# Anatomical Study of Twelve Mimosoideae Species in Iraq

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## Abstract

A field collection of plant samples from the province of Baghdad included 12 species belonging to the subfamily Mimosoideae (Fabaceae)to study the anatomical properties of the stems, petioles, leaf blade and midrib. The results showed a distinct difference in the target anatomical properties. Where *Calliandra haematocephala* had the highest blade thickness (206.3,205.4-209.2) µm, and *Albizia lebbeck* gave the highest cuticle thickness (34.8, 28.1-35.2) µm and the lower epidermis (26.1-30.5 (28.4) µm. Furthermore, *Calliandra haematocephala* achieved a thickness of (29.1 -33.1 (31.6)) µm. Anatomical images of the midrib and petiole revealed obvious differences in the bundle shapes. The study of the anatomical characteristics of the stem showed a superiority of *Albizia julibrissin* in cuticle thickness (3.4-5.6 (4.75)) µm., *Leucaena leucocephala* subsp. *leucocephala* was superior in epidermal thickness ((30.2-36.5 (35.6) µm. while *Prosopis juliflora* outnumbered and superior in cortex thickness ((71.2-75.6 (72.4 µm)). Both species, *Albizia julibrissin*, *and Leucaena leucocephala* subsp. *glabrata*, had eglandular hairs on the epidermis of the stem. *Mimosa pudica* was superior in vascular bundle thickness (353.4) µm. Cross sections of the stems showed clear differences between the examined species in their anatomical features.

**Keyword:** Mimosoideae, Anatomical characters, Iraq.

# دراسة تشريحية لأثنى عشرة نوعا من عويئلة المستحية في العراق

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## المستخلص

جمعت العينات النباتية حقليا من محافظة بغداد وتضمنت على 12 نوع نباتي تابعة لعويئلة المستحية (العائلة البقولية) لدراسة الصفات التشريحية لسيقان وحوامل ونصول الاوراق ومنطقة العرق الوسطي. أظهرت النتائج اختلافا واضحا في صفات الورقة التشريحية والساق. اذ اعطى *Calliandra haematocephala* اعلى سمك نصل (206.3, 205.4 −209.2) µm، وأعطى *Albizzia lebbeck* اعلى سمك (34.8, 28.1−35.2) µm cuticle والبشرة السفلى (26.1−30.5 (28.4) µm. وقد حقق *Calliandra haematocephala* اعلى سمك (31.6, 29.1−33) µm adaxial epidermis. كما اظهر تصوير المكونات التشريحية للجزء midrib و petiole اختلافات واضحة في شكل الحزمة الوعائية. اما دراسة صفات الساق التشريحية فقد أظهرت تفوق *Albizia julibrissin* في سمك (4.75, 3.4−5.6) µm cuticle، وتفوق *Leucaena leucocephala* subsp *leucocephala* في سمك البشرة ((30.2−36.5 (35.6) µm. بينما تفوق *Prosopis juliflora* في سمك cortex (71.2−75.6 (72.4) µm. وامتلك النوعان *Albizia julibrissin*, *Leucaena leucocephala* subsp *glabrata* شعيرات غير غدية في بشرة الساق. وتفوق *Mimosa pudica* في سمك الحزمة الوعائية (353.4) µm. أظهرت مقاطع الساق اختلافات واضحة بين الأنواع المدروسة في صفاته التشريحية.

الكلمات المفتاحية: عويئلة المستحية، الصفات تشريحية، العراق.

## Introduction

Fabaceae (Leguminosae nom. alter.) are one of the most prominent families of angiosperms, consisting of ca. 770 genera and 19,500 species of trees, shrubs, and herbs distributed throughout the world (Mabberley, 2008; Christenhusz & Byng, 2016; LPWG, 2017). Mimosoids" are the major groups of legumes and have been usually recognized as the subfamily Mimosoideae family Fabaceae. This consists of trees, shrubs, and lianas found in tropical, sub-tropical and warm temperate regions where they serve as important sources of forage and fuel Mimosoids are accounted for the greater diversity in tropical America, Africa and Australasia. Members of this subfamily are common in lowland tropical rainforests, especially along rivers and near lakes, but have also successfully adapted to drier savannas, scrub and thorn forests, and arid desert regions in the Americas (Espinoza and Leon, 2003; Espinoza

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and Melandri, 2000; Espinoza and Melandri, 2006) and Africa (Elias, 1981). From the economic standpoint, many commercially valuable species, either for the quality of their timber, as food or medicinal plants. Family members exhibit high economic value since the family includes medicinal and aromatic plants, several fibre plants, and many members used around the world for other financial aspects, such as food cereals in the human diet, oil production, gums, and dyes from some species such as *Acacia* and *Indigofera*, timber, and horticulture.

