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Taxonomic Diversity in Epidermal Cells of some Sub-tropical Plant Species

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ABSTRACT

A total of 40 angiosperm plant species from 38 genera of 22 families were investigated for the type and shape of leaf epidermal cells. The result showed substantial variations in the type and shape of epidermal cells from straight to polygonal up to wavy. The present results showed that the shape of leaf epidermal cells can not play its role in correlating the taxa but is significant in delimiting the related taxa. © 2010 Friends Science Publishers

Key Words: Leaf epidermal cells; Sub-tropical plant species

INTRODUCTION

The Foliar epidermis is one of the most noteworthy taxonomic characters from the biosystematic point of view and the taxonomic studies of a number of families are made on the basis of leaf epidermis (Bhatia, 1984; Stace, 1984; Jones, 1986; Baranova, 1972). Although taxonomists lately realized the importance of microscopic features of the epidermis, taxonomic monographs are now considered incomplete without them (Rejdali, 1991).

The role of anatomical data in traditional taxonomy has been long recognized since the variations within the species, genera or a family is usually reflected in anatomical features as well. Leaf epidermal anatomical features such as stomata, trichomes and other characters are useful anatomical tools. Although studies conducted on gross morphology and wood anatomy of the plant have proved valuable in the identification of the plants but identification criteria would be incomplete without foliar epidermal morphology (Kadiri, 2005/2006). Measurements of leaf epidermal cell length and width are regarded useful aids in distinguishing varieties with similar flowering date in perennial ryegrass (Wilkins & Sabanci, 1990). Anatomical features are of particular value to scientists who need to identify small scraps of plant material. Epidermal cells are quite variable in their configuration. The characters, which have been proven to be of systematic value are cuticular characters, epidermis, stomata, subsidiary cells and trichomes (Ellis, 1976). There has been a remarkable evolution in the past 30 years or so in the investigation of vascular plant anatomy and its uses in classification (Behnke, 1975). The taxonomic significance of epidermal morphology is well documented in botanical literature (Dehgan 1980). Some particular groups of plants or taxa seem to be characterized by specific type of epidermal features, which are the epidermis, stomata, gland and trichomes (Park 1994; Hong & Son 1999, 2000). The present study deals with the diversity in the type and shape of leaf epidermal cells in some plant species of the District Tank, Pakistan, which is located at 32.00°–32.30° North latitude and 70.05°-70.40° East longitude, with an altitude of 320.04 meters from sea level (Anonymous, 1998). The significance of foliar epidermal anatomy in the systematics of many plant groups has been emphasized (Inamdar & Chohan, 1969; Bhatia, 1984; Stace, 1984; Jones, 1986; Baranova, 1972; Adedeji & Dloh, 2004; Rudgers *et al.*, 2004; Celka *et al.*, 2006; Zou *et al.*, 2008; Yasmin *et al.*, 2009) but there is a lack of attentions from taxonomists to work solely on this character and elaborate its significance. So the present work is the step towards this objective.

MATERIALS AND METHODS

Fresh samples for the type and shape of leaf epidermal cell studies were collected from the field and prepared generally from mid-way between the leaf base and apex of lamina including the midrib, according to the modified method of Clark's (1960). The leaves were placed in test tubes and treated with 88% lactic acid, in water bath (model: memert GmbH^{+}Co.KG D-91\26, Schwabach FRG, Germany) at 100C$^{\circ}$ for 30 min. They were then removed from the test tube into a Petri dish. A drop of lactic acid was used to soften the tissue of leaf due to which it's peeling off is made possible. Slides of both abaxial and adaxial sides of leaves were prepared and observed under light microscope.

Microphotographs were taken by using CCD digital camera (Model: DK 5000) fitted on Leica light Microscope (model: DM 1000). These micrographs were useful for identification and differentiation of epidermal cells on the basis of microscopic features.

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RESULTS AND DISCUSSION

In the present study a total of 40 angiosperm plant species belonging to 38 genera of 22 different families were investigated for the type of leaf epidermal cell. The studies proved very rewarding and resulted in exploration of valuable intergeneric and interspecific variations in the configuration of epidermal cells that can be used as an important supportive taxonomic tool to demarcate many species under study. Four species of family Papilionaceae were delimited by the characteristic shape of epidermal cells. *Lathyrus aphaca* was characterized by epidermal cells with wavy configuration on both adaxial and abaxial leaf surfaces (Fig. 1e), whereas in *Vicia faba* the epidermal cells on adaxial leaf surface were smooth, longitudinal and linear in shape while cells with wavy outline were found on abaxial surface (Fig. 2c). *Melilotus indica* could be delimited by highly undulating epidermal cells on adaxial surface and cells with slight undulations abaxially (Fig. 2a & b). *Trifolium alexandrianum* stays apart by possessing epidermal cells with polygonal configuration. Idu *et al.* (2000) described the epidermal morphology and the structure and development of stomata in 10 species of Fabaceae. According to them the epidermal cells varied from irregular to straight-walled and in some taxa sinuous patterns were observed.

