous	Highly sinuous	Highly sinuous
No. of subsidiary cells	upper	A	3	3	3	3 to 4	4	A	3	4	A
	lower	3	3 to 4	3	3	4	4	3	4	3 to 4	3 to 4
Stomatal abnormalities		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

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Table 3. Stomatal Index and Stomatal Frequency (Per sq.cm.) in ten members of Solanaceae

Sl. No	Name of plant	Stomatal index		Stomatal frequency	
		Upper epidermis	lower epidermis	Upper epidermis	lower epidermis
1	*Solanum nigrum*	A	61.2	A	374
2	*Solanum torvum*	22	53.7	101	690
3	*Solanum melongena* C-1	20	33	108	393
4	*Solanum melongena* C-2	27	36	177	135
5	*Lycopersicon esculentum*	20.3	67.1	191	588
6	*Capsicum annum*	25.1	65.5	148	282
7	*Capsicum frutescens*	A	20.6	A	370
8	*Capsicum cultivar*	21.2	33.33	38	313
9	*Datura metel*	17.3	46.1	99	153
10	*Brugmansia sp.*	A	24.3	A	346

Table 4. Trichomes in ten members of Solanaceae

Name of plant	upper epidermis	lower epidermis
Solanum nigrum	multicellular finger hair	Stellate hair
Solanum torvum	Stellate hair- small	Stellate hair- large
Solanum melongena C-2	Stellate hair	Stellate hair
Solanum melongena C-2	multicellular finger hair	Stellate hair
Lycopersicon esculentum	multicellular finger hair	multicellular finger hair
Capsicum annum	multicellular finger hair	multicellular finger hair
Capsicum frutescens	unicellular finger hair	multicellular finger hair
Capsicum cultivar	bicellular finger hair	bicellular finger hair
Datura metel	multicellular finger hair	multicellular finger hair
Brugmansia sp.	bicellular finger hair	multicellular finger hair