Moreover, some types of nitrogen-fixing bacteria associated with their roots enrich the soil nitrogen reserves and raise the productivity of other commercial plants (Pickersgill, 1996; Judd *et al*., 1999). Mundotiya et al. (2016) did not illustrate any variance among twelve species belonging to Mimosoideae in anatomical parameters —leaflet anatomy of 14 taxa in the Mimosa sect. Batocaulon's series Quadrivalves is described for the first time using cleared leaflets and light microscopy. The systematic value of leaflet anatomical characters is discussed, and leaflet anatomy provides significant characters for distinguishing groups and individual taxa in series Quadrivalves (Flores-Cruz *et al*., 2004). The vessels and the width of rays demonstrated enough variance to be significant as classification values. The primary parenchyma type was in wide bands In *Calliandra laxa*, *Prosopis juliflora* (León 2008). In Iraq, Al-Saddi (2017) studied phenotypic and some anatomical characteristics (stomata and venation) for *Albizia lebbeck* plant and found that the venation type was reticulate, with secondary veins didn't reach the edge of the blade and the central midrib was more visible on the bottom surface compared with the top surface. Another study in xylem tissue found that fiber lengths were normally ranged. Their widths were narrower than in hardwoods. fiber lengths were little increased. Wall thickness is according to the fibres' position (Ali, 2014). macromorphological and anatomical features of *Albizia lebbeck* and *Leucaena leucocephala* possess interesting taxonomic values to characterize the two mentioned species where Epidermis markers have significant taxonomic value (Ali *et al.,* 2022). Because there is a scarcity of literature on these species' taxonomical and environmental importance, an anatomical study was conducted on twelve species of Mimosoideae in Iraq.

## Materials and Methods

Twelve Mimosoideae taxa samples were collected from different locations (Table 1) in Baghdad from 2019-2021 and saved in Formalin acetic acid (FAA) for anatomical study.

**Table 1. Collection locations of Mimosoideae taxa in Baghdad.**

| No. | Taxa | Location | Data |
|---|---|---|---|
| 1 | *Acacia cynophella* | Baghdad –Al- Zafaraniya; Al-Zawra park Baghdad- Airport Street | April-May |
| 2 | *Acacia farnesiana* | Baghdad – Zaafaraniya; Baghdad - Abu Ghraib Baghdad - Jadriya | April-May |
| 3 | *Albizia lebbeck* | Baghdad –Sidiya; Baghdad –Jadriya Al-Zawra park | March-June |
| 4 | *Albizia lebbeck* var. *pubescens* | Baghdad – Jadriya | March-June |
| 5 | *Albizia julibrissin* | Baghdad – Adhamiya- Al-Kuraiyat | April-May |
| 6 | *Calliandra haematocephala* | Baghdad – Qanat al-jaish | March-June |
| 7 | *Leucaena leucocephala subsp. leucocephala* | Baghdad - Al-Ghazalia; Al-Zawra park | March-July |
| 8 | *Leucaena leucocephala* subsp. *glabrata* | Baghdad – Jadriya | March-July |
| 9 | *Mimosa pudica* | Baghdad – Mansour; Baghdad – Adhamiya-Al-Kuraiyat | May –July |
| 10 | *Pithecellobium dulce* | Baghdad – Adhamiya-Al-Kuraiyat | April-May |
| 11 | *Prosopis farcta* | Baghdad - Abu Ghraib; Baghdad - Jadriya | June-July |
| 12 | *Prosopisjuliflora* | Baghdad - Abu Ghraib | April-June |

### Anatomical study

### Free-hand sectioning method

Fresh plant samples of stems and leaves were sectioned using the sectioning method (Al-Masoudi & Al-Dobaissi, 2022) as follows:

Stems and leaves of the selected plant were cut into small pieces of length between (4-6) cm. Segments were sectioned into thin pieces by a razor blade, and the samples were treated with 0.5% Sodium Hypochlorite for 5 minutes to remove the chlorophyll pigment from the epidermis of the stem and leave to obtain clear and clean samples. Then, all plant samples were passed through treatments the following:

1. It was stained by 1% safranin for (1-2) hours.
2. Wash with 70% alcohol to remove the excess pigment.
3. 90% ethanol alcohol for 5 minutes.
4. 95% ethanol alcohol for 5 minutes.
5. Absolute ethanol alcohol for 5 minutes.
6. Xylene + absolute ethanol alcohol (1:1) for 2 minutes.
7. Xylene for 5 minutes.

Finally, the samples were put on the slides and mounted on the cover slides by (D.P.X), examined by a KRÜSs light microscope, and photographed using an AmScope camera.

**Preparing permanent slides**

**Killing and fixation**

Stem and Leaves were cut into small segments with a length of (0.5-2) cm. Segments were put in vials with (20) ml Formalin acetic acid (F.A.A.) and left for (20-24) h at room temperature.

