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Foliar Micromorphology of *Felicia muricata* Thunb., A South African Medicinal Plant

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Abstract: The foliar micromorphology of *Felicia muricata* (Thunb.) Nees (Asteraceae) was observed with the JEOL (JSM-6390LV) Scanning Electron Microscope (SEM). Both the abaxial and adaxial surfaces were characterized by anisocytic stomata which were more prevalent on the abaxial surface than the adaxial surface. The leaves have only one type of multicellular non-glandular trichomes that are long and cylindrical, tapering to a sharp point and running parallel to the leaf surface in the direction of the apices. Crystal deposits were also observed on the surfaces of the leaves near the stomata. Energy dispersive X-ray spectroscopy-SEM shows that Na, Al, Si, and K were the major constituents of the crystal analyzed. Since no glandular trichomes were present on the leaves of this herb, the bioactive components present in this plant may be produced in some other tissues in the leaf other than the trichomes.

Key words: *Felicia muricata*, micromorphology, stomata, trichomes, crystal deposit, bioactive components

INTRODUCTION

Felicia muricata (Thunb.) Nees, also known as white *Felicia* (English) and Ihbosisi (Xhosa), is a member of the family Asteraceae. It is a small drought resistant perennial herb growing up to 20 cm in height. The leaves are simple and are arranged in alternate manner. The species is regarded as an indicator of desertification, becoming increasingly invasive in grassland regions of South Africa (Jordaan and Kruger, 1993). *F. muricata* is one of the species used by the traditional healers of southern Africa in the treatment of headaches, pains or inflammations (Hutchings, 1989a; Hutchings and Van Staden, 1994; McGaw *et al*., 1997; Okoli and Akah, 2004). An ethnobotanical survey carried out among the traditional medicine practitioners in the Eastern Cape revealed that the plant, mixed with other plant materials, is used in the management of cancer and for the relief of stomach catthar. In addition to the scanty reports on the medicinal uses of this plant, no information was found in literature on the micromorphology of its leaf appendages. As part of our ongoing study on the medicinal potentials of *F. muricata*, it was decided to investigate the foliar micromorphology using the scanning electron microscope. According to many workers, some bioactive compounds of plants are found in the leaves (Koduru *et al*., 2006; Aliero *et al*., 2006). In this study, we present the micromorphology of the foliar appendages of *F. muricata*. The leaves of many plants have been reported to contain volatile essential oils (Magwa *et al*., 2006; Sandri *et al*., 2007). Information on foliar micromorphology can shed more light on the structural features and their possible functional attributes in plants.

MATERIALS AND METHODS

Plants materials used for this study were collected in August 2007 from one population of *F. muricata* growing within the Alice campus of the University of Fort Hare. The species was authenticated by Mr. Tony Dold, Selmar Schonland Herbarium, Rhodes University, South Africa. A voucher specimen (Ashafa Med. 2007/2) was prepared and deposited in the Griffen Herbarium of the University of Fort Hare.

Fresh leaves, 4-6 mm in length, were removed from the aerial part of the plant and were fixed in 6% w/v glutaraldehyde in 0.05 M sodium cacodylate for 24 h. After washing with 0.05 M cacodylate buffer (pH 7.5), samples were dehydrated in a graded series of ethanol (10 -100%×3) for 15 min per rinse. This was followed by critical point drying with liquid CO_2 in an Autosampler 810 critical point dryer, and sputter-coating with gold palladium in a Hummer V-sputter coater (Robinson *et al*., 1987). Both the adaxial and abaxial surfaces were observed in JEOL (JSM-6390LV) Scanning Electron Microscope, operating at 10-15 kV acceleration voltage. Images were captured digitally using Microsoft image programme for Windows.

