AASCIT Journal of Biology
2018; 4(2): 40-46
http://www.aascit.org/journal/biology
ISSN: 2381-1455 (Print); ISSN: 2381-1463 (Online)

AASCIT American Association for Science and Technology

Morpho-Anatomical Study of Seven Plants from the Sub Class (Asteridae)

Ahlam Salih Eltahir*, Mustafa Mubarak Abdalla, Hatil Hashim El-Kamali

Botany Department, Faculty of Science and Technology, Omdurman Islamic University, Omdurman, Sudan

Email address

ahlam.eltahir@yahoo.com (A. S. Eltahir)

*Corresponding author

Citation

Ahlam Salih Eltahir, Mustafa Mubarak Abdalla, Hatil Hashim El-Kamali. Morpho-Anatomical Study of Seven Plants from the Sub Class (Asteridae). *AASCIT Journal of Biology.* Vol. 4, No. 2, 2018, pp. 40-46.

Received: February 27, 2018; **Accepted**: April 2, 2018; **Published**: May 16, 2018

Abstract: Aim: To assist as a relevant source of information and contribute towards the standards to dispose the quality and identity of the studied plants to avoid adulterations. Morpho-anatomical characters of seven plants from the sub class (Asteridae) *Solanum dubium*, *Datura innoxia* and *Datura stramonium* family (Solanaceae), *Solenostemma argel, Calotropis procera, Leptadenia arborea* family (Asclepiadaceae) and *Convolvulus arvensis* family (Convolvolaceae) were studied. Radar shape for morphological leaf characters (leaf length, leaf width, leaf apex angle and leaf base angle) was used. Standard method of double staining technique used for anatomical studies. The results shown in tables and plates. The leaves of the plants from the same family have the same radar structure which mean that these plants are similar in their leaf morphology. Two stomatal types were distinguished anomocytic type in *S. dubium, S. argel, C. procera* and *L. arborea* while the anisocytic type was found in the two *Datura* species and *C. arvensis*. Trichomes were classified into Stellate non-glandular and Simple non-glandular. Mesophyll typed into two features, isobilateral in *S. dubium, S. argel* and *C. arvensis*, dorsiventral in the rest. The vascular bundles were bicollateral crescent-shaped in all species studied while it was collateral in *C. arvensis* only. This study suggested that the observed morph anatomical characters are of great value in quality control and formulation development of the plant studied.

Keywords: Solanaceae, Asclepiadceae, Convolvolaceae, Morphology, Anatomy

1. Introduction

Although studies conducted on morphology of the plants have proved valuable in the identification of the plants but identification criteria would be incomplete without foliar epidermal morphology used in taxonomic studies that rely virtually on the qualities and characteristics of anatomy of species for distinguishing between species close to each other and to confirm the deemed status of many plant species The leaf is the most important part of the plant and can be studied histologically to find out its anatomical characteristics as good taxonomic evidence [1]. The distribution and forms of trichomes are of important qualities and used to differentiate between the genera and species of plants [2].

Some particular groups of plants or taxa seem to be characterized by specific type of epidermal features which are the epidermis, stomata, glands and trichomes [3].

A number of research workers have recognized and reported unmistakable taxonomic importance of epidermal cells, type of trichomes and types of stomata. These variations in the epidermis on the other hand have been attributed to the functional multiplicity of the dermal tissue [4]. According to WHO, the morphological (macroscopic) and anatomical (microscopic) descriptions of a medicinal plant is the first step towards establishing its identity and should be carried out. Microscopic evaluation is an indispensable tool for identification of medicinal plants and is one of the essential parameters in modern monograph.

Although some morph-anatomic characters were already reported elsewhere, present work re-investigate some of them and reports different other necessary parameters of leaves so as to achieve greater quality control over the commercial

plant material.

The main objectives of the present investigation is to identify the morphological and anatomical characters of the leaves of the studied important Sudanese medicinal plants for the purpose of the proper identification of the leaves and to avoid adulterations.