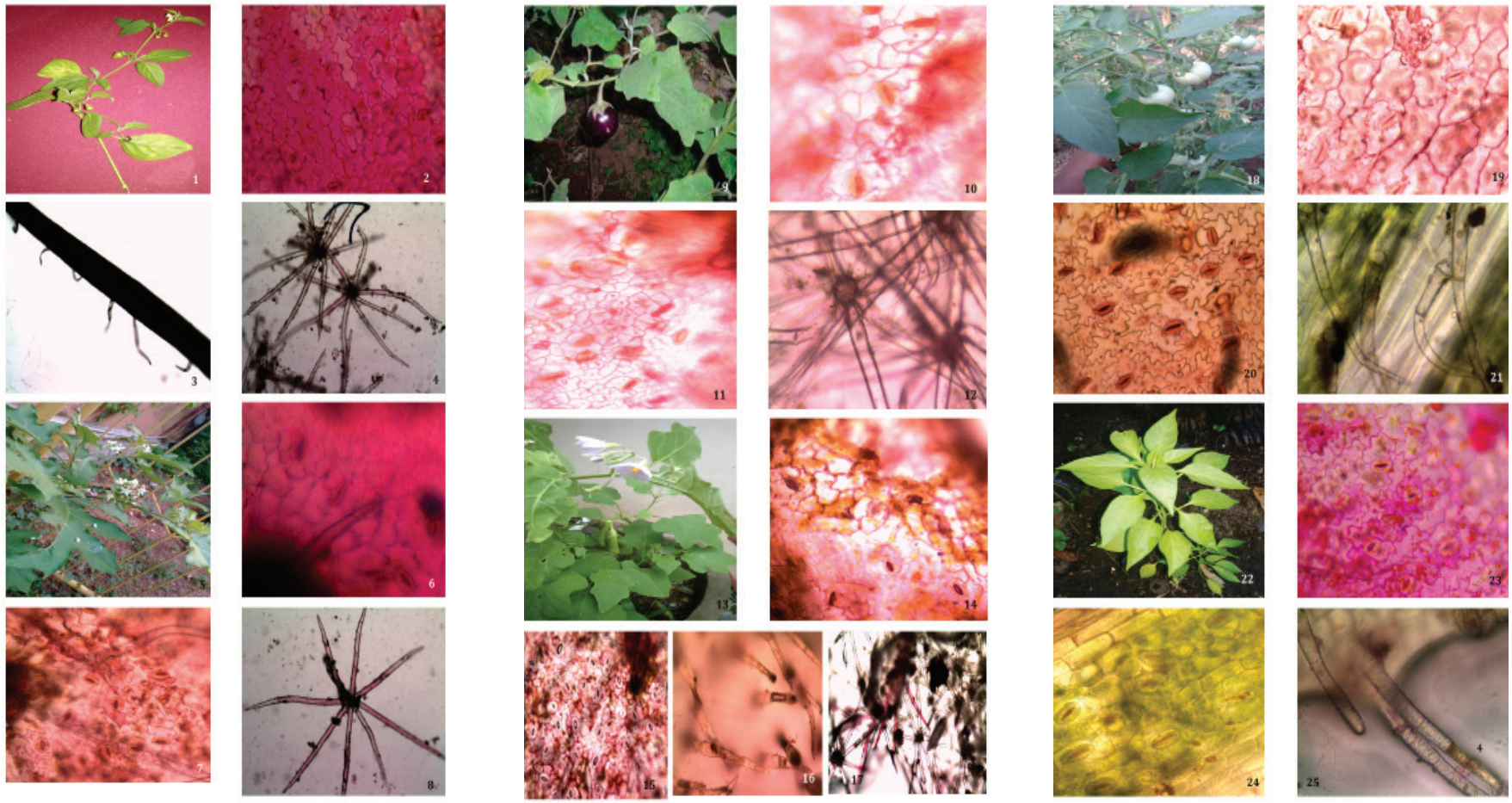

Fig.1- Habit of S. nigrum
Fig. 2- Stomatal distribution in the lower epidermis of *S. nigrum*
Fig. 3- Multicellular finger hairs in upper epidermis of *S. nigrum*
Fig. 4- Long stellate hairs in lower epidermis of *S. nigrum*
Fig. 5- Habit of *S. torvum*
Fig. 6- Upper epidermis with stomata in *S. torvum*
Fig. 7- Distribution of stomata in lower epidermis in *S .torvum*
Fig. 8- Stellate hairs in lower epidermis in *S. torvum*
Fig.9- Habit of *S. melongena* C-1
Fig.10- Upper epidermis of *S. melongena* C-1
Fig.11- Lower epidermis with stomata in *S. melongena* C-1
Fig.12- Stellate hairs in *S. melongena* C-1
Fig.13- Habit of *S. melongena* C-2
Fig.14- Distribution of stomata in upper epidermis of *S. melongena* C-2
Fig.15- Lower epidermis with stomata in *S. melongena* C-2
Fig.16- Multicellular finger hairs in upper epidermis of *S. melongena* C-2
Fig.17- Stellate hairs in lower epidermis of *S. melongena* C-2
Fig.18- Habit of *L. esculentum*
Fig. 19- Stomatal distribution in the upper epidermis of *L. esculentum*
Fig. 20- lower epidermis of *L. esculentum*
Fig. 21- Multicellular finger hairs in of *L. esculentum*
Fig. 22- Habit of *C. annum*
Fig. 23- Upper epidermis with stomata in *C. annum*
Fig. 24- Distribution of stomata in lower epidermis in *C. annum*
Fig. 25- Multicellular finger hairs in *C. annum*

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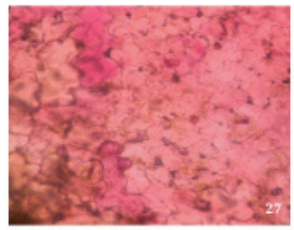
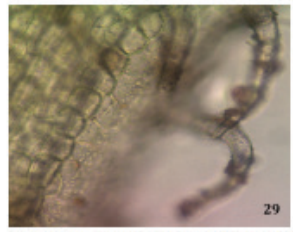




