

Anatomical Characteristics of *Leucaena leucocephala* (Lam.) De.Wit Growing in Iraq

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Abstract. *Leucaena leucocephala* (Lam.)De.Wit is cultivated in Iraq as an ornamental plant .In this paper anatomical characters of different parts of *Leucaena leucocephala* were studied in details ,the study included the characteristics of the epidermal cells ,as the anticlinal walls and the distribution of stomatal complexes of the leaflet ,stem, calyx and corolla .The ornamentation of cuticle as well as the internal structure of the stem ,pulvinus ,petiole ,leaflet and fruit were described , different types of crystals distribution in different parts of the plant also present .It was found that most characters have a good taxonomic value as a diagnostic characters for this species.

Keywords. *Leucaena leucocephala* ,Transverse section, Micromorphological Characteristics, Anatomical characteristics.

1. Introduction

The genus *Leucaena* Benth. belongs to the family Mimosaceae, It has 22 species, *Leucaena leucocephala* is the most important species and known for its economic importance [1]. It was called the miracle tree for its rapid growth and for its long life and high fodder value [2]. Usually, named the lead tree and epil epil. [3]. The plant is a medium-sized trees, reaches 10 m in height . The roots are fast-growing and extends to a depth of 5 m. The diameter of the stem is small, and the bark is brown in color and rough to the touch. Leaves pinnately compound, leaflets elongated, asymmetrical at the base and sharp or spur-like at the top. Inflorescences are long and clustered. The flowers are numerous, white, The sepals are seated. The fruit is horny brown, without thorns [2]. The plant has the ability to tolerate drought as it fixes atmospheric nitrogen. Different types of pigments were studied in this plants as carotenoids and xanthophylls and beta-carotene [4-6]. In addition to the presence of other compounds such as mimosine and tannin in different parts of the plant as the leaves, stems, fruits and seeds, in addition to cellulose, hemicellulose, calcium and phosphorus, which an important source of ruminants food [7,8]. The plant contains a high percentage of protein and used in feeding sheep and livestock [9,10] .The aim of this research was to study the anatomical characteristics of the species of *Leucaena leucocephala* cultivated in Iraq.

2. Materials and Methods

The samples used for the study were collected from different areas of the city of Babylon and cultivated in gardens, parks and nurseries. The samples were diagnosed based on [11] to study the internal anatomical characteristics of the stems, leaflets, petiole , pulvinus and fruits. The permanent

sections were prepared using a wax method. Paraffin wax as mentioned by [12] and then examined and photographed using the Olympus BX4LTF optical microscope supplied With Camera Video TK-C1381EG. Epidermis of leaflet, stem and corolla were prepared by scraping for light microscope, and for scanning electron microscope, mature air dried, leaflet, corolla and fruits were coated with gold and examined under the Dutch-made scanner in the Faculty of Science/University of Kufa type a Inspect S50. To prepare samples of the epidermis, the fresh samples put in ethanol 70 %, then scrapped by the anatomical blade to get the upper and lower epidermis while cross-sections prepared by hander catting[13]. Stomatal index was calculated according to [14].

$$\text{Stomatal index} = (\text{Number of stomata} / \text{Number of stomata} + \text{Number of ordinary epidermal cells}) \times 100 \%$$

3. Results and Discussion

3.1. The Surface View of the Epidermis

3.1.1. Stem

The epidermis was simple and uniserate, consist of a single row of elongated parenchyma cells ,with straight-curved anticlinal walls . The length of the epidermal cell ranged between 30-62.5 μm and an average of 46.25 μm , and its width ranged between 10-25 μm and an average of 17.5 μm . Stomata is anomocytic type, as mentioned by[15]. Mean of stomatal length range from 27.5-37.5 μm and width from 20-30 μm . The stomatal index 2. Table 1. & Figure 1.

3.1.2. Leaflets

Epidermal cells of Leaflets are undulate on the upper and lower side. stomata occur on both surfaces, the leaflet is amphistomatic, Paracytic stomatal complexes type was viewed on adaxial and abaxial surfaces ,in addition to anomocytic type on the adaxial surface These results are in agreement with [16]. The stomata length reached to 17.5-27.5 (22.5) μm and the width is 13.75-22.5 (18.125) μm on the adaxial surface, While the stomata length reached to 16.5-26 (21.25) μm and the width is 12.5-21.25 (16.875) μm abaxial surfaces. stomatal index more on the abaxial side than on the adaxial surfaces, this agrees with [17]. Table 1. & Figure 1.