2. Materials and Methods

2.1. Plant Materials

Seven Sudanese medicinal plants from the subclass Asteridae were selected for this study, they belong to two orders and three families (table 1), they were collected from Khartoum state Central Sudan, taxonomicaly identified and voucher specimens were deposited at the herbarium of Botany Department, Faculty of Science and Technology, Omdurman Islamic University.

2.2. Methods

2.2.1. Morphological Studies

In this study; leaf shape, margin, apex, base, venation and color were examined. Radar shape of leaf characters (leaf length, leaf width, leaf apex angle and leaf base angle) were made using Microsoft Excel (2010).

2.2.2. Anatomical Studies

(i) Epidermal surface views

Samples were taken from identical regions of the surfaces of the leaves. The epidermis was peeled off and gently removed with a razor blade. The epidermal peels were mounted in 10% aqueous glycerin and examined.

(ii) Preparation of Permanent Slides

Transverse sections from the leaves were prepared using double staining technique as described in [5] with some modifications.

Table 1. *Plant materials of the study.*

Order	Family	plant Species
Gentianales	Asclepiadoidae	*Solenostemma argel* (Del.) Hayne
		Calotropis procera (Aiton) Dryand
		Leptadenia arborea (Forrssk.) Schweinf
		Solanum dubium (Fresen.) Dunal
Solanales	Solanaceae	*Datura innoxia* Mill
		Datoura stramonium L.
	Convolvulaceae	*Convolvulus arvensis* L.

3. Results and Discussion

3.1. Morphology

Leaf characters (leaf length, leaf width, leaf apex angle and leaf base angle, leaf length X leaf width and leaf width/leaf length) are shown in table 2, 3 and 4, radar shapes of the values of these parameters are shown in figures 1, 2 and 3. It is observed that the leaves of the plants from the same family have the same structure which mean that these plants are similar in their leaf morphology. The results obtained from the morphology of the two studied Datura species are typical to the previous studies [6].

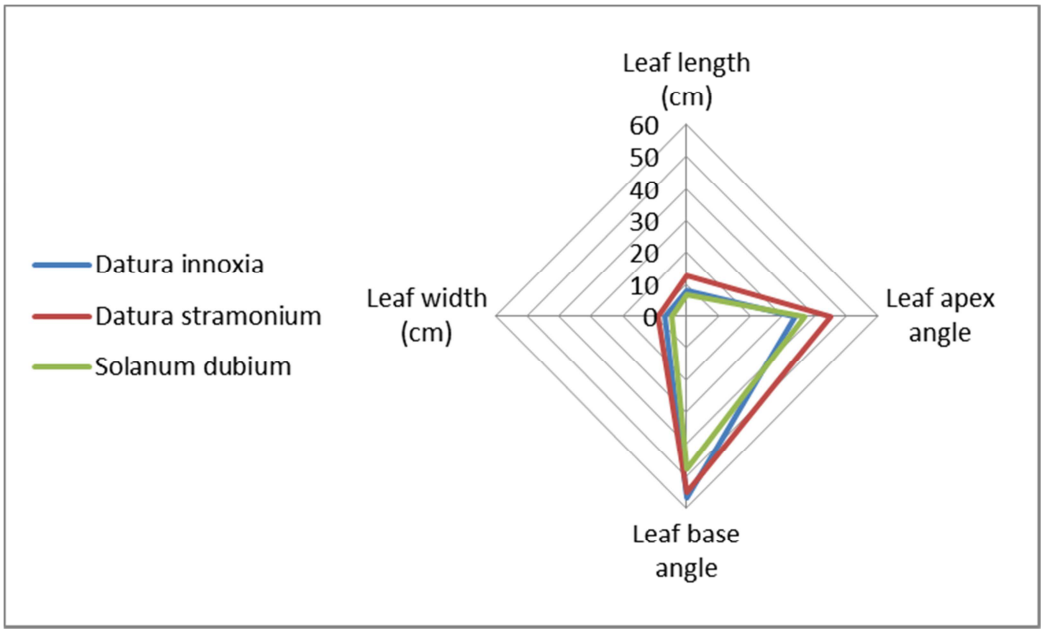


Figure 1. *Radar shape in leaf characters of D. innoxia, D. stramonium, S. dubium.*