The members of Brassicaceae were distinct, in *Brassica campestris* the epidermal cells were with slight undulations, polygonal to nearly linear in *Lepidium apitalum*, polygonal to nearly rounded and linear in *Raphanus sativus* and in *Sisymbrium irio* polygonal at some places and polygonal to less undulating to clearly irregular at other spots. Three species of family Zygophyllaceae were different in showing polygonal and isodiametric walls in *Tribulus terristris* (Plate 2e) Tetra, penta to polygonal and irregular to less undulating walls in *Fagonia indica* and polygonal to longitudinal walls some cells are nearly irregular in *Peganum harmala* L. Similarly, three species of family Solanaceae were different in having much undulating walls in *Datura stramonium*, wavy walls in *Lycopersicon esculentum* (Plate 1f), while in *Solanum surratense* polygonal walls.

Two species of family Polygonaceae were clearly distinguishable by having clearly polygonal walls in *Polygonum plebijum* (Plate 1b), while penta, hexa to heptagonal to spherical walls, in *Rumex vesicarius*.

Fig. 1: Photographs of leaf epidermal cells

(a), Abaxial surface of *Vaccaryia pyramedica* (20X); (b), Abaxial surface of *Polygonum plebijum* (40X); (c), Abaxial surface of *Poa annua* (40X); (d), Abaxial surface of *Ochthochloa compressa* (20X); (e), Adaxial surface of *Lathyrus aphaca* (40X); (f), Adaxial surface of *Lycopersicon esculentum* (20X)

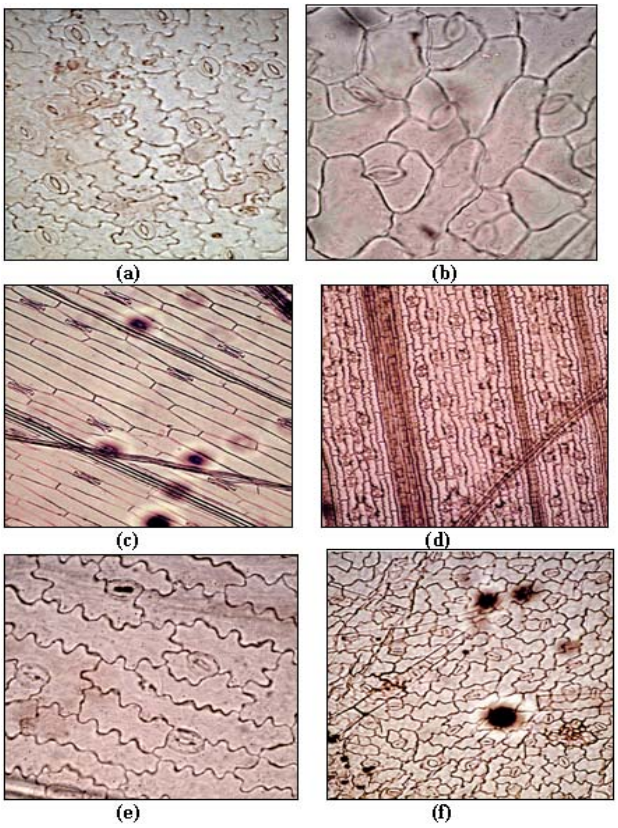

Fig. 2: Photographs of leaf epidermal cells

(a), Adaxial surface of *Melilotus indica* (40X); (b), Abaxial surface of *Melilotus indica* (20X); (c), Adaxial surface of *Vicia faba* (40X); (d), Adaxial surface of *Euphorbia helioscopia* (40X); (e), Abaxial surface of *Tribulus teristris* (40X); (f), Abaxial surface of *Polypogan monspeliensis* (40X)