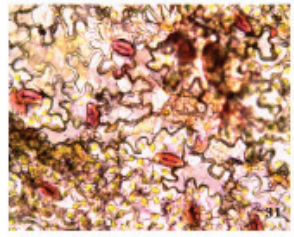
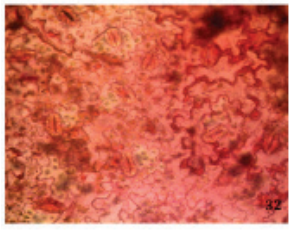
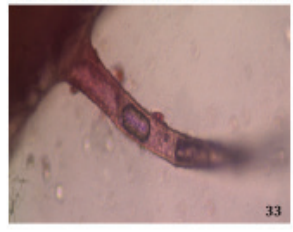
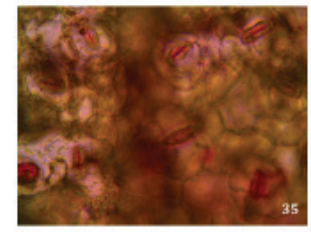
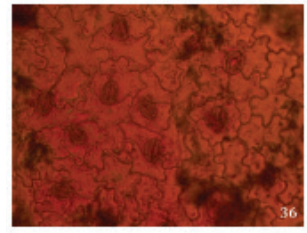
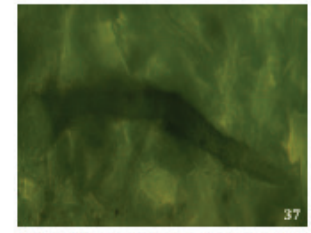




Fig.26- Habit of *C. fruitescens*
Fig.27- Lower epidermis with stomata in *C. fruitescens*
Fig.28- Upper epidermis showing unicellular finger hairs in *C. fruitescens*
Fig.29- Lower epidermis with multicellular finger hairs in *C. fruitescens*
Fig.30- Habit of *Capsicum cultivar*
Fig.31- Distribution of stomata in upper epidermis of *Capsicum cultivar*
Fig.32- Lower epidermis with stomata in *Capsicum cultivar*
Fig.33- multicellular finger hairs in *Capsicum cultivar*

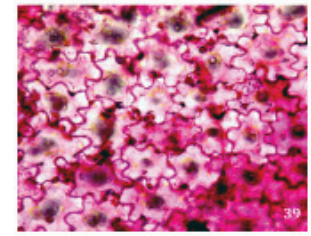
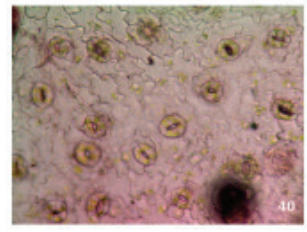
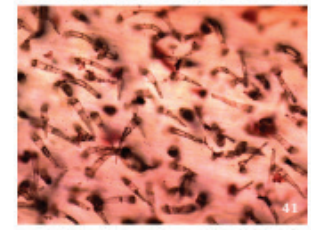




Fig.34- Habit of *D. metel*
Fig. 35- Stomatal distribution in the upper epidermis of *D. metel*
Fig. 36- lower epidermis of *D. metel*
Fig. 37- Multicellular finger hairs in of *D. metel*
Fig. 38- Habit of *Brugmansia sp.*
Fig. 39- Upper epidermis with highly sinuous walls in *Brugmansia sp*
Fig. 40- Distribution of stomata in lower epidermis in *Brugmansia sp*
Fig. 41- Unicellular finger hairs in *Brugmansia sp*

cate, reflexed lobes with a long tube. The stamens are distinct, alternating with the lobes of the corolla, and adnate to the corolla tube or perigynous zone. The gynoecium with single compound pistil of 2 carpels, style single, superior ovary with 2 or rarely more locules by false partitioning, each with nearly always numerous axile ovules. A nectary disk is generally present around the base of the ovary. The fruit is a berry or septicidal capsule, 2.5 to 3.5 inches long with a round to egg-shaped appearance.

Epidermal characters

Leaf hypostomatic with upper epidermal cells irregular and highly sinuous. Lower epidermis with both anomocytic and anisocytic stomata; subsidiary cells three; epidermal cells irregular with highly sinuous walls (Fig.39); stomatal complex 59.6µm x 45.73µm; stomatal frequency 346 and stomatal index 24.3 is. Both upper and lower epidermis showed numerous unicellular finger hairs (Fig. 40).