Table 2. *Leaf characters in 3 plants belong to family Solanaceae.*

Characters	*Solanum dubium*	*Datura innoxia*	*Datura stramonium*
Leaf length (cm)	6.8	7.9	12.5
Leaf width (cm)	4.5	7.0	9.0
Leaf base angle	48.0	57.0	55.0
Leaf apex angle	37.0	34.0	45.0
Leaf length X Leaf width	30.6	55.3	112.5
Leaf width/Leaf Length	0.66	0.88	0.72

Table 3. *Leaf characters in 3 plants belong to family Asclepiadaceae.*

Character	*Solenostemma argel*	*Calotropis procera*	*Leptadenia aroborea*
Leaf length (cm)	2.9	19.2	9.5
Leaf width (cm)	0.6	11.5	2.9
Leaf base angle	20	48.0	25.0
Leaf apex angle	21	60.0	27.0
Leaf length X Leaf width	1.74	220.8	27.55
Leaf width/Leaf Length	0.20	0.59	0.30

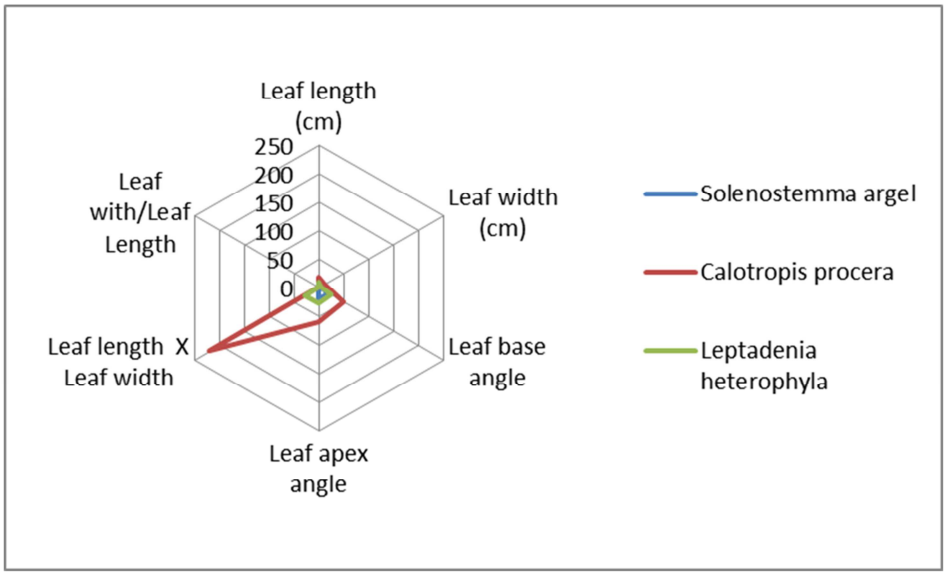


Figure 2. *Radar shape in leaf characters of S. argel, C. procera and L. arborea.*