**Washing and dehydration**

The samples were currently washed with distilled water. They put in 70% alcohol, then put in the sectioning device for (24) h to for sectioning and leaching to remove $O_2$ from cells, then dehydrated in the tertiary butyl alcohol (TBA) series as in (Table 2).

**Clearing, infiltration and embedded**

Samples were put in paraffin four times, each remaining for three days, then embedded in paraffin poured into boxes made of cardboard satin for sectioning with a sliding microtome.

**Sliding microtome sectioning**

Sectioning was performed using sliding microtome (Leica SM 200R sliding) with a thickness of (8-12 µm), after sectioning the ribbons were put in a water bath (40-45 C°) with the aid of 0.5% gelatin to fix the stripes on the slide and then put on hot plate (40 C°) for drying.

**Removing the wax and staining**

The wax was removed from the ribbon by passing the slides containing plant segments in different solutions as follows:

Xylene for (5 min).
Xylene + 100% alcohol (1:1) for (5 min).
Ether + 100% alcohol (1:1) for (5 min).
100% alcohol for (5 min).
95% alcohol for (5 min).
70% alcohol for (5 min).
Stained in 1% safranin in alcohol for (12-24) h.
Washing with distilled water 3-4 times for (1-2) sec.
95% alcohol for (10 sec.).
Fast green for (1-3) sec.
Clove oil + 100% alcohol + xylene (2:1:1) 2-3 times.
Xylene + 100% alcohol (1:1) for (5 mins.).
Xylene for (10 mins.).
The sections were mounted in D.P.X.

All permanent slides were examined by an Olympus BH2 light microscope and photographed using an Olympus CH3 camera. The prestaining and staining procedure was performed according to (Al-Mayoudi & Al-Dobaissi, 2022).

**Table 2. Tertiary butyl alcohol (TBA) dehydration series**

| TBA series | Distilled water | Absolute ethanol | 95% ethanol | TBA | Time |
|---|---|---|---|---|---|
| TPA1 | 50% | 0 | 40% | 10% | 3-6 h |
| TPA2 | 30% | 0 | 50% | 20% | 3-6 h |
| TPA3 | 15% | 0 | 50% | 35% | 24 h |
| TPA4 | 0 | 0 | 45% | 55% | 24 h |
| TPA5 | 0 | 25% | 0 | 75% | 24 h |

## Results and Discussion

### Leaves

### Cross sections of Leaf blade

Examination of leaf blade cross sections in species revealed the following:

### Dermal tissue system

This system represented the adaxial and abaxial epidermis. From the current study, it was clear that all species studied varied in the thickness of the blades. The thickness ranged from (103.2, 100.2-105.4) µm as a minimum in *(Mimosa pudica)* and (206.3,205.4- 209.2) µm as a maximum in *(Calliandra haematocephala)*. Upper epidermis covered by cuticle with varied thickness, ranging from (19.4, 18.4-23.1) µm as a minimum in (*Prosopis juliflora*) to (34.8, 28.1-35.2) µm as a maximum in (*Albizzia lebbeck*), while the lower epidermis showed very thin cuticle (Table 3). The thickness of the adaxial epidermis ranged between (17.9-22.5 (20.4)µm as a minimum in (*Acacia cynophobia*) and (29.1-33.1 (31.6)) µm as a maximum in (*Calliandra haematocephala*), while thickness of lower epidermis ranged between (16.4-18.4 (16.7))µm as a minimum in (*Leucaena leucocephala* subsp. *glabrata*) to (26.1-30.5 (28.4) ) as a maximum in (*Albizzia lebbeck* )(Table 3).

**Table 3. The character thicknesses of leaf blades in studied *Mimosoideae taxa* (µm), LE; lower epidermis, UE; upper epidermis.**