3.1.3. Calyx

The epidermal cells on the adaxial and abxial surface are straight-curved shaped, Cells sizes are variable 12.5-40 (26.25) μm long and 20-27,5(23.75) μm wide on the adaxial surface While ranges from 12.5-40(26.25) μm long and 20-27.5 (23.75) μm wide on the abaxial surface (Table 1). Stomata: present paracytic and anisocytic Type , as mentioned [18] indicated that the calyx epidermis is important in isolating and identifying species. There are many simple, rough surface unicellular eglandular trichomes Table 1. & Figure 1.

3.1.4. Corolla

Anticlinal walls of corolla epidermis are straight- curved. Mean length was 54 μm and the mean width was 23.75 μm (Table 1). Stomata is present, paracytic and anisocytic,, rough surface unicellular e glandular trichomes were found in the epidermis.This was Table 1. & Figure1. confirmed by [19]. (Figure 4).

Table 1. The measurements characters of Epidermis in the *Leucaena Leucocephala*.

Characters	Surface	Cell shape	Dimensions of epidermal cells		Observed stomatal complex	Dimensions of Stomata		Stomatal index
			Length (μm)	Width (μm)		Length (μm)	Width (μm)	
stem	St	curved-stright	30-62.5 (46.25)	10-25 (17.5)	Anomocytic	27.5-37.5 (32.5)	20-30 (25)	2
Leaflet	Ad	undulate	18.5-65 (41.75)	13.75-50 (31.875)	Paracytic& Anomocytic	17.5-27.5	13.75-22.5	6

Characters	Surface	Cell shape	Dimensions of epidermal cells		Observed stomatal complex	Dimensions of Stomata		Stomatal index
			Length (µm)	Width (µm)		Length (µm)	Width (µm)	
			22.5-61.5 (31.25)	20.5-61.5 (42)		(22.5)	(18.125)	
Calyx	Ab	undulate			Paracytic	16.5-26 (21.25)	12.5-21.25 (16.875)	20
	Ad (Ca)	Straight-curved	12.5-40 (26.25)	20-27.5 (23.75)	Paracytic & Anisocytic	20-30 (25)	17.5-25 (21.25)	10
	Ab (Ca)	Straight-curved	20-37.5 (28.75)	15-27.5 (21.25)	Paracytic & Anisocytic	20-27.5 (23.75)	17.5-25 (21.25)	9
Corolla	Co	Straight-curved	27.5-80.5 (54)	17.5-30 (23.75)	Paracytic & Anisocytic	25-35 (30)	17.5-22.5 (20)	9