Discussion

The taxonomic value of epidermal morphology is well documented in botanical literature by Adedeji (2004) and Adedeji and Illoh (2004). Metcalfe and Chalk (1950) gave some description of the general anatomy of the family Solanaceae. Edeoga, 1991; Edeoga and Osawe, 1996; Mbagwu and Edeoga, 2006 constantly reaffirmed that epidermal and cuticular traits of plants could serve as vital tools exploitable in the systematics of the present day angiosperms.

The walls of the epidermal cells of the ten species showed that the upper and the lower epidermal cell wall are irregular in shape. The nature of the cell wall in the taxa analysed ranged from slightly sinuous to highly sinuous, with majority being highly sinuous cell walls. The importance of distribution of stomata in taxonomic classification has been stressed by Watson (1962) in Epacridaceae. In the present study out of the ten plants analysed, seven were amphistomatic with stomata on both the surface of the leaves. The remaining three i.e. *S. nigrum*, *C. frutescens* and *Brugmansia sp*. were hypostomatic, with stomata distributed only on the abaxial side. Hypostomatic plants are considered to be xeric with woody habits, while amphistomatic types are mesophytes (Rajagopal, 1979).

The size of the stomata ranged from moderate to large size. This is based on the earlier report of Pataky (1997), where the stomata whose size is less than 15 µm is considered small and the size above 38 µm is considered large.

The number of stomata in both the upper and lower epidermis also varied. Although stomata appeared on both the upper and lower leaf surfaces but they are more on the lower leaf epidermis. This was apparent in the variation of the stomatal frequency on both the sides. This is probably an adaptation to water loss. This is in agreement with the observations of Metacalf and Chalk (1950) in species of Amaranthus, Mbagwu and Edeoga (2006) in Vigna and Mbagwu et al (2007) in species of Solanum. The stomatal frequency varied in the lower epidermis among taxa with the values ranging from 135 in S. melongena C-2 and 690 in S. torvum.

The stomatal indices also have a wide range of variation. Stomatal index was more in the lower epidermis compared to th upper epidermis. This is in accordance with the studies of Krishnaveni and Thaakur (2009) in *Argyreia nervosa* and Hameed and Hussain (2011) in medicinal Solanacean members. Although stomatal indices have been given considerable importance for making comparison in different taxa, it does not seem to be of any significance in the present.study. This is because their values vary inconsistently in different taxa. This was in accordance with the stomatal studies by Hameed and Hussain (2011) in medicinal Solanacean members.

The stomatal index ranged from 0 - 20.6% in *C. frutescens* and 20.3 - 67.1% in *L. esculentum*. In the amphistomatic taxa, when the stomatal index values of both the upper and lower side were combined, highest value of 90.6 was observed in C. annum, whereas lowest value of 53 was noted in *S. melongena* C-1. The stomatal types varied from anisocytic to anomocytic. Metcalfe and Chalk (1950) reported three different types of stomata in Solanaceae. They are 'rananculaceous' or anomocytic, 'cruciferous' or anisocytic and caryophyllaceous or diacytic stomata.

In the four Solanum species studied the stomatal type was anisocytic, though anomocytic stomata were also found in the lower epidermis of *S. torvum*. The observations made in leaf epidermal characters of the four Solanum species are important especially as they help to establish interspecific relationships among the investigated taxa. The similarities in leaf epidermal features of the four Solanum species showed strong interspecific relationship and thus suggest reasons for four taxa to belong to the same genus. Variation in the epidermal characters among the four Solanum species was only in the stomatal frequency and stomatal indices. These differences suggest reasons for the taxa to exist as different species.

In the remaining six taxa the stomatal type was predominantly anomocytic, and anisocytic type was noticed in *C. frutesens* and upper epidermis of Capsicum cultivar. On the other hand lower epidermis of Capsicum cultivar and both epidermis *C. annum* had anomocytic stomata. Thus there is a transition from anisocytic to anomocytic stomata in the three Capsicum species studied. The anomocytic type of stomata found in the two capsicum species indicates that the species are phylogenetically related. The result observed in the present study regarding the epidermis of *Capsicum annum* and Capsicum cultivar is in accordance with that observed by Mbagwu (2005).