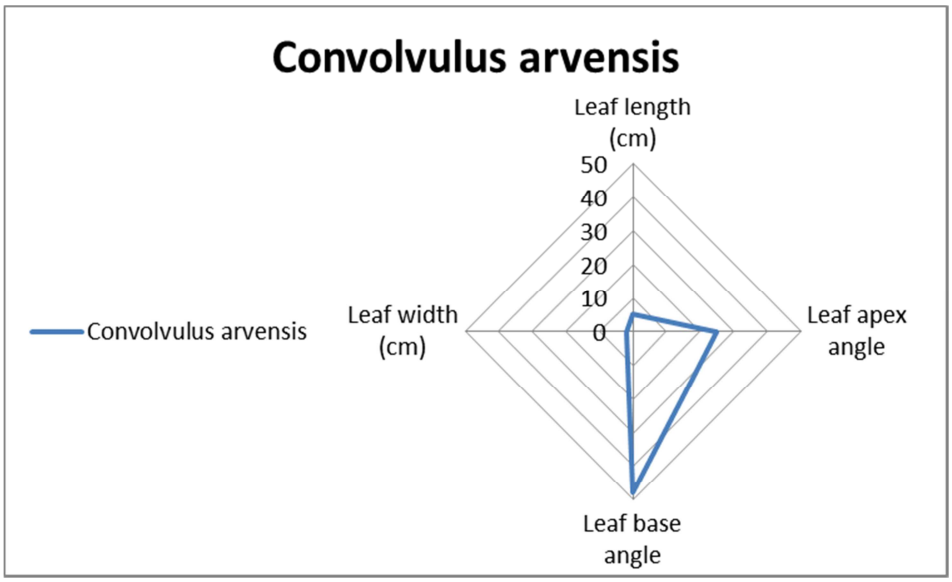


Figure 3. *Radar shape in leaf characters of Convolvulus arvensis.*

Table 4. *Leaf characters of Convolvulus arvensis family Convolvulaceae.*

Characters	*Convolvulus arvensis*
Leaf length (cm)	5.0
Leaf width (cm)	1.9
Leaf base angle	48.0
Leaf apex angle	25.0
Leaf length X Leaf width	9.5
Leaf width/Leaf Length	0.38

3.2. Anatomy

3.2.1. Epidermal Surface Views

(i) *Solanum dubium*

Solanum dubium stomata are anomocytic type and the hairs are stellate and non glandular [2] agreed with our study in hairs of many kinds occur various type stellate hairs in species of *solanum dubium*.

(ii) *D. innoxia* and *D. stramonium*

In the leaves of the two Datura species studied, the stomata are anisocytic (cruciferous type), the hairs are much denser and taller in *D. innoxia*. These observations were typical characters of the family S*olanaceae* as it had been described by [7]. The numbers, sizes and densities of the epidermal hairs were found to be more in *D. innoxia*. These features are noticeable macroscopically and also mentioned [8]. the dense hairs of leaf surfaces of *D. innoxia* singles it from the rest of the genus [9], *D. innoxia* wide spread and can be found in relatively in dry places whereas *D. stramonium* is found only in places provided with sufficient amount of water, this may be due to the presence of plenty of hairs in *D. innoxia* protecting it against water loss.

(iii) *Solenostemma argel* (Delile) Hayne

The stomata are anomocytic type. Trichomes are simple-unicellular and non glandular.

(iv) *Calotropis procera*

Stomata are anomocytic type, there are no epidermal hairs appeared,

(v) *Leptadenia arborea*

Stomata are anomocytic type, no epidermal hairs appeared

(vi) *Convolvulus arvensis*

Stomata are anisocytic type, the epidermal hairs are simple and glandular.

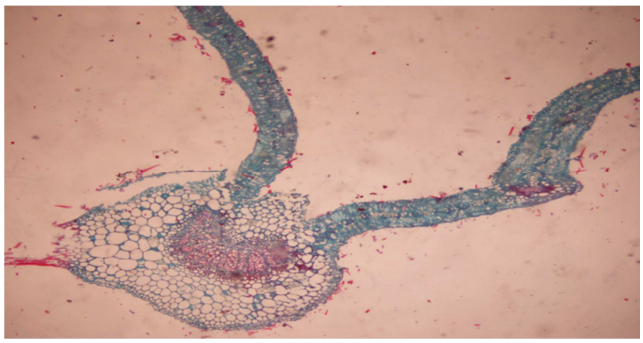
3.2.2. Transverse Sections of the Leaves