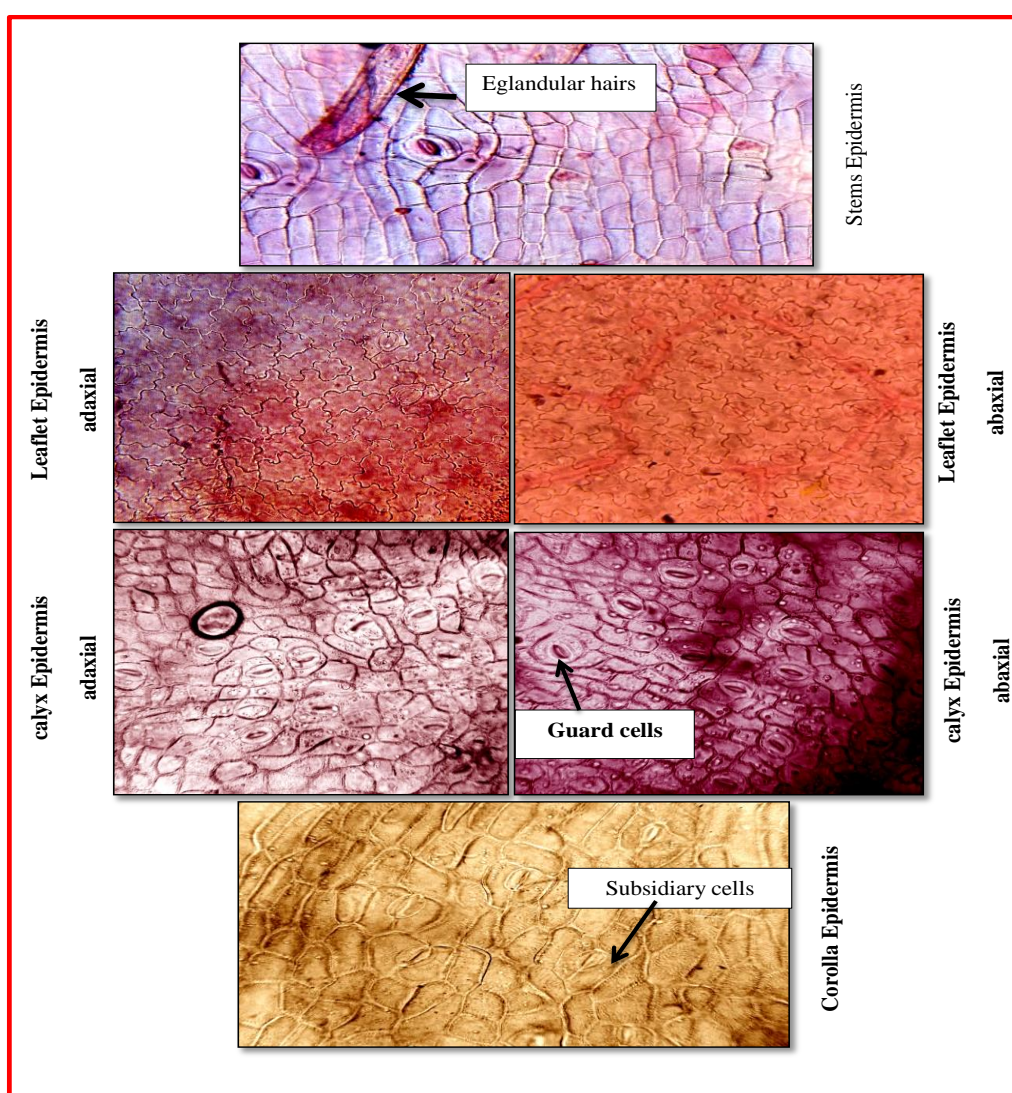


Figure 1. Epidermal peel showing the epidermal type and stomata complex of *Leucaena leucocephala* (400X).

3.2. Characteristics of Cross Section

3.2.1. Stem

The outline of stem cross section is pentagonal. Epidermis consist of a single row of quadrate-rectangle parenchyma cells(7.5-17.5) μm in thickness, Cuticle(2.5-5.25) μm . the cortex composed of angular collenchyma in the ridges and furrows regions),(22.5-55) μm and oblong-ovate parenchymatous cells in the remain regions(25-62.5) μm . The vascular bundles are continuous and surrounded by a sclerenchyma tissue. The pith is large with polygonal parenchymatic cells and the internal cells larger than the peripheral ones(1075-1550) μm in thickness. The Cortex and pith characterized by presence of druses and prismatic crystals as well as the sand crystals in the cortex region.

3.2.2. Pulvinus

Pulvinus is rectangular in cross section figure(3). Epidermis is uniseriate comprised of quadrate-rectangle cells, coated with thin layer of cuticle ,have no stomata. The cortex composed of oblong rectangular parenchymatous cells become smaller in size near the epidermis, with a mean thickness 593.75 μm ,This result coincides with [20,21].Xylem and phloem appear in the form of continuous cylinder and the average of vascular bundle thickness are 462.5 μm , Pith composed of spherical and polygonal cells. Prismatic and druses crystals observed in the pith and cortex in small amounts.

3.2.3. Petiole

The cross-section of petiole cordate in shape, the epidermis is single-layered with quadrate-rectangle parenchyma cells(10-16.25) μm . The cortex includes 3-4 layers of collenchyma cells beneath the epidermis and 3-4 layered of parenchyma cells. Vascular bundles are continuous,9-10 in number , rows of xylem (3-13) . Pith includes parenchyma cells isodiametric in shape with mean thickness 600 μm . Prismatic and Druses crystals observed in the pith and cortex. These characteristics of petiole was confirmed by some authers such as [22,23].

3.2.4. Leaflet

Transverse section of leaflet showed that, the upper epidermis was uniseriate, covered with thin cuticle layer. Leaflet lamina was dorsiventral type. The palisade layer represented by 1 – 2 rows of elongated cells. The spongy layer comprised of 2 – 3 rows of irregular parenchymatous cells. The presence of osteosclereids embedded in the mesophyll tissue was observed .In the midrib, one central circular vascular bundle was observed, Tracheary elements of this bundle arranged in 4 – 5 rows and the lower epidermis like the upper (8.75-16.25 μm), Leaflet blade of this species contains some druses and prismatic crystals in its tissues figure (3).

3.2.5. Friut

Figure(4) represents the structure of *Leucaena Leucocephala* fruit. cross section is Bone- shaped, This agrees with [24], The exocarp consists of an epidermis only; the outer epidermis has uniseriate, quadrate-rectangle -shaped cells(5-8.75) μm with stomata and is covered with thick layer of cutin. The mesocarp consists of 1-4 rows of collenchyma, then 12-14 rows of parenchymatous cells in the inner regions. The inner epidermis is endocarp and consists of uniseriate, cylindrical parenchyma cells. There are several oval- shaped vascular bundles embedded in the ground parenchyma.

