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Foliar epidermal micro-morphology of selected brinjal varieties: A study on leaf surface characteristics

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ABSTRACT

Studies on the leaf epidermal morphological characteristics were conducted on the three varieties of brinjal (*Solanum melongena* L.) belonging to the family Solanaceae. The varieties used in the study were Bhavani Gold, Purple Round and Haritha. Fresh mature brinjal leaves were randomly selected from the three experimental genotypes, and the foliar epidermal features were studied by using light microscopy and SEM imaging. Measurements were taken with an ocular and stage micrometer using 10X and 40X magnifications. The photographs were taken from mounted slides. The stomatal count and each measurement represent the average of ten readings. The upper and lower epidermal surfaces of leaf were studied for stomatal features including, stomatal distribution, stomatal type, stomatal index, stomatal pore length, stomatal pore width, guard cell length, guard cell width, subsidiary cell length and width, epidermal cell type, epidermal cell length and width, trichome type, trichome length and width. Amphistomatous, anisocytic, and with more stomata on the lower epidermal surface than the upper epidermal surface were present in all leaf varieties. On the leaves, the abaxial stomatal index ranged from 68.19 mm⁻² (Bhavani Gold) to 56.67 mm⁻² (Purple Round) to 58.8 mm⁻² (Haritha). While on the adaxial surface, it varied from 59.67 mm⁻² (Bhavani Gold), 53.46 mm⁻² (Purple Round) and 56.67 mm⁻² (Haritha). The three varieties of this study exhibited similarities in the pattern of epidermal cell on the adaxial and abaxial surfaces and were irregular in shape. Among the three varieties epidermal cell become irregular in outline and trichomes were present on both leaf surfaces. It becomes stellate, non-glandular, glandular and 8-12 in number. The highest trichome length was obtained in Bhavani Gold (63 µm) followed by Haritha (57.5 µm) and Purple Round (43 µm) on the upper epidermis. On the lower epidermal region maximum length was obtained in Bhavani Gold (65.5 µm) followed by Haritha (53 µm) and Purple Round (44 µm).

KEYWORDS: Amphistomatous, Anisocytic, Brinjal, Epidermis, Stomata, Stomatal index, Trichomes

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INTRODUCTION

Among the crops, vegetable crops are common in the Indian diet. Brinjal (*Solanum melongena* L.) is frequently called as eggplant and is a widely cultivated vegetable in India. Eggplants are grown semi-shrubs or shrubs as well as they have eye catching flowers and fruits. Foliar characteristics involve microscopic and macroscopic features like stomatal morphology, plays an important role in taxonomical and pharmacognostical analysis. Stomatal distribution patterns and their micro-morphological features used for the classification of angiosperms (Parveen *et al.*, 2000). Micro-morphological measurements in variety of plant parts have been used as a tool for taxonomic identification of species (Prabhu *et al.*, 2011).

In *Solanum*, worldwide stomatal studies conducted in several species. However, there is great controversy regarding the nature

of stomata, as observed by various workers (Santhan, 2014). Stomatal distribution, frequency and their size are specific to taxa and are used as significant parameters in taxonomy as well as in elucidating phylogeny (Ahmed, 1979; Idu *et al.*, 2000; Barkatullah *et al.*, 2014). Trichomes or plant hair cells, develop from the outgrowth of one or more epidermal cells (Levin, 1973).

Trichomes have been found to play a direct or indirect role in shielding plants from UV radiation, mitigating drought stress and coping with high salinity levels (Skaltsa *et al.*, 1994; Espigares & Peco, 1995). Zhuang *et al.* (2011) suggested that foliar adaptations in response to specific environments mainly involve trichomes and epidermal features. Stomata, glandular trichomes, and non-glandular trichomes are notable secretory structures involved in the transport of gases, transpiration as well as the storage and secretion of various metabolic products (Stant, 1973). Present study used to compare the differences between

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foliar epidermal features in local and released brinjal varieties as well as also select the better brinjal varieties for further plant breeding programme.

MATERIALS AND METHODS

Fresh mature brinjal leaves from three experimental genotypes were chosen at random for analysis (Figure 1). In the experimental field, the leaves were carefully gathered from healthy plants.