(i) *Solanum dubium*, *D. innoxia* and *D. stramonium*

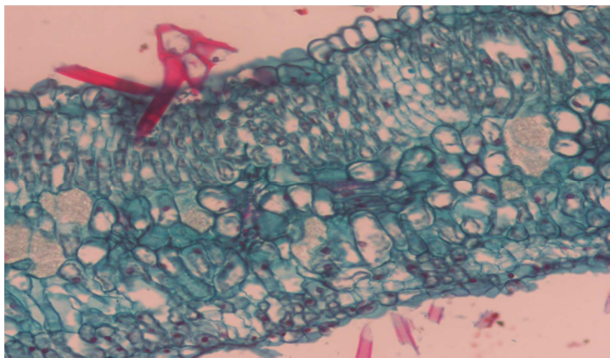
Upper epidermis is formed of a single layer polygonal cells of different sizes, frequently interrupted by stomata, the epidermal cells are covered by thin cuticle. The leaf in *solanum dubium* (figure 4) is an isobilateral with an upper and a lower palisade layers surrounding a narrow spongy parenchyma layer, where as the leaves are dorsiventral in the two Datura species consisting of a single layer of long thin-walled cylindrical palisade cells followed by larger thin-walled spongy parenchyma cells (plates 2, 3 A). In the first layer of the spongy parenchyma cells; there are large numbers of calcium oxalate druses form a crystal sheath in both species but their numbers are larger in *D. innoxia* than in *D. stramonium*. The width of the palisade layer is wider in *D. innoxia* (91.6µm) compared to (76.8µm) in *D. stramonium*. The rest of the mesophyll consists of larger thin-walled spongy parenchyma cells; it is about 140 µm in *D. innoxia* and 114.5 µm in *D. stramonium* (plates 2, 3 A). The lower epidermises consist of a single layer of small irregular-shaped cells interrupted by stomata, some hairs are found in the lower epidermis and the cuticle is thinner than the upper epidermis.

In the midrib region, 5 layers of collenchyma cells are found below the upper epidermis, followed by 3-4 layers of parenchyma cells. The vascular bundle is bicollateral crescent –shaped in the three species of the Solanaceae family (figures 4, 5, 6 B), this feature was reported by [7] to be of universal occurrence in the genus *Datura* and the family *Solanaceae*, there are outer and inner phloems, proto xylem in the upper region, meta xylem in the lower region, rows of xylem vessels are separated by parenchyma cells, below the vascular bundle 3 layers of collenchyma cells followed by 6-7 parenchyma above the lower epidermis. The width of the midrib region in *D. innoxia* is 450µm compared to 292.2µm in *D. stramonium*, the upper and the lower epidermises are followed by 2-4 layers of collenchyma cells followed by an upper 12-13 layers of parenchyma cells and a lower 6-7 layers of large parenchyma cells.

The number of xylem vessels in *D. stramonium* is more and the vessels are of small size while in *D. innoxia* the xylem vessels are larger in size and less in a raw with more xylem parenchyma.

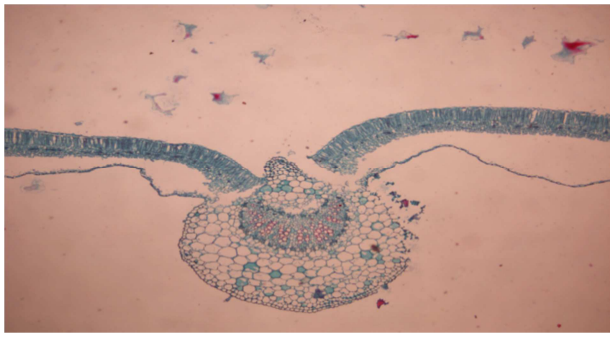


A



B

Figure 4. *T. S. of the leaf of Solanum dubium: (A) Diagrammatic T.S in the midrib at the middle portion (X 100). (B) Detailed T.S in part of lamina at the middle portion (X 200).*