In the remaining three genus the stomatal type were either anomocytic or a combination of anomocytic and anisocytic. The anomocytic type of stomata that characterized the six taxa is not strange since This type was observed in species of Boeheavia (Edeoga and Ikem, 2001); Vigna (Mbagwu and Edeoga, 2006) and in the studies of some dicotyledonous plants by Metcalfe and Chalk (1960). In each of this study, the authors emphasized the importance of epidermal features and their relevance in systematic botany. The qualitative leaf epidermal features observed in this investigations are of systematic value because they are reasonably constant in the taxa stuied.

Trichomes have long been of considerable importance in comparative investigations in angiosperms. They are frequently present, easily observable and have often been found to have variation patterns which correlate with other features of the taxa under investigation (Cutler, 1969). Rao and Ramayya (1977) used the structure and distribution of trichomes to separate two species of Malvastrum in India. Inamdar et al. (1990) also reported the structure, ontogeny, organographic distribution and taxonomic significance of trichomes in the family Cucurbitaceae. Trichomes are the common and easily identifiable characters of Solanaceae (Harisha and Jani, 2013). Studies regarding the organographic distribution of trichomes in the family was done by Adedeji et al., 2007.

In the present study diverse type of trichomes were observed among the taxa. Diversity of trichomes is considered as a measure of evolutionary progress of the species (Cowan, 1950). *S.torvum* and *S.melongena* C-1 has stellate trichomes in both the abaxial (lower epidermis) and adaxial (upper epidermis) surfaces. This is in concurrence with the report of Adedeji et al. (2007), where *S.torvum* has stellate hair on both the surfaces. Stellate trichomes in *S.torvum* was striking with lage sized ones in the lower epidermis and the upper epidermis having small stellate hairs. *S.melongena* C-2 and *S. nigrum* has stellate hairs only on

the lower side with its upper surface having multicellular finger hair.

Multicellular finger hairs were the major trichome type in majority of the species with the exception of Capsicum cultivar having bicellular finger hair on both the sides. Brugmansia sp. have bicellular finger hair only on the upper epidermis. *C. frutescens* have unicellular finger hair on upper epidermis. Lavania (1990) proposed an evolutionary trend in trichome development, from glandular to non glandular, non stalked to stalked, stalk unbranched to branched, uniseriate stalk to multiseriate, few to many branches and hairs with neck cell to hairs without neck cell. In the present study all the ten taxa showed elaborate trichome development from unicellular hairs to stellate type.

Different shapes of epidermal cells, type and arrangement of stomata, size and shape of trichomes and number of vascular bundles are all vital in systematic botany (Nwachukwu and Mbagwu, 2006). The epidermal characters such as stomata type, number of subsidiary cells, shape of epidermal cells and presence of trichome are the same for the two taxa hence this study confirms the values of morphological and leaf epidermal features in the systematics and biological consideration of taxa in Solanaceae. The leaf epidermal features might be utilized in the systematic consideration of the taxa in view of their perceived similarities in structural aspects.

Summary and Conclusion

The present study emphasized the importance of epidermal features and their relevance in systematic botany. The observations made in leaf epidermal features of the Solanacean members are important especially as they help to establish interspecific relationships among the ten investigated taxa. Though the quantitative epidermal characters like size of the stomatal complex, stomatal index and stomatal frequency showed marked variation, the qualitative characters were almost the same with only slight variations. This support the grouping of the taxa under the family Solanaceae. The species under the same genus also showed similarities with only small variations.

All the ten plants displayed elaborate trichome development with gradation in trichome type from unicellular hair to stellate type. The trichome types of the taxa are useful in distinguishing the species to the corresponding genus and even to analyse their inter relationships. Variation in the trichome type can be attributed to the evolutionary progress of the plants within the family. All these caharacters play an impotant role in systematic for analysis of variability as well as uniformity.

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