Light Microscopy

Using a razor blade, epidermal peelings were taken from both the adaxial and abaxial leaf surfaces of three brinjal varieties. The peelings were rinsed in distilled water and dyed for one minute with a 1% aqueous safranin solution. The stained peelings were put on clean glass slides with 50% glycerin and observed under a stereo microscope (Leica-DM500) at 10X and 40X



Figure 1: Three varieties of brinjal: a) Bhavani Gold, b) Purple Round and c) Hariitha

magnifications. An ocular and a stage micrometre were used to collect measurements. The mounted slides were photographed and documented (Anil Kumar & Murukan, 2015).

Scanning Electron Microscopy

Fresh leaves were chosen from the upper centre region of mature, undamaged brinjal leaves. Two leaf pieces were cut and taped to stubs using double-coated Scotch tape. One piece was placed on the stub from the higher side to reveal the lower leaf surface, while the other was mounted from the lower side to expose the upper leaf surface. The leaf specimens were coated with a thin layer of gold-palladium and observed under scanning electron microscope (SEM) at the University of Kerala's Central Laboratory for Instrumentation and Facilitation (CLIF). The stomatal frequency and all values were based on an average of ten readings. The upper and lower surfaces of the leaf were studied for stomatal characters including, stomatal distribution, stomatal type, stomatal index, stomatal pore length, stomatal pore width, guard cell length, guard cell width, epidermal cell type, epidermal cell length and width, trichome type, trichome length and width.

The stomatal index was calculated by, $I = S/E + S$, 'S' is the number of stomata per unit area, 'E' is the number of epidermal cells in the same area (Metcalfe & Chalk, 1979).

RESULTS AND DISCUSSION

Leaves are the most varied organ in angiosperms used for the classification of plants up to species level. So the microscopic features of foliar epidermis provides helpful for the identification especially in angiosperm classification at species level in many genera (Adedeji *et al.*, 2007). Present investigation revealed that,

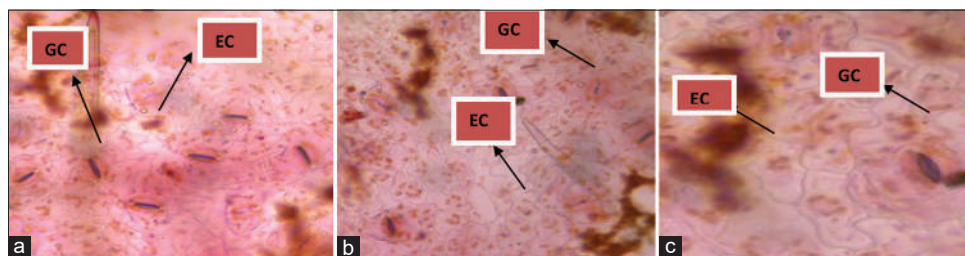


Figure 2: Light micrograph of upper leaf surface of three varieties of brinjal at 40 X objective a) Bhavani Gold, b) Purple Round and c) Hariitha (EC: Epidermal cell, GC: Guard cell)

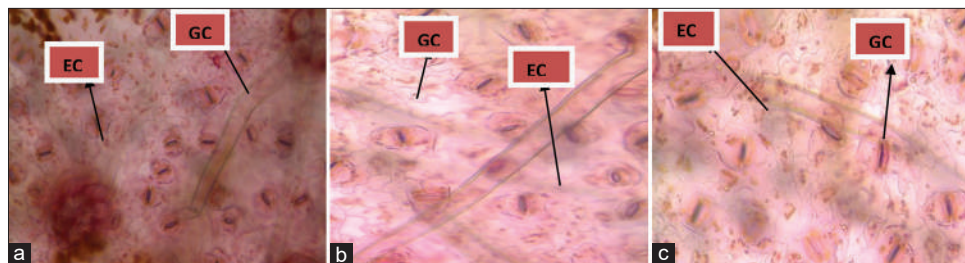


Figure 3: Light micrograph of lower leaf surface of three varieties of brinjal at 40 X objective a) Bhavani Gold, b) Purple Round and c) Hariitha (EC: Epidermal cell, GC: Guard cell)

amphistomatic and anisotypic type of stomata present on the upper and lower surfaces of the leaves of three brinjal genotypes. Greater number of stomata distributed on the lower surface of leaves (Figure 2). This type of stomata distribution helps reduce transpiration and enhances gas exchange by increasing the surface area for carbon dioxide diffusion and removing excess water vapor in a moist environment (Ashafa *et al.*, 2008). The upper and lower surfaces of the foliar epidermis were studied for stomatal index, stomatal pore length and breadth, guard cell length and width, epidermal cell type, and kind of trichomes.