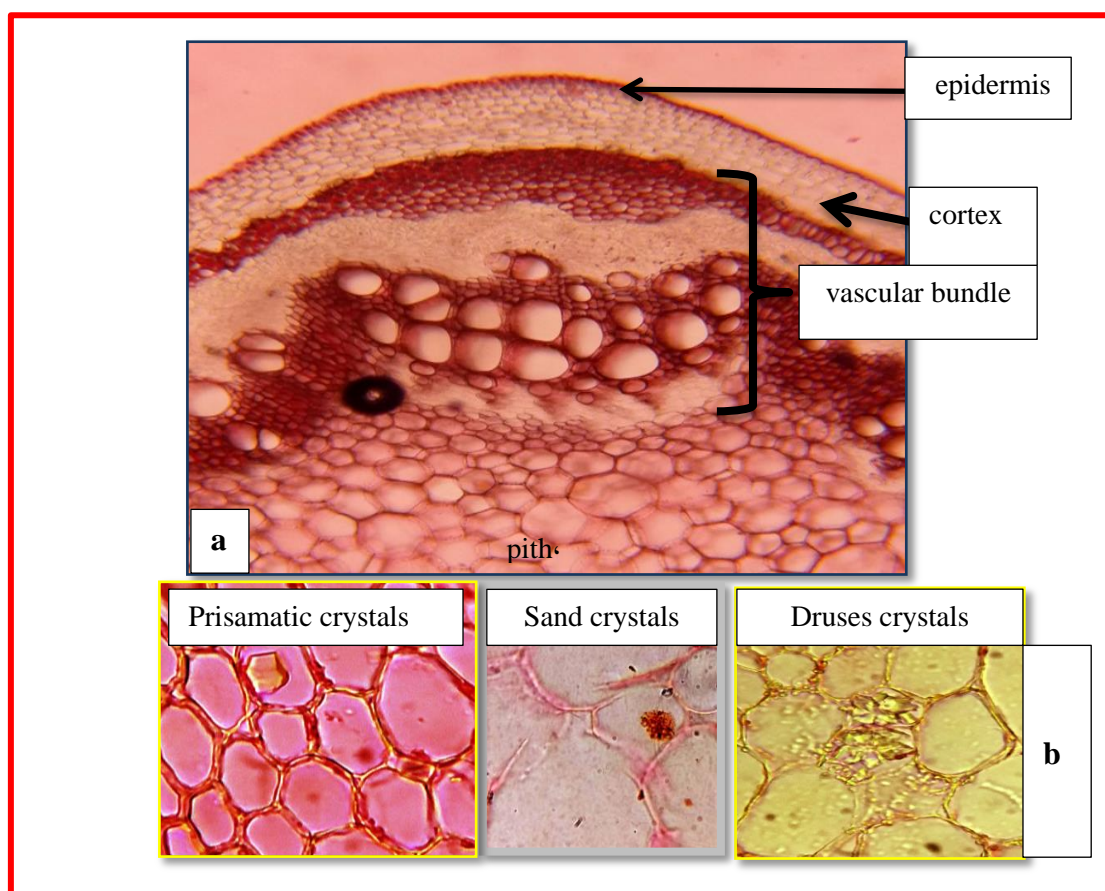


Figure 2. a-Transverse section of *Leucaena leucocephala* stem(100X), b- Variations in the shapes of the types of crystals in cortex and pith(400X).

3.3. Venation

Venation type usually pinnate Brochidodromous ,the secondary veins not terminating at the margin but joined together in a series of prominent upward arches, this characteristics are mentioned by [25]. Figure (4).