| No. | Species | Cuticle | Upper epidermis | Lower epidermis | Palisade (UE) | Palisade (LE) | Spongy layer | Blade | Vascular bundle |
|---|---|---|---|---|---|---|---|---|---|
| 1. | *Acacia cynophella* | 2.5-2.9 (2.8) | 17.9-22.5 (20.4) | 16.9-19.6 (18.2) | 26.4-33.5 (30.1) | 26.7-34.8 (32.5) | 93.6-101.2 (98.4) | 200.4-206.1 (203.8) | 178.8-182.3 (180.5) |
| 2. | *Acacia farnesiana* | 2.1-2.3 (2.2) | 18.5-25.3 (24.1) | 20.1-26.4 (25.5) | 32.5-39.5 (35.4) | 33.1-40.2 (39.4) | 34.2-37.4 (36.5) | 160.7-166.4 (163.2) | 263.1-266.5 (264.1) |
| 3. | *Albizia lebbeck* var. *pubescens* | 3.1-3.5 (3.3) | 19.6-25.5 (24.3) | 14.2-17.4 (17.1) | 23.5-28.4 (26.4) | 20.1-25.5 (23.1) | 21.3-26.4 (24.5) | 116.5-119.4 (117.5) | 79.5-81.2 (80.5) |
| 4. | *Albizzia lebbeck* | 2.5-3.5 (3.3) | 28.1-35.2 (34.8) | 26.1-30.5 (28.4) | 34.1-38.5 (36.4) | - | 41.2-46.5 (45.5) | 144.5-148.2 (146.2) | 70.3-79.3 (77.5) |
| 5. | *Albizia julibrissin* | 2.3-3.4 (3.1) | 24.2-30.5 (26.7) | 22.1-25.5 (23.6) | 43.1-46.8 (45.3) | - | 30.6-36.4 (35.2) | 130.5-134.2 (132.6) | 97.1-100.5 (99.4) |
| 6. | *Calliandra haematocephala* | 2.5-2.8 (2.6) | 29.1-33.1 (31.6) | 30.2-37.8 (36.9) | 87.8-90.2 (88.5) | - | 43.9-49.3 (48.6) | 205.4-209.2 (206.3) | 202.8-208.5 (205.4) |
| 7. | *Leucaena leucocephala* subsp. *glabrata* | 3.2-3.5 (3.3) | 18.5-22.3 (20.1) | 16.4-18.4 (16.7) | 56.2-59.1 (57.4) | - | 33.2-36.5 (35.2) | 130.2-133.5 (131.5) | 47.8-50.2 (49.5) |
| 8. | *Leucaena leucocephala* subsp. *leucocephala* | 3.5-3.8 (3.6) | 28.5-33.1 (30.2) | 25.5-29.1 (26.4) | 37.5-39.6 (38.1) | - | 25.9-28.4 (26.3) | 120.5-124.1 (123.6) | 69.5-72.5 (70.1) |
| 9. | *Mimosa pudica* | 2.6 - 3.7 (3.5) | 19.6-22.3 (20.5) | 16.1-19.4 (17.5) | 35.7-39.1 (37.4) | - | 24.5-29.5 (26.1) | 100.2-105.4 (103.2) | 50.2-55.3 (54.1) |
| 10. | *Pithecellobium dulce* | 2.1-3.5 (3.2) | 28.5-33.1 (30.1) | 25.5-28.3 (26.4) | 34.5-39.5 (36.2) | - | 44.1-49.6 (45.5) | 139.5-142.3 (140.5) | 51.3-56.1 (52.4) |
| 11. | *Prosopis farcta* | 2.4-2.9 (2.7) | 23.3-26.5 (24.1) | 18.5-22.3 (20.1) | 33.6-39.4 (36.4) | 26.5-30.1 (27.4) | 31.2-36.7 (35.1) | 144.2-147.2 (145.5) | 63.1-66.5 (64.2) |
| 12. | *Prosopis juliflora* | 2.3-2.6 (2.5) | 18.4-23.1 (19.4) | 16.5-19.4 (17.2) | 30.1-35.6 (30.5) | 33.1-36.1 (34.5) | 22.5-27.4 (25.5) | 126.4-130.2 (127.4) | 60.8-64.5 (63.1) |

**Ground tissue system:**

The ground tissue system of the studied species was represented by mesophyll, which differentiated into palisade parenchyma and spongy parenchyma. Differences in the thickness of mesophyll were recorded among species studied (Table 3); however, according to mesophyll type, the species were categorized into:

Group 1: species with bifacial mesophyll (i.e. differentiated into upper palisade parenchyma and lower spongy parenchyma) this group includes (*Calliandra haematocephala, Albizzia lebbeck, Albizia julibrissin, Leucaena leucocephala* subsp. *glabrata, Leucaena leucocephala* subsp. *leucocephala, Mimosa pudica, Pithecellobium dulce*).

Group 2: species with isolateral (or isobilateral) mesophyll (i.e. differentiated into upper and lower palisade parenchyma with spongy parenchyma between them). This group include (*Acacia cynophella, Acacia farnesiana, Prosopis farcta, Prosopis juliflora* and *Albizia lebbeck* var. *pubescens*).

The thickness of palisade layers was ( 26.4-33.5 (30.1)) µm as minimum in (*Acacia cynophella*) and were (56.2-59.1 (57.4) ) µm as maximum in (*Leucaena leucocephala* subsp. *glabrata*), while the thickness of spongy layers were (24.5-29.5 (26.1)) µm as minimum in (*Mimosa pudica*) and were ( 93.6-101.2 (98.4)) µm as maximum in (*Acacia cynophella*) (Table 3, plate 1).

**Vascular tissue system:**

Open collateral vascular bundles represented the vascular tissue system; thus, these results confirm that all these species were within the C3 carbon fixation type (plate 2). The Midrib region in cross-section in all species revealed as crescent shape (plate 2) but differs in the form of vascular bundles and can be divided into two groups:

Group 1: species with a crescent shape of vascular bundle included (*Calliandra haematocephala*) (plate 2).

