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Botanical studies of leaves of *Malvaviscus arboreus* Cav. family: Malvaceae, cultivated in Egypt

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Abstract

Malvaviscus arboreus cav. is a perennial plant belongs to family Malvaceae, having a number of culinary and medicinal properties. It is an erect, deciduous herb or shrub, commonly known as Turk cap or sleeping hibiscus as its flowers never fully open. The plant is indigenous to central and south America but was also introduced to other tropical and subtropical areas in Asia, Africa, Australia, and pacific lands. The present study deals with macro and micro morphological investigation of *M. arboreus* leaves, which will be greatly helpful in identification and authentication of this plant species.

Keywords: Malvaviscus, Malvaceae, Leaves, Stellate hair, Clusters of Ca Ox

1. Introduction

Malvaceae (Hibiscus or Mallow family) is a large family of flowering plants containing around 243 genera representing 4,225 species, including herbs, shrubs, and trees. It is distributed all over the world in tropical regions and includes some economically important plants such as cotton, okra, Hibiscus and other ornamental shrubs [1]. *Malvaviscus* is a small genus within the Mallow family, and a variety of secondary metabolites with important biological and economic values were detected in this genus, e.g. flavonoids, phenolic acids, and anthocyanin [2, 3]. *M. arboreus* cav. (synonyms: *Achania coccina* and *Malvaviscus mollis*) is an erect, perennial, deciduous herb or shrub. Owing to its valuable phytoconstituents and biological potentials, *M. arboreus* has a worldwide folk and medicinal reputation. Hence, the current botanical study was undertaken to examine the macroscopic and microscopic characters of *M. arboreus* leaves, which could be a useful tool for authentication of this plant.

2. Taxonomy [4-5]

M. arboreus belongs to: Kingdom: Plantae; Subkingdom: Viridaplantae (green plants); Infrakingdom: Streptophyta (land plants); Superdivision: Embryophyta; Division: Magnoliophyta; Subdivision: Spermatophytina; Phylum: Tracheophyta; Class: Magnoliopsida; Superorder: Rosanae; Order: Malvales; Family: Malvaceae; Subfamily: Malvoidea; Tribe: Hibisceae; Genus: Malvaviscus; Species: arboreus

3. Materials and Methods

3.1 Plant material

The plant material consisted of *M. arboreus* leaves (**Fig. 1**) that were collected from plants cultivated in the campus of Minia University in March 2015. The plant was kindly identified by Prof. Mahmoud Abdelhady Hassan, Professor of Horticulture, Faculty of Agriculture, Minia University. A voucher sample (Mn-ph-Cog-027) was kept in the Herbarium of Pharmacognosy Department, Faculty of pharmacy, Minia University, Minia, Egypt. The plant material used for the botanical study was taken from the fresh samples, as well as the samples preserved in alcohol (70%)-glycerin-water (1:1:1). Leaves was also left for air drying in the shade, reduced to a fine powder for microscopical examination and stored in well-closed containers.

3.2 Preparation of samples for microscopical examination

Safranin, light green, phloroglucinol, concentrated hydrochloric acid, and iodine were used for examination of the plant sections as well as its powder.

3.3 Microscopical studies

Surface preparations, transverse sections (T.S.), as well as the powder of the leaf were used for

observation of various microscopic features. All microscopical investigations were done by using a microscope with Leica® camera (Germany) and 10 megapixels digital camera, Samsung (Korea).



Fig 1: Photos of *Malvaviscus arboreus* cav.

4. Results and discussion

4.1 Macroscopical characters of the leaf

The leaf (Fig. 2) is simple, oval to ovate in shape, alternate, and petiolated. The petiole is cylindrical, hairy, green in colour measuring 2-3 cm in length and 0.2-0.3 cm in width. The lamina has an acute apex, a serrate margin, and a symmetric base showing reticulate venation. The midrib is more prominent on the lower surface. The leaf has fine hairy texture with a green upper surface and a paler lower one. It measures 8-9 cm in length and 6-7 cm in width with a mucilaginous taste and a faint odour.



Fig 2: A photo of *Malvaviscus arboreus* cav. Leaf

4.2. Microscopical characters of the leaf

4.2.1 The Leaf blade

A transverse section in the leaf blade is biconvex in outline (Fig. 3), showing that the midrib is more prominent on the lower surface. It reveals a dorsiventral mesophyll interrupted in the midrib region by the cortical and vascular tissues. In addition, a mass of sub-epidermal collenchyma is found under both the upper and lower epidermises in the midrib region. The vascular system of the midrib is formed of a large collateral vascular bundle forming a large arc of vascular tissues with the xylem to the upper side and the phloem to the lower one with islets of non-lignified pericyclic fibers below it. Idioblasts containing mucilage and clusters of calcium oxalate are scattered in both the lamina and midrib region ^[6] (Fig. 4 and 5).