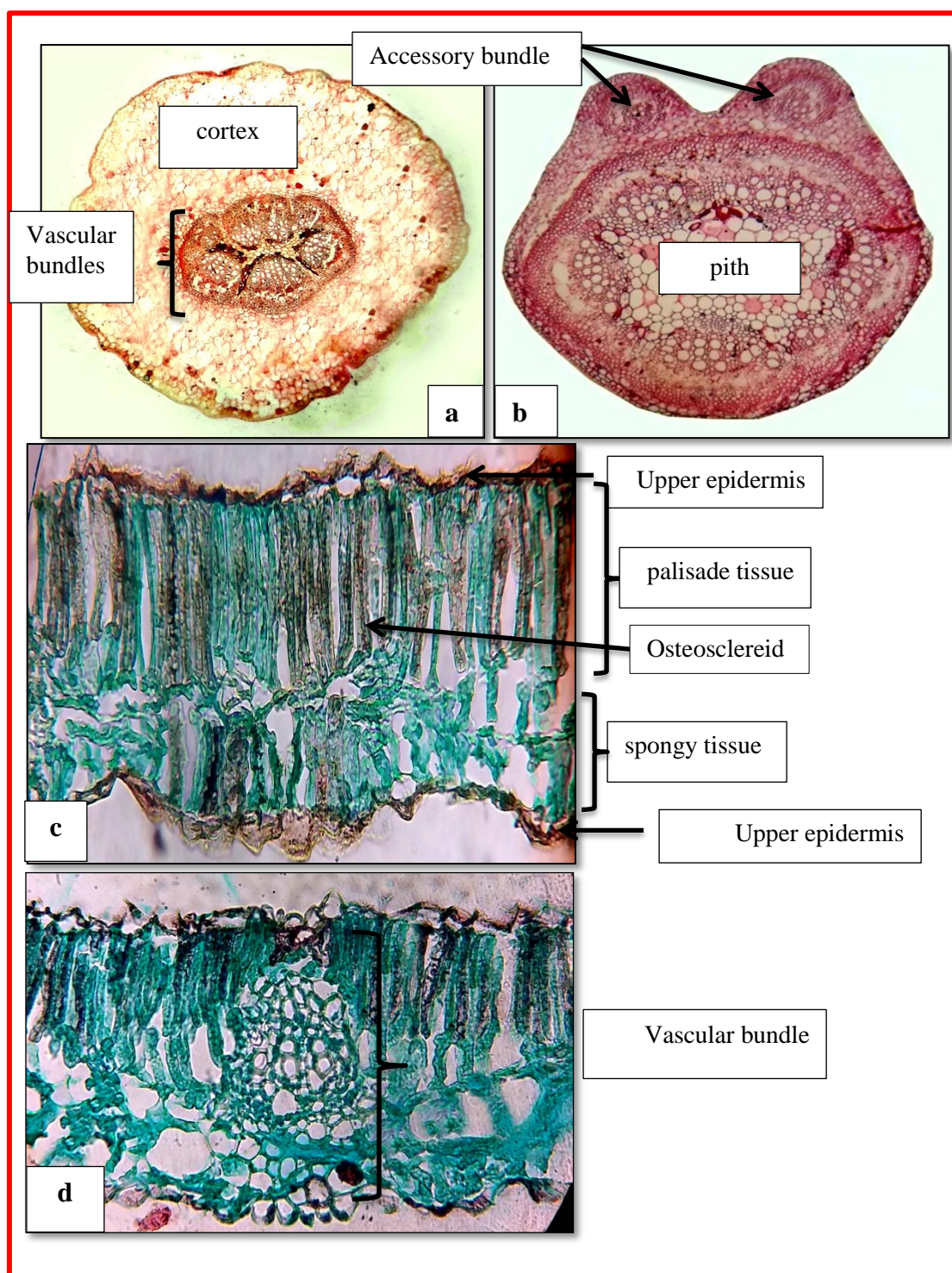


Figure 3. a-Transverse section of *Leucaena leucocephala* Pulvinus .b- petiole(40X). c-d: Transverse section of *Leucaena leucocephala* leaflet blade (100X).