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RESULTS AND DISCUSSION

The leaf surfaces are characterized by anisocytic stomata which are more abundant on the abaxial than the adaxial surfaces (Fig. 1). This is a natural phenomenon in most angiosperms (Koduru *et al*., 2006; Aliero *et al*., 2006). Only one type of non-glandular trichome was found on the surfaces of the leaves but more on the adaxial than the abaxial surfaces (Fig. 2). Trichomes have a range of functions: Non-glandular trichomes function to reduce the heat load of plants, increase tolerance to freezing, seed dispersal, water absorption and protection of plant tissues from UV light and biotic factors such as insect herbivores (Johnson, 1975; Mauricio and Rausher, 1997; Werker, 2000; Serna and Martin, 2006) and possibly airborne propagules of fungi (Afolayan and Meyer, 1995). Some types of non-glandular trichomes consist of extremely elongated single cells, which are important in the textile industry (Wilkins *et al*., 2000). The non-glandular trichomes of *F. muricata* are multicellular in nature displaying three-layered cell segmentation at the basal portion (Fig. 2d). The form and function of the foliar trichome has reached its most refined state and is reportedly a crucial adaptation in the ability of plants to successfully inhabit the often extreme environmental conditions (Benzing *et al*., 1978; Benzing, 2000).

The foliar trichomes of *F. muricata* are long and cylindrical, tapering into a sharp point, all running parallel to the surface of the leaves in the direction of the leaf apex (Fig. 2). This type of trichomes however, may contain irritant compounds (Bytnerowicz *et al*., 1998) as well as some other bioactive compounds and essential oils. The development of the trichomes from the epidermis usually results from differential enlargement and subsequent division of the epidermal cells and their derivatives (Carlquist, 1958). Scientific interest in plant trichomes is based on their functional importance and on the economic usefulness of some trichome-produced products (Valkama *et al*., 2003). The only type of trichomes identified on the leaves of *F. muricata* might be responsible for lowering the temperature of the plant, increase its tolerance to freezing, seed dispersal, water absorption and protection of plant tissues from UV light and biotic factors such as insect herbivores (Johnson, 1975; Mauricio and Rausher, 1997; Werker, 2000; Koricheva, 2002; Serna and Martin, 2006). Contrary to the general believe that secondary metabolites of aromatic plants are either produced or stored in the glandular trichomes (Dell and McComb, 1978; Wagner, 1991; Koduru *et al*., 2006) no such trichomes were found on the surfaces of the leaves of this herb. Essential oil, flavonoids and terpenes, however, were found to be

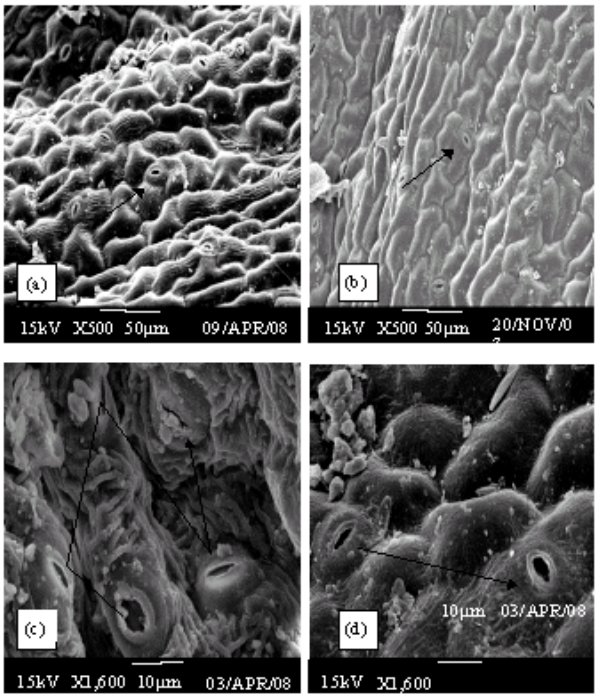

Fig. 1: Stomatal distribution on the leaf surfaces of *F. muricata*. (a) abaxial surface, (b) adaxial surface, (c) higher magnification from abaxial and (d) adaxial surfaces