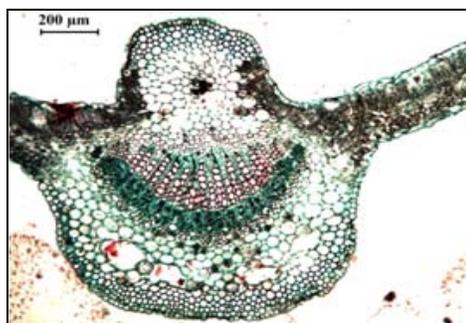


Fig 3: A T.S. in the leaf. (x40)

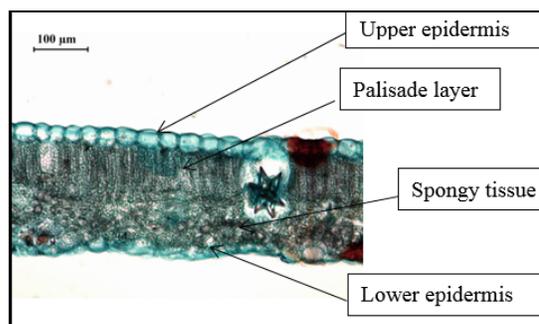


Fig 4: A detailed T.S. in the lamina of the leaf (x100)

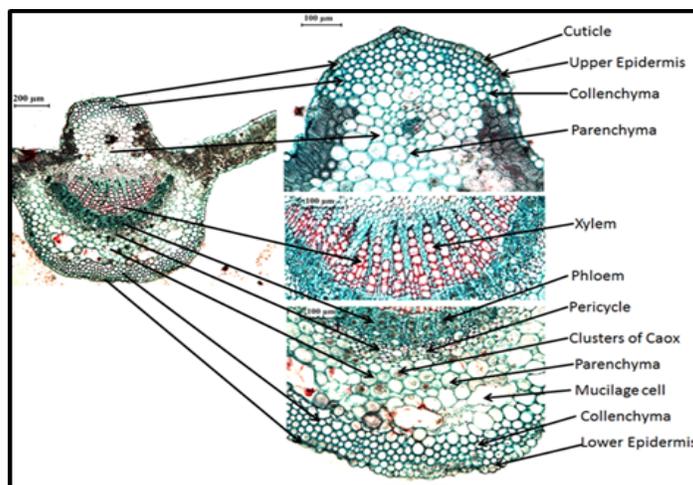


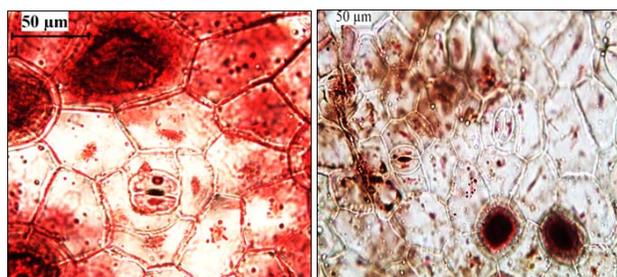
Fig 5: A detailed T.S. in the midrib region of the leaf (x100)

4.2.2. The upper epidermis

The upper epidermis is formed of one row of rectangular cells

covered with a thin cuticle as seen in the transverse section (Fig. 4 and 5). In surface view, the cells are polygonal,

isodiametric to slightly elongated with straight anticlinal walls covered with striated cuticle showing anomocytic stomata (Fig. 6). The stomata are rounded in shape with wide osteoles and are surrounded by 3-5 subsidiary cells.



A- Upper epidermis B-Lower epidermis

Fig 6: Surface preparation of the leaf: (A) Upper epidermis, (B) Lower epidermis. Both are showing anomocytic stomata (x200).

4.2.3. The lower epidermis

The lower epidermis is formed of one row of rectangular cells covered with a thin cuticle as seen in the transverse section (Fig. 4 and 5). In surface view, the cells appear polygonal, isodiametric with slightly wavy anticlinal walls covered with a smooth cuticle showing anomocytic stomata the same as in upper epidermis (Fig. 6).