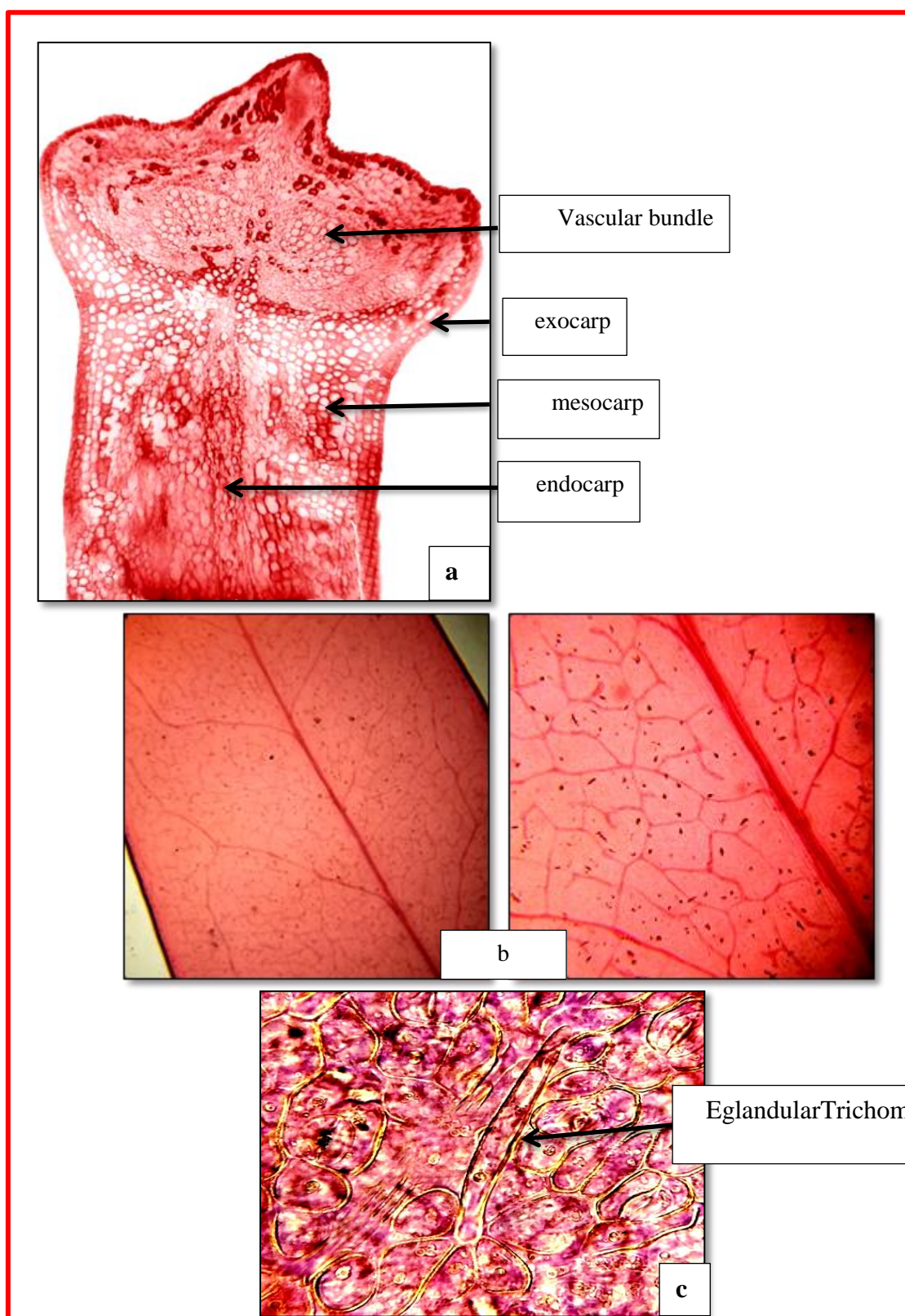


Figure 4. a. Transverse section of *Leucaena leucocephala* fruit(40X). b. Venation. c. Eglanular Trichomes.

3.4. Micromorphological Characteristics of the Epidermis Surfaces

3.4.1. Leaflets

The ornamental appeared Finely Cellular-Papillate on both surfaces of the type leaflet, while the shape of the cells was irregular on the lower surface and the upper surface was slightly elongated. The shape of the epidermal cells are taxonomically significant [26].

3.4.2. Corolla

In corolla cuticular ornamentation was stright, The cells appeared fusiform-shaped, with straight-curved wall, while the ornamentation of the surface of the corolla was similar to the ornamentation of the Leaflet(Finely Cellular-Papillate). epidermal surface of corolla is important in pollination by influencing the pollinators. The corolla epidermal type and its surface ornamentation affect color depth, iridescence, scent production, temperature, and provide tactile cues [27,28].

3.4.3. Fruit

The cell walls are straight-curved, and the shape of its cells is slightly elongated. The surface ornamentation is Reticulate, this features was confirmed by [29].