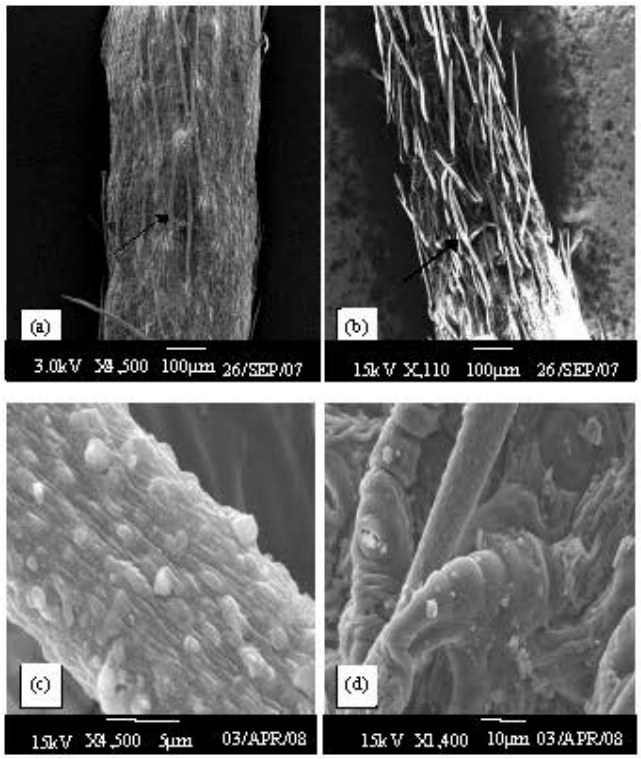

Fig. 2: Micromorphology of trichomes of *F. muricata*. (a) trichome arrangements on abaxial, (b) adaxial surfaces, (c) enlarged trichome with swollen patches or spots and (d) multicellular segmented basal portion of the trichome

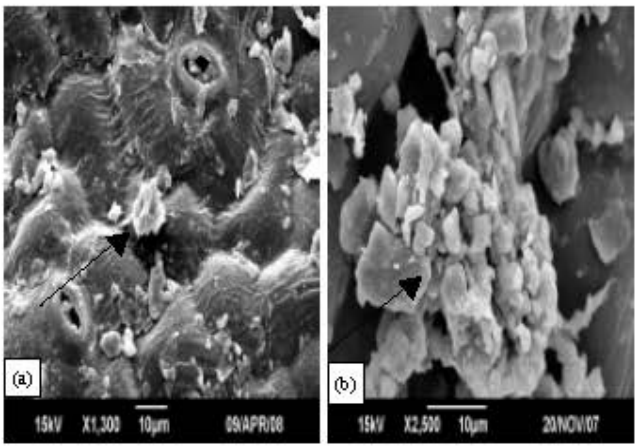

Fig. 3: Deposits of crystals at various leaf surfaces of *F. muricata*. (a) crystal deposit around the stoma and (b) shape and general appearance of the crystals

present in the leaves of this species. It is therefore plausible to assume that these secondary metabolites may be produced in other tissues within the leaf of *F. muricata*.

Some crystal deposits were found on the surfaces of the leaves, mostly around the stomata (Fig. 3). Crystal formation is a common feature on the leaves of many Asteraceae, and has been variously classified as crystal

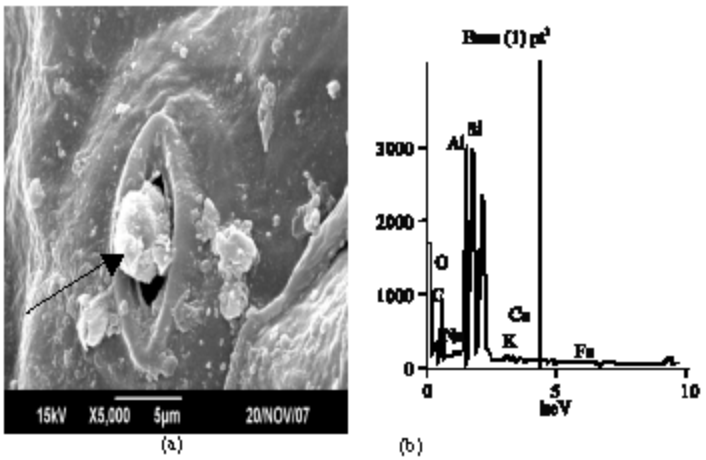

Fig. 4: (a) Arrow indicates the crystal analyzed and (b) Energy dispersive X-ray spectroscopy-SEM of crystal on the leaf surface of *F. muricata*