Group 2: species with an ovoid shape of vascular bundle included (*Acacia cynophella, Acacia farnesiana, Albizzia lebbeck, Albizia julibrissin, Leucaena leucocephala* subsp. *glabrata, Leucaena leucocephala, Mimosa pudica, Pithecellobium dulce, Prosopis farcta, Prosopis juliflora, Albizia lebbeck* var. *pubescens*) (plate2).

(Table 3) showed differences among species in the thickness of the central bundle; this region ranged between (47.8-50.2 (49.5)) µm in (*Leucaena leucocephala* subsp. *glabrata*) as minimum and (263.1266.5 (264.1)) µm in (*Acacia farnesiana*) as maximum.

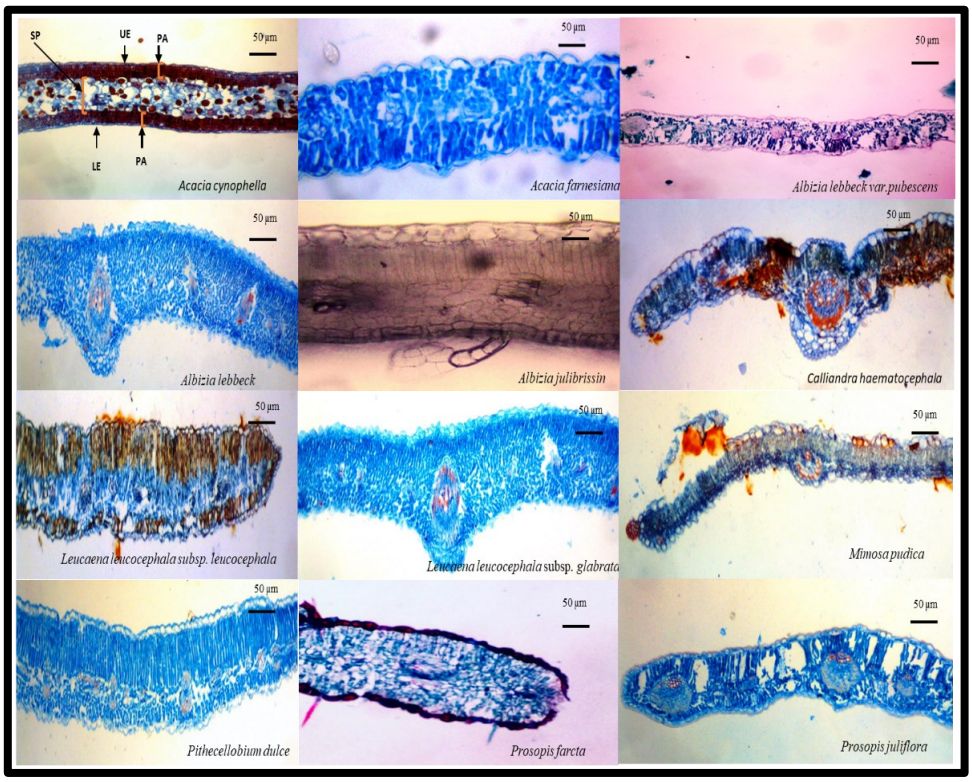


**Plate 1. Cross sections of leaf blades in the species include the UE: upper epidermis, LE: lower epidermis, PA: palisade layers, and Sp: spongy layers. 10X (all photo scale bar of 50 µm)**