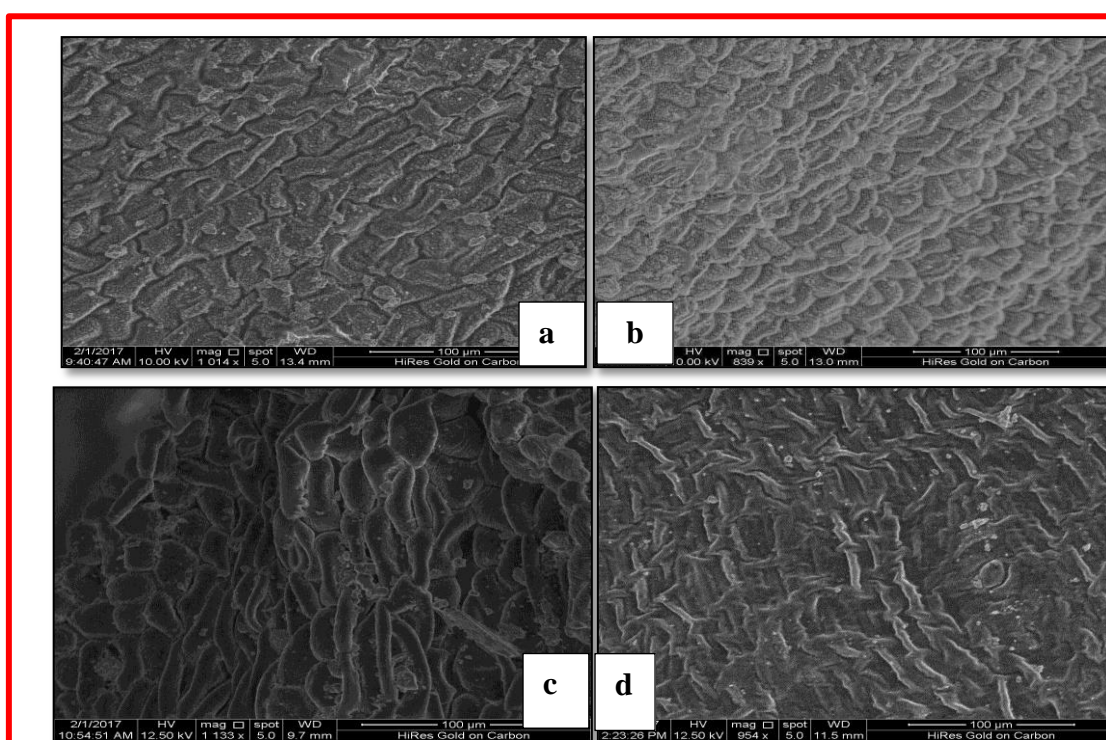


Figure 5. SEM micrographs of *Leucaena leucocephala* a: Leaflet epidermis(adaxial),b: Leaflet epidermis(abaxial),c: Corolla epidermis. d:fruit epidermis.

Conclusion

In this study, the anatomical structure of *Leucaena leucocephala* belongs to the Mimosaceae , which has medical importance, was clarified. *The results* presented in this study allowed the identification of epidermal cells of Leaflets, stem, calyx and corolla anatomical characteristics. The osteosclereids embedded in the mesophyll tissue in Leaflets as well as The outline of petiole cross section is cordate. It can be an identical anatomical characteristics that allowed to distinguish *Leucaena leucocephala* from the other species of Mimosaceae, which is being important taxonomical.