The stomatal index of the adaxial epidermis among three varieties were was 59.67 mm⁻² in Bhavani Gold, 53.46 mm⁻² in Purple Round, 57.97 mm⁻² in Haritha and the abaxial epidermis was 68.1 mm⁻² in Bhavani Gold, 56.6 mm⁻² in Purple Round and 58.86 mm⁻² in Haritha (Table 1). The longest mean stomatal pore length on the adaxial surface was recorded in Haritha (7.5 µm), and followed by Bhavani Gold (7.25 µm) and Purple Round (6.25 µm). The longest mean stomatal pore length on the abaxial surface was recorded in Bhavani Gold (9.58 µm) followed by Haritha (8 µm) and Purple Round (7 µm). Stomatal pore

width on the adaxial surface was the same in all varieties. Guard cell length on the adaxial surface was highest in Bhavani Gold (10.25 µm) and lowest in Purple Round (9.50 µm) and Haritha (10 µm). Guard cell length on the abaxial surface was highest in Bhavani Gold (10.5 µm) followed by Haritha (10.25 µm), and Purple Round (10 µm). Guard cell width of the adaxial epidermis in three varieties are Bhavani Gold (5.25 µm), Purple Round (4.5 µm) and Haritha (5 µm). Guard cell width of the abaxial epidermis was Bhavani Gold (5.5 µm), Purple Round (5 µm) and Haritha (5 µm) (Table 1 & Figures 2-5).

The three varieties studied exhibited similarity in the pattern of epidermal cell on both the upper and lower surfaces and were irregular in shape. On the adaxial surface highest epidermal cell length was recorded in Haritha (16 µm), and the least one was Purple Round (14.25 µm). On the abaxial surface, the mean value varied Haritha shows 16.75 µm followed by Purple Round (15.5 µm). Epidermal cell width of all varieties in their upper epidermis was Haritha (10.5 µm), Bhavani Gold (9.25 µm), Purple Round (9 µm) and lower epidermis were Haritha (11 µm), Bhavani Gold (10 µm) and Purple Round (10.25 µm) (Table 2).

The biological functions of trichomes have been of scientific interest for a long time. This includes, among others, protection against insect herbivores, lowering of leaf temperature and storage of phytochemicals (Ashafa *et al.*, 2008). In this study, trichomes were found on both surfaces of leaves in all varieties. It becomes stellate, non-glandular and 8-12 in number. The highest trichome length was obtained in Bhavani Gold (63 µm) followed by Haritha (57.5 µm) and Purple Round (43 µm) on the upper surface. On the lower surface, the maximum length obtained in Bhavani Gold (65.5 µm) followed by Haritha

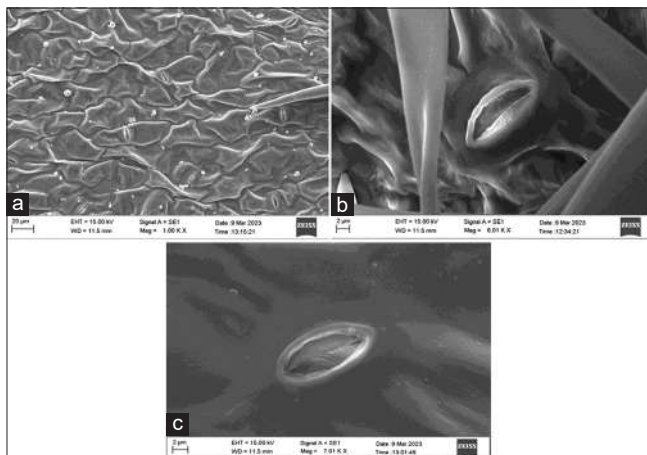


Figure 4: SEM images of upper epidermal surfaces of a) Bhavani Gold, b) Purple Round and c) Haritha