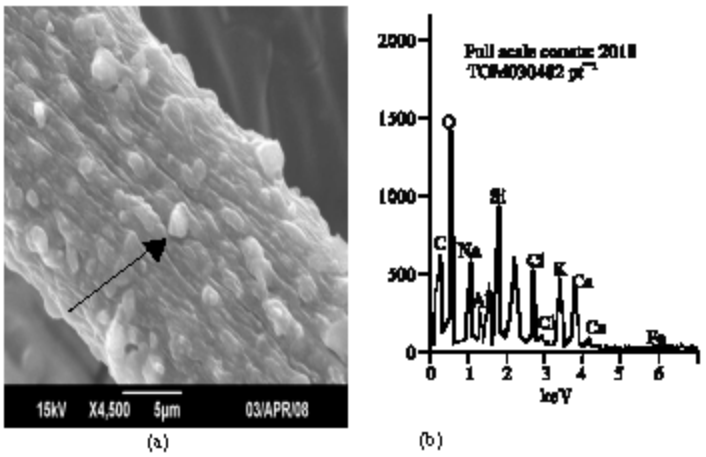

Fig. 5: (a) Arrow pointing to one of the patches/spots analyzed and (b) Energy dispersive X-ray spectroscopy-SEM of swollen patches on the trichomes of *F. muricata* leaf surface

sand, crystal drusa and crystal prisms (Maiti *et al*., 2002). The criteria used in this classification are not clearly defined. It was therefore difficult to relate the particular crystals of *F. muricata* to one of these three types. Foliar crystals in some plants have been found to be mainly composed of Al, K, Na and Si (Aliero *et al*., 2006). Similar observation was made in the energy disperse X-ray spectroscopy-SEM of the crystals of *F. muricata* leaves (Fig. 4). In the same manner, the energy disperses X-ray spectroscopy-SEM of the swollen patches (Fig. 5), on the trichomes revealed the same chemical composition as found in the crystals. It is likely that these chemicals are produced as a defense mechanism. Trichomes have been reported to secret, to the surface, ions such as Na, Cl (salt glands), Ca, Cd, Zn, Mn, Ni, Pb, S, Si and other salts (Salt *et al*., 1995; Choi *et al*., 2001). It could be assumed that the anionic contents of the crystals found on the leaves of the plant were produced in other foliar tissues, as glandular trichomes were not present. These features could give this plant anti-herbivory characteristic. Although micro-morphological studies alone do not provide the information required to establish sites of synthesis in cells (Afolayan and Meyer, 1995), we believe that the therapeutic compounds in *F. muricata* are likely produced by some other tissues in the leaf other than the trichomes.

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REFERENCES

Afolayan, A.J. and J.J.M. Meyer, 1995. Morphology and ultra structure of secreting and non secreting foliar trichomes of *Helichrysum aurenitens* (Asteraceae). Int. J. Plant Sci., 156: 481-487.

Aliero, A.A., D.S. Grierson and A.J. Afolayan, 2006. The foliar micromorphology of *Solanum pseudocapsicum*. Flora, 201: 326-330.

Benzing, D.H., J. Seemann and A. Renfrow, 1978. The foliar epidermis in illandsioideae (Bromeliaceae) and its role in habitat selection. Am. J. Bot., 65: 359-365.

Benzing, D.H., 2000. Bromeliaceae: Profile of An Adaptive Radiation. 1st Edn., Cambridge University Press, Cambridge, ISBN: 052143031 .

Bytnerowicz, A., K.E. Percy, G. Riechers, P. Padgett and M. Krywult, 1998. Nitric acid vapor effects on forest trees-deposition and cuticular changes. Chemosphere, 36: 697-702.

Carlquist, S., 1958. Structure and ontogeny of glandular trichomes of Madinae (Compositae). Am. J. Bot., 45: 675-682.

