Chapter 6

The foliar micro-morphology of *Hermannia incana* Cav.

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Foliar Micromorphology of *Hermannia icana* Cav.

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Abstract: The structure and distribution of foliar appendages on the leaves of this plant were investigated with the JEOL (JSM-6390LV) scanning electron microscope (SEM). Both glandular and non-glandular trichomes were observed, which differed from each other in morphology and location on the leaves. Long stalked glandular trichomes were present on both the abaxial and adaxial surfaces while short stalked glandular trichomes were present only on the adaxial surface. Glandular trichomes were capitate while non-glandular trichomes were stellate with many arms. Some crystal deposits were observed on the surfaces of the leaves. Energy dispersive X-ray spectroscopy-SEM of these crystals showed that Al, Ca, K, Na, Ti and Si were the major constituents. We hypothesize that the bioactive therapeutic compounds secreted by *H. incana* may be produced in the glandular trichomes.

Key words: Micromorphology, capitate trichomes, stellate trichomes, bioactive, therapeutic

INTRODUCTION

Hermannia incana Cav. (Sterculiaceae), locally known as Mavulakuvaliwe (sweet yellow bells), is a medicinal plant used by the people of the Eastern Cape for the treatment of diarrhoea. It is a prostrate herb with yellow flowers. The leaves are hairy occurring in grassland and marshes in the Eastern Cape Province of South Africa. From discussion with traditional healers, herbalists and local people it was found that the plant is used as an emetic and the leaf sap extracted in cold water is used to treat stomach-ache and diarrhoea, having purgative and diaphoretic effects. Decoctions of the whole plant are taken to soothe coughs. The flavonoid, quercetin, present in most of the Sterculiaceae species (Watson and Dallwitz, 1992), which was found to be responsible for the antidiarrheal activity (Palombo, 2006) is expected to be present in this plant.

Leaves of many plants are densely covered with glandular and non-glandular trichomes, which originate from epidermal cells (Werker, 2000) and are a natural phenomenon of most Sterculiaceae species (Watson and Dallwitz, 1992). Plant species that contain glandular trichomes generally produce relatively large amounts of bioactive compounds which include highly concentrated secondary metabolites with biological activity of interest to pesticide, pharmaceutical, flavour and fragrance industries (Duke, 1994).

No information is available on the micromorphology and ultrastructure of the leaf appendages of *H. incana*. We hypothesize that the bioactive therapeutic compounds of this plants are produced in the glandular leaf trichomes. The aim of this study therefore, was to investigate the structure and distribution of different foliar appendages present on the leaves of *H. incana*.

MATERIALS AND METHODS

Plant material was collected in August 2007 from a natural population growing near the University of Fort Hare in the Eastern Cape Province of South Africa. Fresh leaves, 2-3 cm in length, were removed from the upper part of the plant and were fixed in 6% 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 graded series of ethanol (10, 20, 30, 40, 50, 60, 70, 80, 90 and 100%×3) for 15 min/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 Vsputter coater (Robinson *et al.*, 1987). Both the adaxial and abaxial surfaces were observed under JEOL (JSM-6390LV) scanning electron microscope, operated at 10-15 kV acceleration voltage. Images were captured digitally using Microsoft image program for windows.

RESULTS AND DISCUSSION

The ultrastructural investigation of the leaf surfaces of *H. icana* has revealed two types of trichomes,