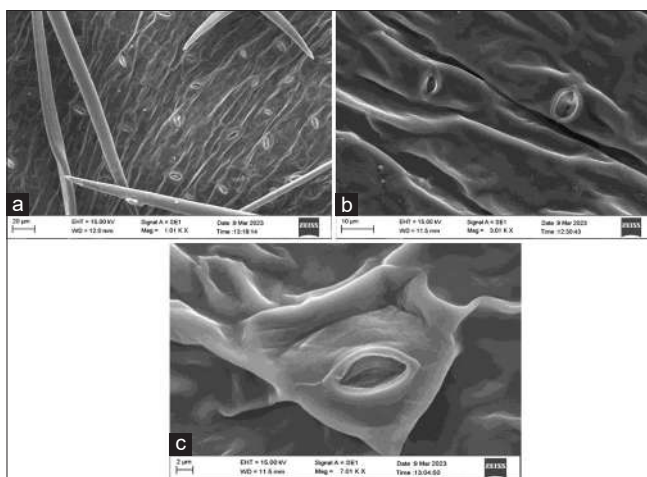


Figure 5: SEM images of lower epidermal surfaces of a) Bhavani Gold, b) Purple Round and c) Haritha

Table 1: Stomatal characteristics of both upper and lower epidermis of three brinjal genotypes

S. No.	Varieties	Stomatal index (mm ⁻²)		Stomatal pore length (µm)		Stomatal pore width (µm)		Guard cell length (µm)		Guard cell width (µm)	
		AD	AB	AD	AB	AD	AB	AD	AB	AD	AB
1	Bhavani Gold	59.67	68.19	7.25	9.58	5	5	10.25	10.5	5.25	5.5
2	Purple Round	53.46	56.67	6.25	7	5	5	9.5	10	4.5	5
3	Haritha	57.97	58.86	7.5	8	5	7.5	10	10.25	5	5

Table 2: Epidermal features of both upper and lower surfaces of leaves in three brinjal varieties

S. No.	Variety	Epidermal Shape		Epidermal cell Length (µm)		Epidermal cell Width (µm)	
		AD	AB	AD	AB	AD	AB
1.	Bhavani Gold	Irregular	Irregular	15.6	16.1	9.25	10
2.	Purple Round	Irregular	Irregular	14.25	15.5	9	10.25
3.	Haritha	Irregular	Irregular	16	16.75	10.5	11



Figure 6: Light micrograph of upper leaf surface trichomes of three varieties of brinjal at 10X objective a) Bhavani Gold, b) Purple Round and c) Haritha

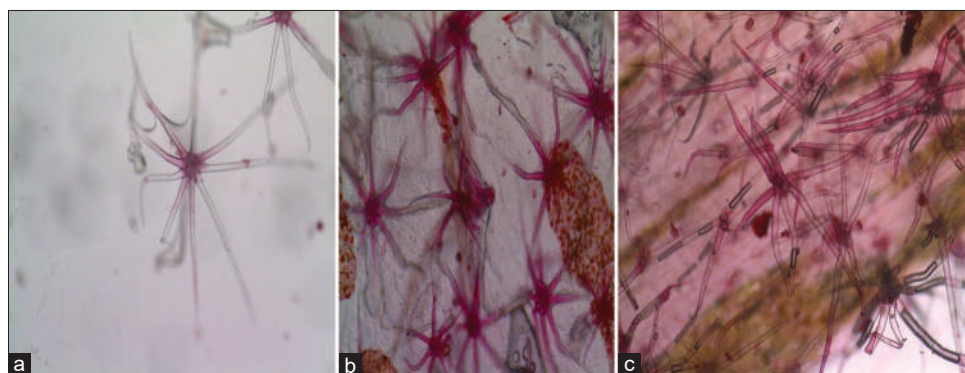


Figure 7: Light micrograph of lower leaf surface trichomes of three varieties of brinjal at 10X objective a) Bhavani Gold, b) Purple Round and c) Haritha

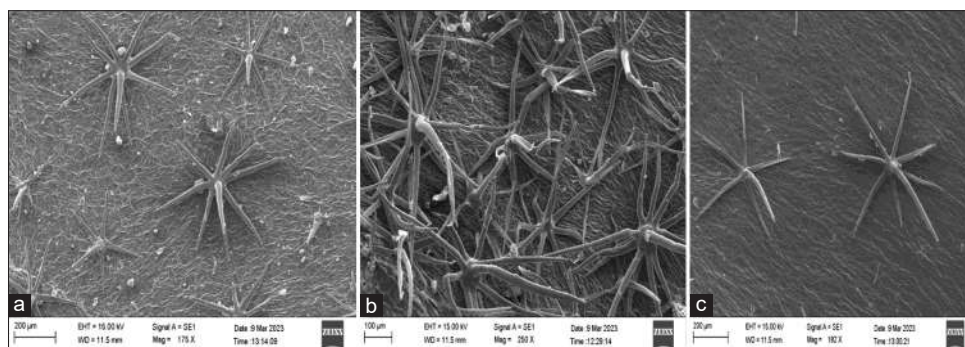


Figure 8: SEM images of adaxial epidermal trichomes of a) Bhavani Gold, b) Purple Round and c) Haritha (SEM: Scanning Electron Microscope)