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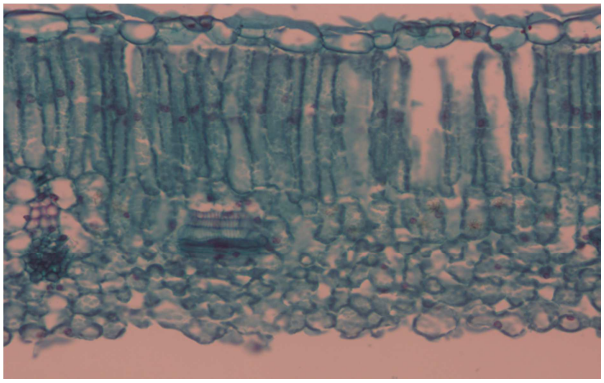
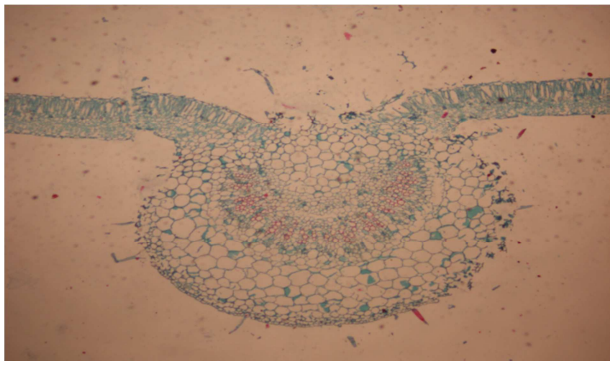
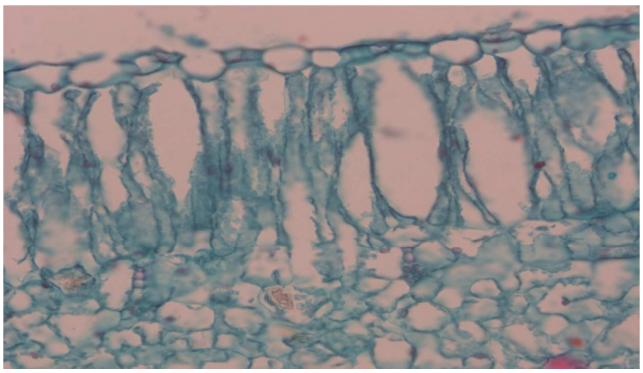


B

Figure 5. *T. S. of the leaf of Datura innoxia (A) Diagrammatic T.S in the midrib at the middle portion (X 40). (B) Detailed T.S in part of lamina at the middle portion (X 200).*



A



B

Figure 6. *T.S of the leaf of Datura stramonium (A) midrib region (X 40). (B) part of lamina (X 200).*

(ii) *Solenostemma argel*

The epidermal cells are small covered by thin cuticle. The leaf is an isobilateral formed of two palisade layers surrounding spongy parenchyma, narrow lateral veins appeared in the middle region of the mesophyll, some of them are in longitudinal sections (figure 7). In the midrib region; the upper and lower epidermises are followed by 5-8 layers of small compact collenchyma cells and 7-8 layers of small parenchyma cells. The vascular bundle is bicollateral formed of two phloems surrounding the xylem which is formed of many rows of xylem vessels separated by xylem parenchyma cells.

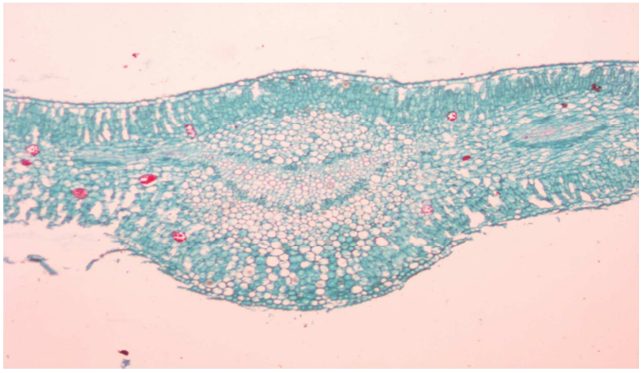


Figure 7. *T.S of the leaf of Solenostemma argel (X 40).*

(iii) Calotropis Procera

The epidermal cells are small and they are covered by thin cuticle (figure 8). The leaf is dorsiventral formed of three palisade layers followed by spongy parenchyma cells with large intercellular spaces, lateral veins appeared in middle region, and the cuticle is thinner than in the upper side. The vascular bundle is bicollateral formed of two phloems surround the crescent shaped xylem, These results had been reported [10, 11].

The lamina is stated to be dorsiventral [12]. The upper and lower epidermis were covered externally with a thick, striated cuticle; laticifers and vascular bundles were also present scattered in this region [13].