References

- [1] Hughes CE.(1998). *Leucaena; a genetic resources handbook*. Tropical forestry Papers No. 37. Oxford Forestry Institute, Department of Plant Sciences, University of Oxford and Department for International Development.
- [2] Shelton, H. M. and J. L. Brewbaker (1994). *Leucaena leucocephala – the most widely used forage tree legume*. In: Gutteridge, R. C. and Shelton, H. M. (ed.), *Forage Tree Legumes in Tropical Agriculture*. CAB International, Wallingford, U. K., 15-30.
- [3] Timyan J.(1996). *Bwa Yo: important trees of Haiti*. South-East Consortium for International Development. Washington D.C.
- [4] D. Mello, J. P. F. and K. W. Fraser. (1981). The composition of leaf meal from *Leucaena Leucocephala*. *Tropic. Sci.*, 23:75-78.
- [5] Johanson, A.D. (1940). *Plant microtechnique*. 1st ed Mc. Graw. Hill Book Company, New York and London, 523.
- [6] NAS [National Academy of Sciences]. (1984). *Leucaena: promising forage and tree crop for the tropics*. 2nd ed. Washington, DC: National Academy of Sciences. 100 p.
- [7] Kewalramani, N., K. S. Ramchandra, V. S. Upadhayay and V. K. Gupta. (1987). Proximate composition, mimosine and mineral contents of *Leucaena* sp. And hybrids. *Indian J. OF Animal Sciences* 57(10):117-1120.
- [8] Akbar, M. A. and P.C. Gupta. (1985)a. Proximate composition, tannin and mineral contents of different cultivars and of various parts subabul (*Leucaena Leucocephala*). *Indian J. of Animal Sciences* 51:57-58.
- [9] Thomas, D. and Addy, B. L.(1997). Stall-fed Beef Production in Malawi. *World Rev. Anim.Prod.*,13:23-30.
- [10] Rahman, M. M., Islam M. R. and M . Islam.(1991). Fodder research and production programme, 2nd annual progress report. BLRI.
- [11] Townsend, C. C. and E.Guest . (1974). *Flora of Iraq*, vol.3. Ministry of Agriculture and Agrarian Reform ,Iraq.662pp.
- [12] Al-Khazraji TA, Aziz FM (1989). *Practical in plant anatomy and microscopic preparations (in arabic)*. In. Riyadh, Saudi Arabia: Ministry of Higher Education.
- [13] Jones, R. J. and R. G. Megarprity.(1983). Comparative toxicity responses of goats fed on *Leucaena Leucocephala* in Australia and Hawaii. *Aust. J. agric. Res.*, 34:781-790.
- [14] STACE, C.A. The significance of the leaf epidermis in the taxonomy of the Combretaceae: I. a general review of tribal, generic and specific characters. *Journal of the Linnean Society of London, Botany*.1965, 59, 378, 229-252.
- [15] Metcalf, C. R. and L. Chalk. (1950). *Anatomy of the dicotyledons*. Oxford at the clarendon press. 1500 PP.
- [16] Metcalfe, C.R. and Chalk, L. (1979) *Anatomy of Dicotyledonous*. 2nd Edition, Clarendon Press, Oxford, 456-473.
- [17] Watson, L. and J. Dallwitz. 1992. The families of flowering plants. [http:// www. biodiversity. Uno. Edu/ delta](http://www.biodiversity.uno.edu/delta). Weiss, R. F.; and V. Fintelmann. 2000. *Herbal medicine*. Georg. Thieme. Verlag.
- [18] AL-Amery, Shaemaa Muhi Hasson Alawy.(2018). Comparative Taxonomic study of some genera Papilionoideae subfamily in Iraq. Doctor of Philosophy. University of Babylon. College of Science.
- [19] Al-Kalabi, Zahraa Qassem Abd Mohsen (2015). A comparative morphological and anatomical study of the genera *Sophora* L. and *Taverniera* DC. and (*Leguminosae*) *Securigera* DC. in Iraq. Master's thesis, College of Education, Al-Qadisiyah University.
- [20] Ming,L.C.; Wen,B.M. and Mei,C.C.(2013). Adaptive anatomical structure for Nastic movement in *Mimosa pudica* L. *Bangladesh J.Bot.*,42(1):131-137.
- [21] Naji,Noor Mahmmod and Abu-Serag, Nidaa Adnan.(2020). Anatomical Study Of The Petiole And Pulvinus In Five Species Of *Cassia* Cultivated In Iraq. *Plant Archives Volume 20* (1). 2443-2446 pp.
- [22] Amirabadizadeh, H., A. Jafari and H. Mohamood Zadeh (2015). Comparative morphology, anatomy and polynological studies of perennial species of *Onobrychis* (Fabaceae) in northeast Iran, *Nordic Journal of Botany.*, 33: 159-169.
- [23] Majeed, Khansaa Rasheed.(2016). Biosystematic study of certain species of the genus *Astragalus* L. from the family *Leguminosae* in Iraq. PhD thesis. Baghdad University .the College of Education for Pure Sciences Ibn-AL-Haitham.
- [24] AL-Moussawi, Ali Hussein Issa. (1987). *Plant taxonomy*. House of books for printing and publishing. University of Al Mosul . 379 p.

- [25] Hickey, L. J. (1973). Classification of the Architecture of Dicotyledonous Leaves. *Amer. J. Bot.*, 60 (1): 17–33.
- [26] Kupicha FK., 1983. The infrageneric structure of *Lathyrus*. Notes from the Royal Botanic Gardens, Edinburgh 41: 209–244.
- [27] Comba L, Corbet S, Hunt H, Outram S, Parker JS, Glover BJ., 2000. The roles of genes influencing the corolla in pollination of *Antirrhinum majus*. *Plant, Cell Environment* 23: 639–647.
- [28] Whitney HM, Kolle M, Andrew P, Chittka L, Steiner U, & Glover BJ., 2009. Floral iridescence, produced by diffractive optics, acts as a cue for animal pollinators. *Science* 323: 130–133.
- [29] Pashirzad , M. ; Vaezi , J. ; Amiri Moghaddam , D. ; Memariani , F. and Joharchi, M. R. (2014) . A Species – Level of Morphological and Nut Micromorphology Study of the *Cyperus L.* Complex (Cyperaceae) in Northeast of Iran. *Annual Research & Review in Biology* , 4 (24) : 3848-3862.