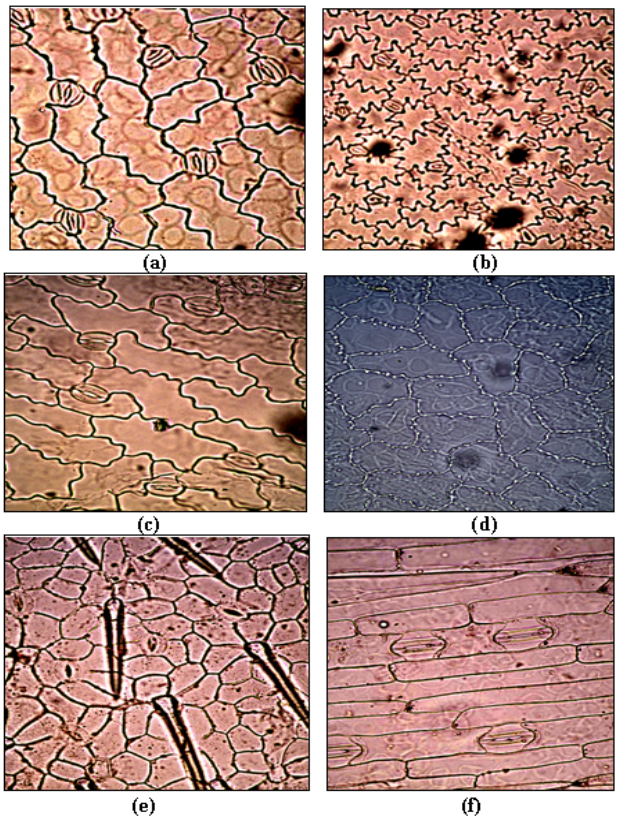

Table I: Qualitative and quantitative analysis of the type of leaf epidermal cells