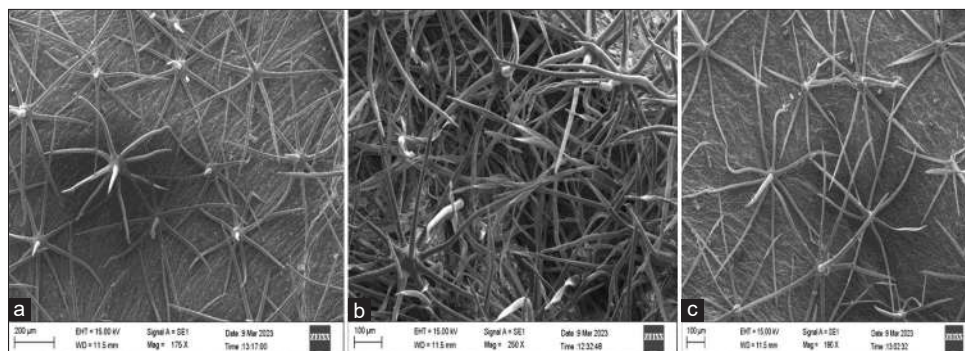


Figure 9: SEM images of abaxial epidermal trichomes of a) Bhavani Gold, b) Purple Round and c) Haritha (SEM: Scanning Electron Microscope)

Table 3: Trichome features of both upper and lower surfaces of leaves in three brinjal varieties

S. No.	Variety	Trichome type		Trichome Length (µm)		Trichome Width (µm)	
		AD	AB	AD	AB	AD	AB
1.	Bhavani Gold	Stellate, non-glandular, glandular, 9-12 in number	Stellate, non-glandular, glandular, 9-12 in number	63	65.5	6.5	6.75
2.	Haritha	Stellate, non-glandular, glandular, 8-12 in number	Stellate, non-glandular, glandular, 8-12 in number	51.5	53	6.5	7
3.	Purple round	Stellate, non-glandular, glandular, 9-12 in number	Stellate, non-glandular, glandular, 9-12 in number	43	44	5.5	6

(53 µm) and Purple Round (44 µm). Trichome width of adaxial surface also recorded in all varieties were, Bhavani Gold (6.5 µm), Haritha (6.5 µm) and Purple Round (5.5 µm). On the abaxial surface were Haritha (7 µm), Bhavani Gold (6.75 µm) and Purple Round (6 µm) (Table 3, Figures 6-9).

CONCLUSION

Present investigation revealed that, the adaxial and abaxial surfaces of the foliar epidermis were studied for stomatal distribution, type, stomatal index, stomatal pore length and width, guard cell length and width, epidermal cell type, and kind of trichomes. All varieties exhibits amphistomatous, and anisocytic, and with more stomata on the adaxial surface than the abaxial surface of the leaf. On the leaves, the abaxial stomatal index ranged from 68.19 (Bhavani Gold) to 56.67 (Purple Round) to 58.8. (Haritha). While on the adaxial surface, it varied from 59.67 (Bhavani Gold), 53.46 (Pourple Round) and 56.67 (Haritha). Both the adaxial and abaxial surfaces of leaves exhibit different in stomatal characteristics. The epidermal cells of the varieties under investigation are irregular in shape. On both surfaces, the trichomes in all forms were stellate, non-glandular, glandular and 8-12 in number.

The interplay of stomatal distribution, epidermal cell morphology, and trichome characteristics serves as a testament to the plants' adaptability and resilience. The variance in stomatal indices between types shows that they have different capability for gas exchange and transpiration. Furthermore, the irregular form of epidermal cells and the presence of stellate, non-glandular trichomes may affect the plant's ability to withstand water loss, guard against excessive light, and prevent herbivores. Understanding these epidermal features can help with plant classification, breeding programmes, and even the production of more efficient crop types with enhanced water-use efficiency or insect resistance.

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