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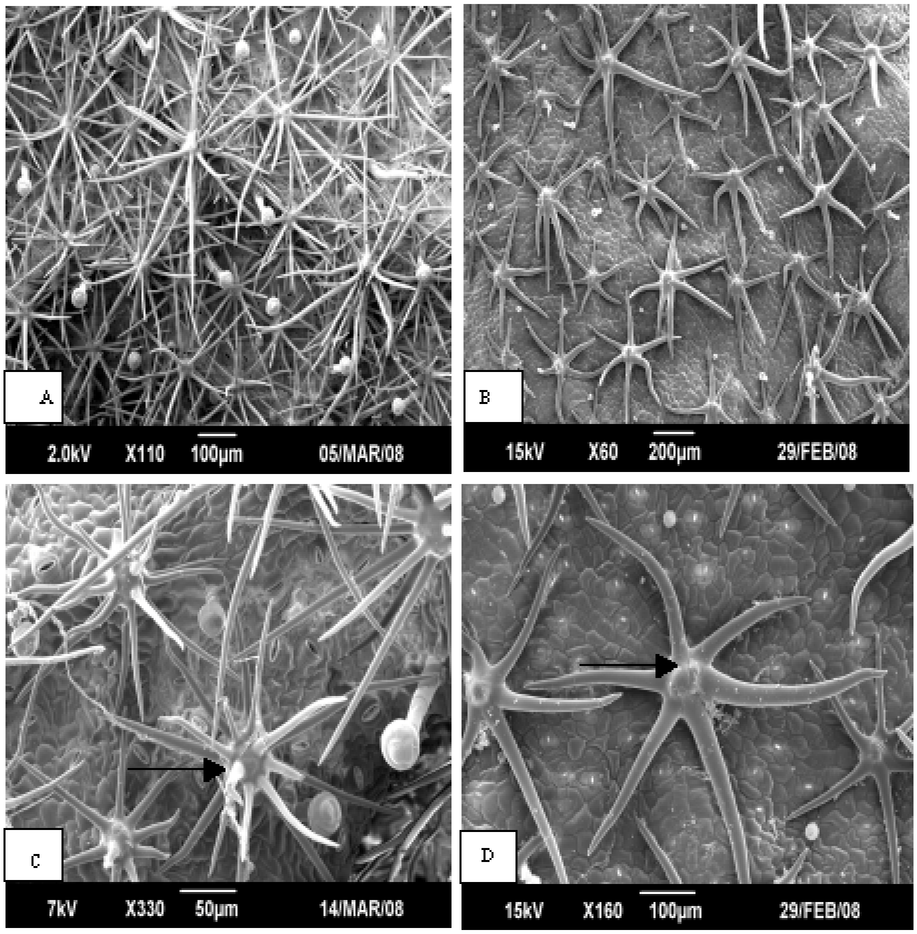

Fig. 1: Trichome distribution on the leaves of *Hermannia incana*; (A) abaxial surface, (B) adaxial surface, (C) higher magnification of stellate trichomes (arrowed) from abaxial surface, (D) adaxial surface. Note the short and long glandular trichomes

glandular and non glandular. The leaves are also characterized by anisocytic stomata which are more abundant on the abaxial than adaxial surfaces.

The non glandular trichomes present on the surface of the leaves are of the stellate type (Fig. 1A-D). These trichomes were more abundant and densely distributed on the abaxial than the adaxial surface. Those on the abaxial side have 14-16 arms, while on the adaxial surface they typically have 6-10 arms. Non glandular trichomes in Sterculiaceae family are mostly stellate, the size and number of cells present varying among species (Lersten and Curtis, 1997). These trichomes form a dense indumentum and may serve as a mechanical barrier against various external factors, such as herbivores and pathogens, UV-B radiation, extreme temperatures and excessive water loss (Werker, 2000).

Glandular trichomes, which are sparsely and evenly distributed over the entire leaf surfaces, are of the capitate type (Fig. 2A-D). Each glandular trichome is morphologically divided into three regions that are easily distinguishable: the multicellular head, stalk and the basal cavities. Capitate trichomes are believed to secrete varying amounts of polysaccharides along with essential oils (Werker, 1993). Two types of glandular trichomes were identified on both surfaces of *H. incana* leaves. They were long stalked and short stalked (Fig. 2A, B). Long stalked capitate trichomes were present on both adaxial and abaxial surfaces while short stalked trichomes were present only on the adaxial surface. Glandular trichomes, which secret lipophilic substances (terpenes, lipids, waxes and flavonoid aglycones) may provide chemical and physiochemical protection against various