Taxon	Family	Type of epidermal cells	Length × width of epidermal cells (µm)
Carum copticum (L.) Bth,.	Apiaceae	Less undulating to irregular	82.91 (36.7-138.33) x 35.41 (33.34-37.5)
Calotropis procera (Wild.) R.Br.	Asclepiadaceae	Penta, hexa and polygonal	22.91 (17.5-28.33) x 15.41 (10.834-20)
Convolvulus arvensis L.	Convolvulaceae	Polygonal on adaxial side and polygonal to nearly undulating on abaxial side	73.75 (60-87.5) x 49.17 (40.8-57.5)
Cynoglossum lanceolatum F.	Boraginaceae	Polygonal	83 (46.67-95) x 35.41 (29.17-41.675)
Brassica campestris L.	Brassicaceae	Less undulating	26.071
Lepidium apitalum Wild.	Brassicaceae	Polygonal to longitudinal to linear	98.34 (42.5-154.167) x 42.92 (32.5-53.34)
Raphanus sativus L.	Brassicaceae	Polygonal to nearly rounded and linear	76.6 x 22.5
Sisymbrium irio L.	Brassicaceae	Polygonal at some places and polygonal to less undulating to clearly irregular at others	59.6 (35.8-83.3) x 25.41 (22.5-28.34)
Cleome brachycarpa V ex DC.	Capparidaceae	Polygonal to irregular	78.34 (48.34-108.34) x 37.84 (26.67-47.5)
Spergularia arvensis L.	Caryophyllaceae	Polygonal and less undulating.	68.94 (48.34-108.34) x 27.5 (22.5-32.5)
Vaccaria pyramedica Medik.	Caryophyllaceae	Undulating	89.16 (47.5-130.84) x 24.58 (24.175-25)
Chenopodium album L.	Chenopodiaceae	Polygonal	70 (55.84-84.17) x 29.6 (29.16-30)
Chenopodium murale L.	Chenopodiaceae	Polygonal to nearly undulating	51.7 (40-63.325) x 20.7 (16-25.33)
Calendula arvensis L.	Asteraceae	Long cells with less undulating walls	95.5 (62.5-129.17) x 43.7 (41.76-45.85)
Cyperus defformis L.	Cyperaceae	Mostly tetragonal but penta and hexagonal cells were also found with wavy walls	62.08 (27.17-100) x 22.92 (22.5-23.34)
Euphorbia helioscopia L.	Euphobiaceae	Tetra to penta and hexagonal only on adaxial side and its walls are wavy on abaxial side	22 (9.167-35.84) x 18.34 (16.67-20)
Salvia aegyptica L.	Labiatae	Smooth, linear and of no specific shape	92.08 (63.34-120.84) x 30 (28.34-31.67)
Allium cepa L.	Liliaceae	Polygonal having swollen mid	194.58 (85-304.16) x 25.83 (22.5-29.16)
Asphodelus tenuifolius Carvan	Liliaceae	Long, narrow and rectangular with smooth walls	51.33 (38.35-65) x 27.3 (23.35-31.25)
Melia azedarach L.	Meliaceae	polygonal with smooth walls	23.34 (15-30) x 15
Bougainvillea glabra Choisy	Nyctaginaceae	Tetra, penta to hexagonal	128.34 (65-191.7) x 21.67 (20-23.4)
Lathyrus aphaca L.	Papalionaceae	Wavy	60.62(37.5-83.75)
Melilotus indica (L.) All	Papalionaceae	On abaxial side are undulating and on adaxial side are less undulating.	36.67 (25.834-47.5) x 26.67 (20-32.5)
*Trifolium alexandrianum*L.	Papalionaceae	Penta, hexa and heptagonal	128.34 (65-191.67) x 21.67 (20-23.34)
Vicia faba L.	Papalionaceae	On abaxial side are smooth, longitudinal and linear but wavy on adaxial side	43.34 x 51.667 (Abaxial) 31.6 x 41.7 (Adaxial)
Plantago major L.	Plantaginaceae	Tetragonal to polygonal	47.5 (35.48-58.34) x 30 (25-35)
Plantago ovata F.	Plantaginaceae	Polygonal and smooth on adaxial side & on abaxial side polygonal and less undulating	40 x 10
Cynodon dactylon (L.) Pers,.	Poaceae	Wavy and rectangular	64.58 (44.167-85 x 8.75 (8.5-10)
Ochthochloa compressa (F.) Hilu	Poaceae	Wavy and rectangular	218.75 (100-337.5) x 27.08 (22.5-31.667)
Poa annua L.	Poaceae	Wavy	221.67 (114.16-329.16)x19.17 (18.34-20)
Polypogon monspeliensis (L.) Desf.	Poaceae	Long, narrow and rectangular with smooth walls	17.916 (11.5-24.17) x 12.5 (10-15)
Polygonum plebijum R. Br.	Polygonaceae	Clearly polygonal	59.17 (40-78.33) x 37.5 (30-45).
Rumex vesicarius L.	Polygonaceae	Penta, hexa to heptagonal to spherical	50 (34.17-65.84) x 29.17 (21.7-34.17)
Salix acmophylla Boiss	Salicaceae	Tetra, penta, hexa and polygonal	92.5 x 47.5
Datura stramonium L.	Solanaceae	Much irregular and undulating	57.5 (40.84-74.17) x 16.05 (15-17.5)
Solanum surratense Br.	Solanaceae	Polygonal	130.83 (49.17-12.5) x 20 (17.5-22.5)
Lycopersicon esculentum Miller	Solanaceae	Wavy	130.83 (49.17-12.5) x 20 (17.5-22.5)
Fagonia indica Br.	Zygophyllaceae	Tetra, penta to polygonal and irregular to less undulating	27.91 (20-35.8) x 18.34 (15-21.67)
Peganum harmala L.	Zygophyllaceae	Polygonal to longitudinal & some cells are nearly irregular	130.8 (49.1-212.5) x 20 (17.5-22.5)
Tribulus terristris L.	Zygophyllaceae	Polygonal and isodiametric	27.916 (20-35.8) x 18.34 (15-21.67)

According to Ayodele and Olowokudejo (2006), in *P. plebeium* type of leaf epidermal cells were polygonal both on adaxial and abaxial surface. The species of the same genus were also distinguishable on the basis of leaf epidermis e.g. The *Chenopodium album* have polygonal walls, while *C. murale* had polygonal to nearly undulating walls. Similarly in *Plantago major* tetragonal to polygonal walls, while in *Plantago ovata* the epidermal cells on adaxial side were polygonal and smooth and on abaxial side polygonal and less undulating. In *Euphorbia helioscopia* (Plate 2d), the type of epidermal cells are tetra to penta and hexagonal only on adaxial side and its walls are wavy on abaxial side. Raju *et al.* (2008) studied the variation in the structure and development of foliar stomata in the Euphorbiaceae and find that the epidermal cells are polygonal, trapezoidal or variously elongated in different directions and diffusely arranged. The epidermal anticlinal walls are straight, arched or sinuous.

CONCLUSION

Results revealed the presence of large variations in epidermal cells configuration at different taxonomic levels. The differences were observed in the abaxial and adaxial surfaces of the same leaf as in *C. arvensis*, *T. terristris*, *P. ovata* and *V. faba*. Even the same surface of the leaf also showed variations at differnt spots as in *S. irio*. It is concluded that yet there is a need of more comprehensive work on the shape and type of leaf epidermal cells for their farther elaboration as a taxonomic character.

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