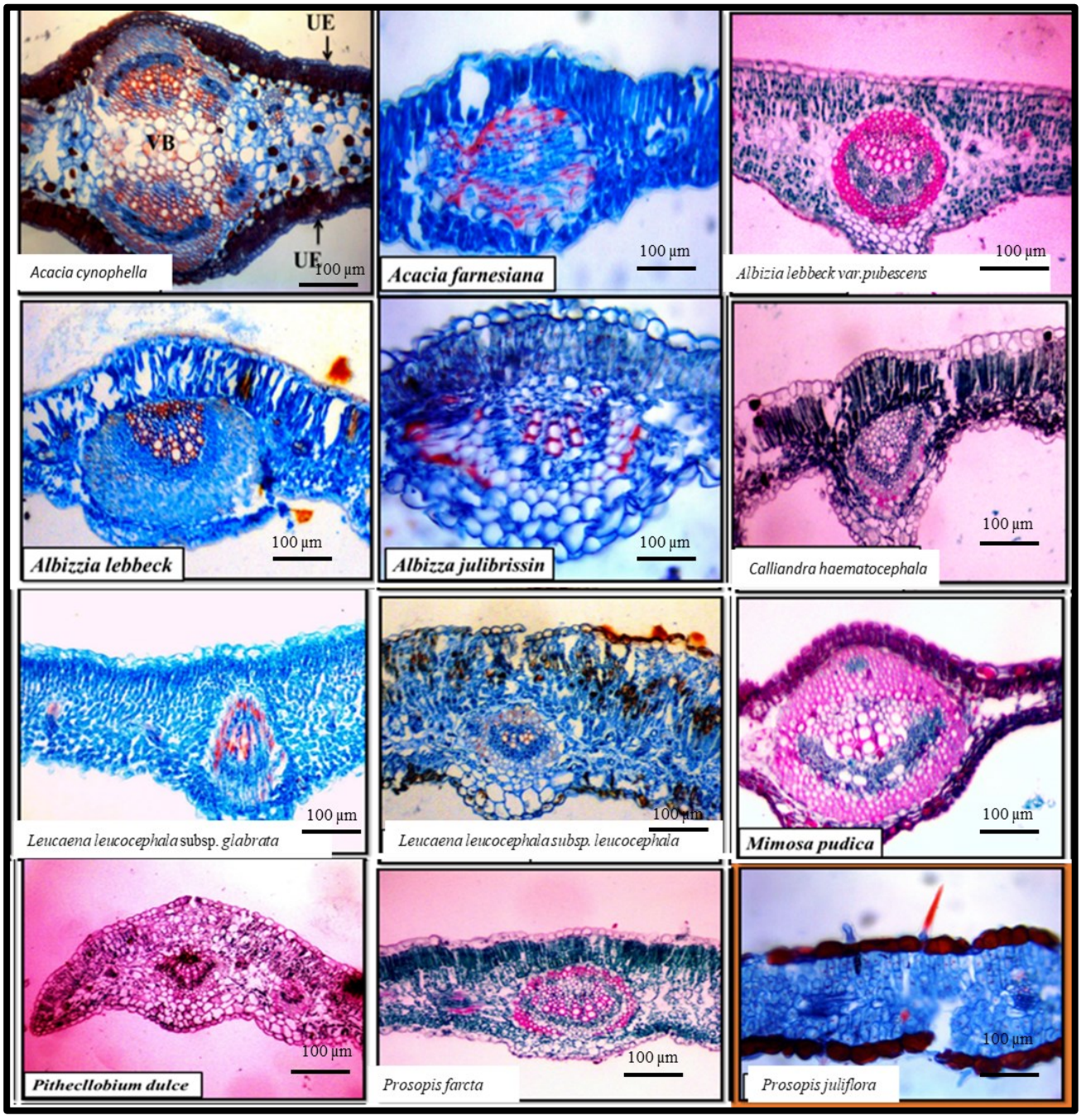


**Plate 2. Cross sections of leaves midribs in the species include the UE: upper epidermis, LE: lower epidermis, and VB: vascular bundle. 10X (all photo scale bar of 100 µm)**