4.2.4. The mesophyll

The mesophyll is dorsiventral and differentiated into a discontinuous upper palisade layer and a spongy tissue. The palisade layer is formed of two rows of cylindrical columnar cells containing chloroplasts. It is interrupted in the midrib region by the cortical tissue. The spongy tissue is formed of 3-5 rows of thin-walled, rounded, and slightly irregular chlorenchymatous cells with wide intercellular spaces. Numerous clusters of calcium oxalate are scattered throughout the lamina region (Fig. 4).

4.2.5. The cortical tissue

The cortical tissue of the midrib region is formed of upper and lower sub-epidermal collenchymatous layers. The upper layer is formed of 4-6 rows while the lower consists of 3-4 rows of small rounded cells with thick cellulosic walls and no intercellular spaces, followed by several rows of polygonal,

large parenchymatous cells with thin cellulosic walls and small intercellular spaces. Idioblasts containing mucilage and clusters of calcium oxalate are scattered throughout the parenchymatous tissue. The endodermis is parenchymatous and indistinguishable (Fig. 5).

4.2.6. The vascular tissue

4.2.6.1. The pericycle

The pericycle consists of parenchyma cells forming a continuous arc below the vascular bundle and separate islets above, each group contains 6-9 fibers.

4.2.6.2. The phloem

The phloem consists of thin-walled, soft cellulosic tissue. Small clusters of calcium oxalate are scattered in the phloem parenchyma.

4.2.6.3. The cambium

The cambium is formed of 3-5 rows of tangentially elongated, thin-walled, cellulosic, meristematic cells.

4.2.6.4. The xylem

The xylem is formed of lignified vessels, fibres, and wood parenchyma (Fig. 5). The vessels are mostly with spiral thickenings as shown in the powder (Fig. 13). The fibres have blunt apices, wide lumen and thick lignified walls as seen in the powder (Fig. 13). The wood parenchyma consists of radially elongated cells with pitted walls. The medullary rays are uni-, bi- or multiserrate forming radiating lines of elongated thin-walled cellulosic cells traversing the xylem.

4.3. Micromorphology of the petiole

A transverse section in the petiole is nearly circular in outline (Fig. 7). It is formed of an epidermal layer covered with a smooth cuticle and carrying non glandular hairs. The cortical tissue is formed of collenchyma and parenchyma cells. The pericycle is represented by groups of lignified fibers. The vascular tissue is formed of 9-10 isolated collateral vascular bundles enclosing wide parenchymatous pith. The endodermis is parenchymatous and indistinguishable. Cluster crystals of Ca oxalate are scattered in the parenchymatous tissues.

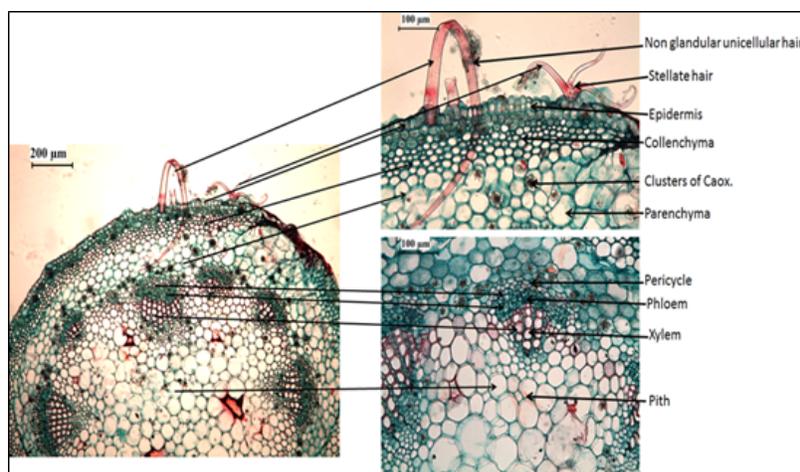


Fig 7: A T.S in the petiole (x100)

4.3.1. The epidermis

The epidermis is formed of small rounded to rectangular cells

similar in structure to the upper and lower epidermises of the leaf, except for the presence of nonglandular unicellular hairs

and stellate hairs which are multicellular branched hairs (with several arms) having thick walls, tapering apices and covered with smooth cuticle (Fig. 7 and 9).

4.3.2. The cortical tissue:

The cortex consists of 4-6 rows of small rounded collenchyma cells with no intercellular spaces followed by 3-4 rows of rounded to polygonal large parenchyma cells with small intercellular spaces. Clusters of calcium oxalate are scattered within the cortical tissue (Fig. 8).