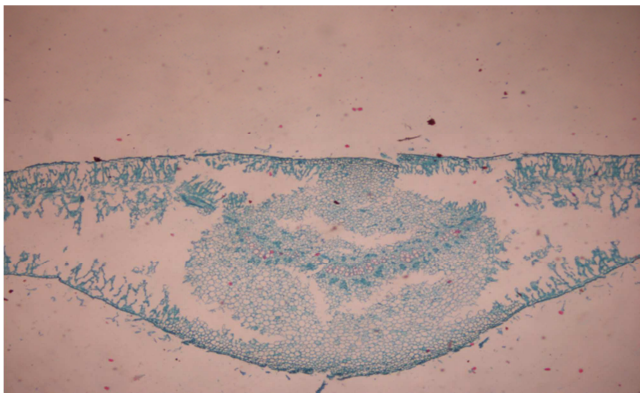


Figure 8. *T.S. of the leaf of Calotropis procera (X 40).*

(iv) Leptadenia Arborea

The leaf is dorsiventral, formed of one palisade layer (one cell thick), followed by spongy parenchyma 5-6 layers, lateral veins appeared in the middle region of the mesophyll, some of them appeared in longitudinal section (figure 9). [2] reported that the leaf is dorsiventral. The vascular bundle is crescent shaped, bicollateral with two phloems surround the xylem,

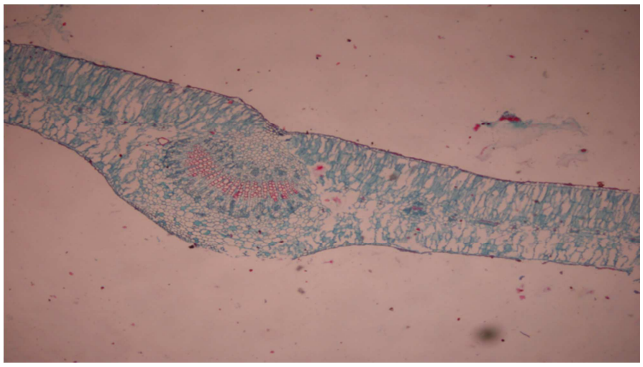


Figure 9. *T.S of the leaf of Leptadenia arborea (X 40).*

(v) Convolvulus Arvensis

A transverse section of *C. arvensis* leaf is shown in figure 10.

The upper epidermis is formed of polygonal cells of different sizes. stomata appeared, simple glandular hairs, the epidermal cells are covered by thin cuticle [2] agreed with our study in this. The leaf is an isobilateral with two palisade layers surrounding a narrow spongy parenchyma cells. Lateral veins appeared in the middle region of the mesophyll between the two palisade layers.

The lower epidermal cells are smaller in size, hairs are scattered in the lower epidermis, stomata are found, cuticle is thinner than that of upper epidermis.

In the midrib region 3 layers of collenchyma cells and 3 layers of parenchyma cells are following the upper epidermis. Collateral circular shaped vascular bundle. the xylem is formed of 5 radial rows of vessels separated by xylem parenchyma. In the lower region there is a wide phloem area. Collenchyma 2-3 layers, and parenchyma 3-4 layers above the lower epidermis,

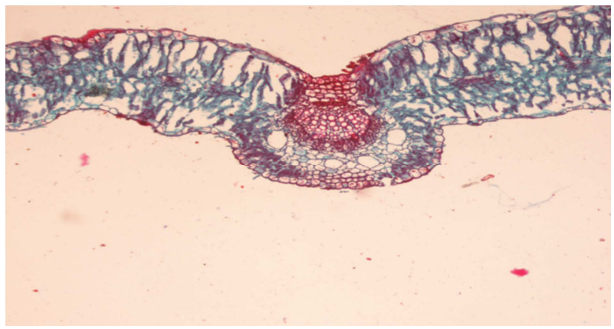


Figure 10. *T.S of the leaf of Convolvulus (X 40).*

4. Conclusion

Macro- and micromorphological studies of *the seven studied plants from the sub class Asteridae* showed that the species from the same family are structurally similar specially in their morphology. However, slight differences exist between them in their anatomical features.

Recommendations

Further morphological and anatomical studies for the all species of these families should be conducted to avoid adulteration because they are important medicinal herbs and there are rare studies done for them.

Acknowledgements

Acknowledgments are to Ustaz Kamil Eljack Osman for preparing the slides for the leaves sections.

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