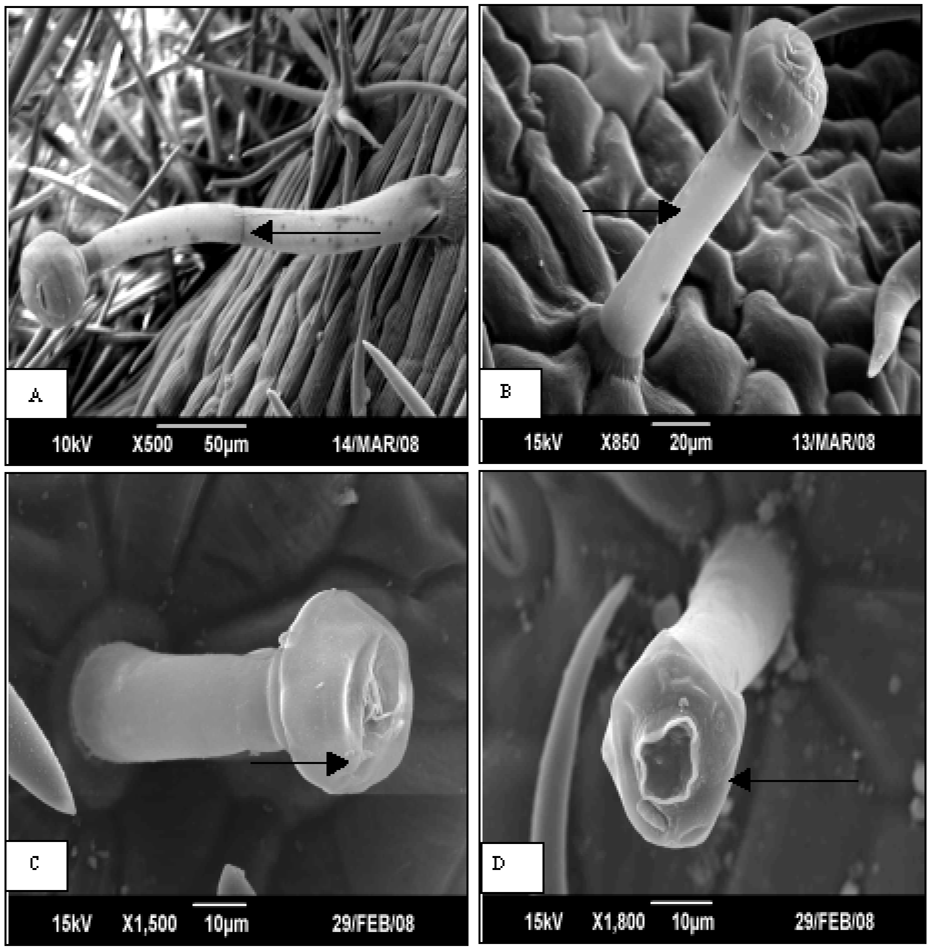

Fig. 2: Glandular capitate trichomes on the leaves of *Hermannia incana*; (A) bicelluar (septate) long stalk, (B) unicellular (non-septate) stalk, (C) capitate head intact, (D) busted capitate head

types of herbivores and pathogens by entrapping, deterring and poisoning (Wanger, 1991). Terpenes and flavonoids are reported to have anti diarrhoeal activity (Palombo, 2006). Essential oils containing these compounds have been used as preservatives and disinfectants, while the antifungal and antibacterial properties of these compounds are thought to have some role in plant defenses against pathogens (Duke, 1994). Although, micromorphological studies alone do not provide the information required to establish sites of synthesis in cells (Afolayan and Meyer, 1995), it is plausible to assume that the therapeutic compounds in *H. incana* are produced by the glandular trichomes.

Some crystal deposits are found on the leaves surfaces and some near the stellate trichomes (Fig. 3C). Crystal formation is a common feature on the leaves of many members of Sterculiaceae and has been classified as druse crystals (cluster crystals) and prismatics (solitary crystals) (Lersten and Curtis, 1997). The criteria used in this classification are not clearly defined. It is therefore, difficult to relate the particular crystals of *H. incana* to one of these two types. Energy dispersive X-ray spectroscopy-SEM of foliar crystals have been reported to be predominantly composed of Al, Ca, K, Na, Ti and Si (Aliero *et al*., 2006). Similar observation was made in the energy dispersive X-ray of the foliar crystals of *H. incana* (Fig. 3D). Glandular trichomes have been reported to secrete to the surface of the leaves, ions such as Na and Cl (salt glands), Ca, Cd, Zn, Mn, Ni, Pb, S, Si and others (Salt *et al*., 1995; Choir *et al*., 2001). The glandular trichomes found on the surfaces of this herb could be responsible for either the production or storage of the therapeutic compounds present in this plant.