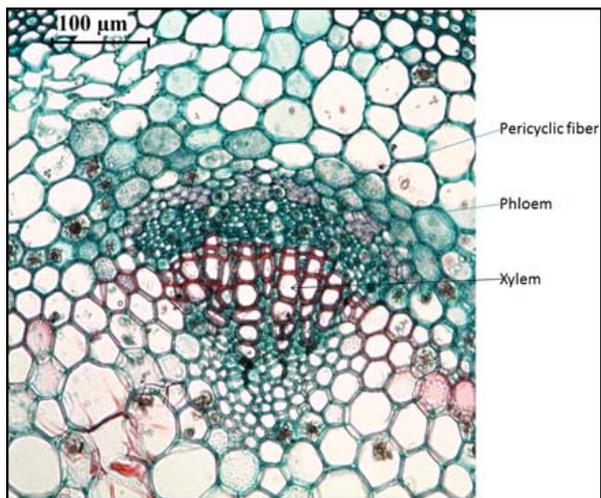


Fig 8: A detailed T.S in the vascular tissue of the petiole (x100)

4.3.3. The Vascular system

The vascular system of the petiole is formed of 9-10 isolated collateral vascular bundles (Fig. 8). The pericycle is represented by parenchyma cells interrupted by groups of lignified fibers. The pericyclic fibers are fusiform with thick non-lignified walls, narrow lumen, and acute apices as shown in the powder (Fig. 12). The phloem is represented by thin walled soft cellulosic elements. Clusters of Ca oxalate are also scattered in the parenchyma of the phloem and pericycle regions. The xylem is formed of wood parenchyma, wood fibers, and lignified xylem vessels. The wood parenchyma are polygonal with thick lignified walls. The wood fibers have blunt apices, wide lumen, and thick lignified walls as shown in the powder (Fig. 13). The medullary rays are uni- or biserrate of elongated, lignified, thick-walled cells. The pith is formed of large thin-walled parenchyma cells containing numerous clusters of calcium oxalate.

4.3. The powdered leaf:

The powder of the leaf is faint green in colour with a faint odour and mucilagenous taste. The powder showed the following fragments:

- 1- Fragments of the upper and lower epidermises (Fig. 6).
- 2- Glandular and non-glandular hair (Fig. 9).
- 3- Fragments of palisade cells (Fig. 10).
- 4- Fragments of spiral xylem vessels (Fig. 11).
- 5- Fragments of pericyclic fibers (Fig. 12).
- 6- Fragments of wood fibers (Fig. 13).

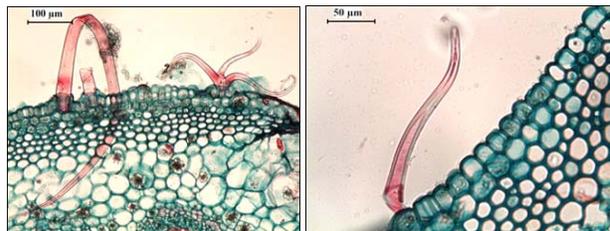


Fig 9: Non-glandular (x100) and glandular (x200) hairs of the petiole

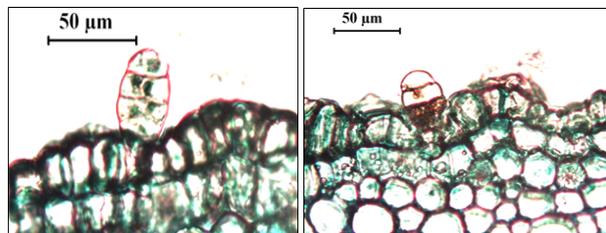


Fig 10: Fragments of palisade cells (x100)

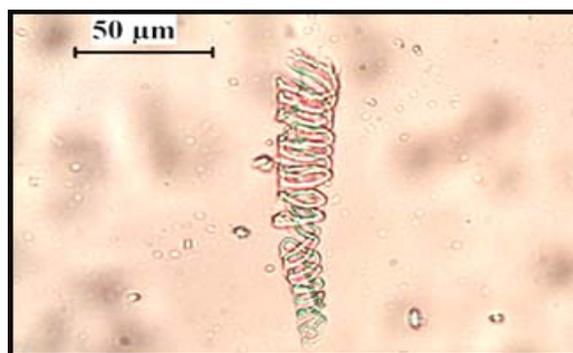


Fig 11: Fragments of spiral xylem vessels (x200)



Fig 12: A pericyclic fiber(x100)



Fig 13: A wood fiber(x100)

5. Conclusion

Examination of both the macroscopical and microscopical features of *M. arboreus* leaves provides a good method in the identification of this plant. In addition, the above mentioned botanical characters may also be helpful in future phytopharmacological investigations of this species following appropriate authentication.

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