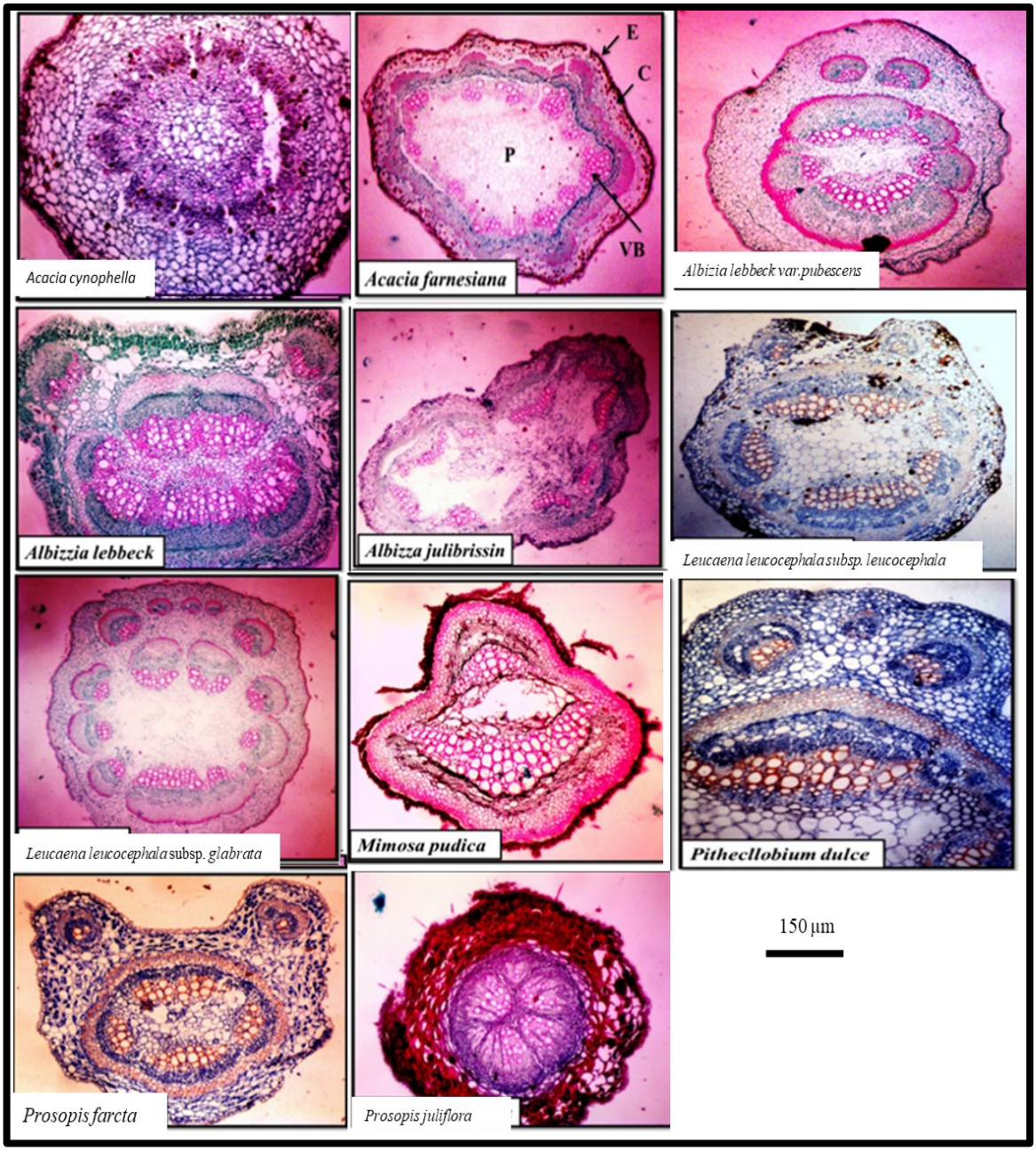


**Plate 3. Cross sections of petioles in the species 10X (all photo scale bar of 150 µm)**

**Stem cross sections:**

**The cross sections of leaves petioles:**

All the species' leaves are petiolated except the species *Calliandra haematocephala* apetiolated. The genera varied by the shape of the cross-section and can divided into 5 groups:

Group 1: the cross section of the petiole is circular and appears in the genera (*Acacia cynophella, Prosopis juliflora*).

Group 2: the cross-section of the petiole is ovoid and appears in the genera (*Leucaena leucocephala*).

Group 3: the cross-section of the petiole is elliptical and appears in the genera *(Acacia farnesiana*, *Albizia julibrissin*).

Group 4: the cross section of the petiole is horseshoe and appears in the genera (*Albizzia lebbeck*, *Leucaena leucocephala* subsp. *glabrata*, *Pithecellobium dulce* and *Prosopis farcta*).

Group 5: the cross-section of the petiole is rhomboid and appeared in the genera (*Mimosa pudica*).

All the petioles consist of an epidermis with about one layer of ovoid cells covered by cuticles from the outer; after the epidermis is located, the cortex consists of 2 layers of tissues. The first layer is collenchyma tissue located under the epidermis, consisting of 2-3 seriate cells, and after it, the parenchyma layers consist of polygonal cells. The vascular bundles in the center consist of the xylem, and phloem tacked to the petiole shape.

According to the shape of the stem in cross sections, all the studied species were circular (plate 4).

The stem in the genus varies in the stage of growth and can be divided into two groups:

Group 1: the stem in the primary growth appeared in the species (*Acacia cynophella*, *Acacia farnesiana*, *Calliandra haematocephala*, *Albizzia lebbeck*, *Leucaena leucocephala* subsp*. leucocephala*, *Mimosa pudica*, *Pithecellobium dulce*, *Prosopis farcta*, *Prosopis juliflora*).

Group 2: the stem in the secondary growth appeared in the species (*Albizia julibrissin*, *Leucaena leucocephala* subsp *glabrata, Albizia lebbeck* var*. pubescens*). Also, all the genera are dicotyledonous.

As have been measured, the thickness of the cuticle was (2.3-4.3(2.75)) µm as minimum in (*Acacia cynophella*) µm and (3.4-5.6 (4.75)) as maximum in (*Albizia julibrissin*) and remain species lying between this range (Table 4).

The stem epidermis of species in the primary growth was superficial with a thickness of (18.5-22.3 (20.5)) µm as minimum in the species *Albizia julibrissin* and (30.2-36.5 (35.6)) µm as maximum in *Leucaena leucocephala* subsp. *Leucocephala* (Table 4).

The stem epidermis of species in the secondary growth consisted of from the outer to inside, the cork, cork cambium and secondary cortex, with a thickness of (26.5-33.1 (30.2)) µm as minimum in the species *Acacia cynophella* and (71.2-75.6 (72.4)) µm as maximum in *Prosopis juliflora* (Table 4). The stem epidermis is glabrous except for the species (*Albizia julibrissin*, *Leucaena leucocephala* subsp. *glabrata*) covered by eglandular trichomes (epidermis hairs), the eglandular trichomes were long and straight appeared unicellular.