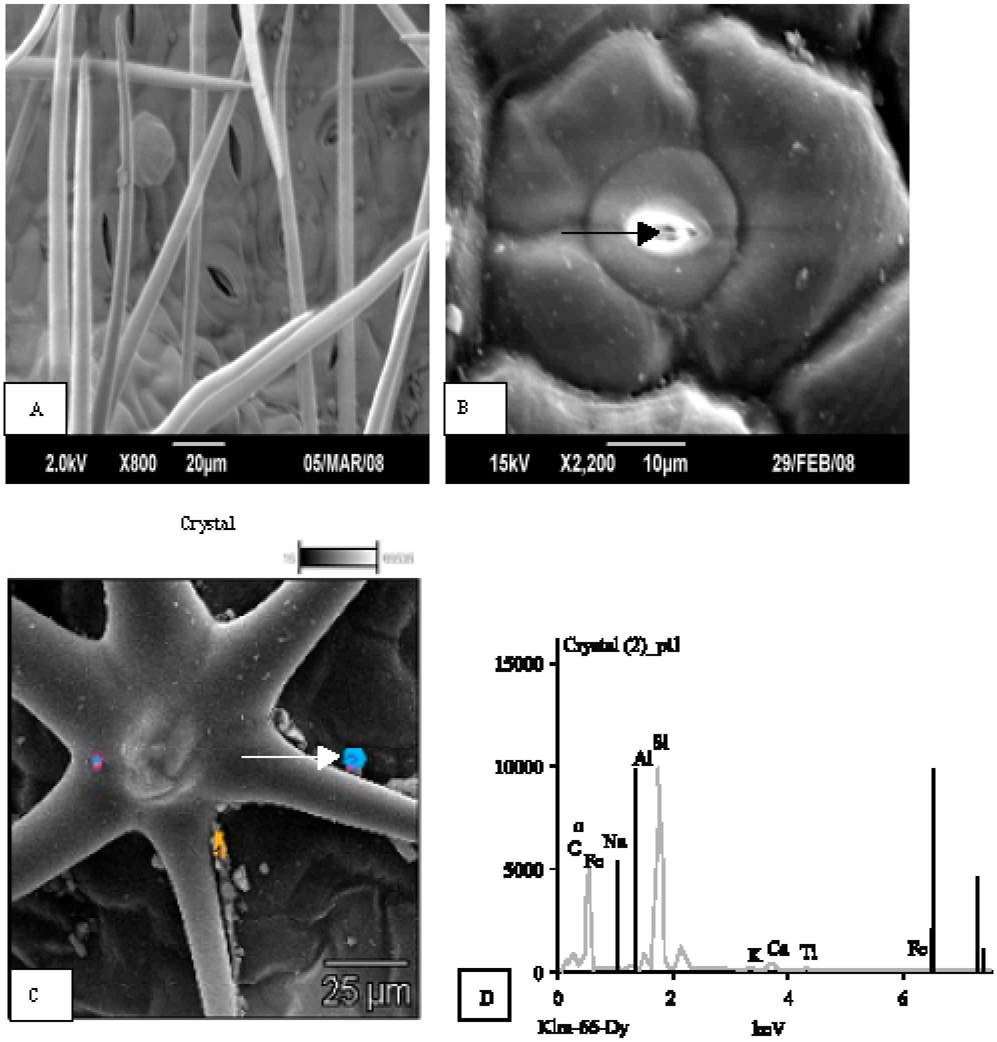

Fig. 3: (A) Stomatal distribution on the leaves of *Hermannia incana*, (B) higher magnification of anisocytic stoma (arrowed), (C) indicates the crystal analyzed and (D) energy dispersive X-ray spectroscopy

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