Choi, Y.E., E. Harada, M. Wada, H. Tsuboi, Y. Morita and H. Kusano, 2001. Detoxification of cadmium in tobacco plants: Formation and active execration of crystals containing cadmium and calcium through trichomes. Planta, 213: 45-50.

Dell, B. and J.A. McComb, 1978. Plant resins-their formation, secretion and possible functions. Adv. Bot. Res., 6: 277-316.

Hutchings, A., 1989. A survey and analysis of traditional medicinal plants as used by the Zulu, Xhosa and Sotho. Bothalia, 19: 111-123.

Hutchings, A. and J. Van Staden, 1994. Plants used for stress related ailments in traditional Zulu, Xhosa and Sotho medicine. Part 1: Plants used for headaches. J. Ethnopharmacol., 52: 89-124.

Johnson, H.B., 1975. Plant pubescence: An ecological perspective. Bot. Rev., 41: 233-258.

Jordan, A. and H. Kruger, 1993. Pollen wall ontogeny of *Felicia muricata* (Asteraceae). Annals Bot., 71: 97-105.

Koduru, S., D.S. Grierson and A.J. Afolayan, 2006. The foliar micromorphology of *Solanum aculeastrum*, a Medicinal plant of South Africa. Pak. J. Biol. Sci., 9: 1056-1060.

Koricheva, J., 2002. The carbon-nutrient balance hypothesis is dead; Long live the carbon- nutrient balance hypothesis? Oikos, 98: 537-539.

Magwa, M.L., M. Gundidza, N. Gweru and G. Humphrey, 2006. Chemical composition and biological activities of essential oil from the leaves of *Sesuvium portulacastrum*. J. Ethnopharmacol., 103: 85-89.

Maiti, R.K., L.R. Villareal, A.V. Trevin and M.C. Vallades-Cerda, 2002. Some aspects of pharmacognosy of ten species of the family solanaceae utilized in traditional medicine. Caldasia, 24: 317-321.

Mauricio, R. and M.D. Rausher, 1997. Experimental manipulation of putative selective agents provides evidence for the role of natural enemies in the evolution of plant defense. Evol. Int. J. Org. Evol., 51: 1435-1444.

McGaw, L.J., A.K. Jager and J. Van Staden, 1997. Prostagladin inhibitory activity in Zulu, Xhosa and Sotho medicinal plants. Phytother. Res., 11: 113-117.

Okoli, C.O. and P.A. Akah, 2004. Mechanisms of the anti-inflammatory activity of the leaf extracts of *Culcasia scandens* P. Beauv (Araceae). Pharmacol. Biochem. Behav., 79: 473-481.

Robinson, D.G., U. Ehlers, R. Herken, B. Herrmann, F. Mayer and F.W. Schumann, 1987. Methods of preparations for electron microscopy. 1st Edn., Heidelberg: Springer-Verlag Berlin, ISBN: 0-387-17592-X .

Salt, D.E., R.C. Prince, I.J. Pickering and I. Raskin, 1995. Mechanism of cadmium mobility and accumulation in Indian mustard. Plant Physiol., 109: 1427-1433.

Sandri, I.G., J. Zacaria, F. Fracaro, A.P.L. Delamare and S. Echeverrigaray, 2007. Antimicrobial activity of the essential oils of Braz. species of the genus Cunila against foodborne pathogens and spoiling bacteria. J. Ethnopharmacol., 103: 823-828.

Serna, L. and C. Martin, 2006. Trichomes: Different regulatory networks lead to convergent structures. Trends Plant Sci., 11: 274-280.

Valkama, E., S. Juha-Pekka, K. Julia and P. Kalevi, 2003. Comparative analysis of leaf trichome structure and composition of epicuticular flavonoids in Finnish Birch species. Ann. Bot., 91: 643-655.

Wagner, G.J., 1991. Secretory glandular trichomes: More than just hairs. Plant Physiol., 96: 643-655.

Werker, E., 2000. Trichome diversity and development. Adv. Bot. Res., 31: 1-35.

Wilkins, T.A., K. Rajasekaran and D.M. Anderson, 2000. Cotton biotechnology. Crit. Rev. Plant Sci., 19: 511-550.