**Table 4. Characteristics of stem cross-section in studied *Mimosoideae* species (µm).**

| NO. | Species | Thickness of cuticle | Thickness of epidermis | Thickness of peridermic | Thickness of cortex | Pith thickness | vascular bundle diameter |
|---|---|---|---|---|---|---|---|
| 1. | *Acacia cynophella* | 2.3-4.3 (2.75) | - | 22.4-26.5 (24.3) | 26.5-33.1 (30.2) | 113.2-116.4 (114.8) | 256.9-260.1 (259.4) |
| 2. | *Acacia farnesiana* | 4.1-5.5 (5.25) | - | 58.1-62.3 (60.5) | 29.5-39.1 (37.6) | 66.6-69.3 (68.1) | 346.8-350.2 (349.2) |
| 3 | *Albizia lebbeck var. pubescens* | 2.5-3.8 (3.1) | 36.4-40.5 (40.1) | - | 56.3-60.5 (59.5) | 288.4-290.1 (288.1) | 145.2-150.2 (148.7) |
| 4. | *Albizzia lebbeck* | 2.25-4.25 (3.5) | - | 32.5-39.4 (38.4) | 55.3-60.4 (60.1) | 120.5-129.4 (128.7) | 322.7-326.5 (325.1) |
| 5. | *Albizia julibrissin* | 3.4-5.6 (4.75) | 18.5-22.3 (20.5) | - | 44.2-49.5 (46.1) | 529.1-433.2 (530.6) | 99.2-106.4 (104.8) |
| 6. | *Calliandra haematocephala* | 3.25-4.5 (4.2) | - | 20.4-26.3 (25.5) | 51.5-59.4 (57.5) | 119.4-124.6 (123.7) | 170.1-177.5 (175.6) |
| 7. | *Leucaena leucocephala* subsp. *glabrata* | 3.25-4.1 (3.5) | 24.5-29.6 (27.4) | - | 42.3-48.5 (46.5) | 222.1-225.6 (223.4) | 106.3-109.4 (108.5) |
| 8. | *Leucaena leucocephala* subsp. *leucephala* | 3.25-4.25 (4.1) | 30.2-36.5 (35.6) | - | 35.1-39.2 (37.5) | 226.3-229.4 (228.4) | 167.5-170.2 (169.3) |
| 9. | *Mimosa pudica* | 3. 5-4.5 (4.1) | - | 44.5-49.5 (47.6) | 50.1-55.6 (53.2) | 189.4-191.2 (190.51) | 350.8-355.6 (353.4) |
| 10. | *Pithecellobium dulce* | 3.5-4.5 (3.75) | - | 45.2-48.3 (46.2) | 57.4-60.1 (60.0) | 212.4-215.5 (213.8) | 349.2-353.4 (350.1) |
| 11. | *Prosopis farcta* | 3.5-4 (3.75) | - | 40.2-46.5 (45.7) | 61.5-66.3 (65.4) | 166.4-169.3 (168.4) | 336.5-339.1 (338.4) |
| 12. | *Prosopisjuliflora* | 3-4.5 (3.25) | - | 48.5-53.1 (52.4) | 71.2-75.6 (72.4) | 151.2-155.6 (153.2) | 309.4-312.5 (310.4) |

Stems in primary growth of all species studied except the species (*Albizia julibrissin*, *Leucaena leucocephala* var. *glabrata*) were essentially the same (i.e. cortex with collenchyma, chlorenchyma and ordinary parenchyma), the thickness of the cortex is (30.2) µm as a minimum in *(Acacia cynophella)* and (72.4) µm as a maximum in *(Prosopisjuliflora )* and the remaining species between this range. The vascular tissue system in all studied species was represented by arranged open collateral vascular bundles forming continuous vascular cylinders. Each vascular bundle consists of the xylem and phloem, with bundle cap fibres covering the phloem. The thickness of the vascular bundle reached (106.3-109.4 (108.5)) µm as a minimum in (*Leucaena leucocephala* subsp. *glabrata*) and (349.2-

353.4 (350.1)) µm as a maximum in (*Pithecellobium dulce*). At the centre of the stem, located the pith or medulla, this layer contains parenchyma cells, big in size and polygonal shape. The thickness of this region was (66.6-69.3 (68.1)) µm as minimum in (*Acacia farnesiana*) and (529.1-433.2 (530.6)) µm as maximum in (*Albizia julibrissin*). The stem in secondary growth the cortex narrow, the thickness of the cortex is (30.2) µm as minimum in *(Acacia cynophella)* and (72.4) µm as maximum in *(Prosopis juliflora)* and the remaining species between this range. The vascular tissue system in all studied species was represented by arranged open collateral vascular bundles forming continuous vascular cylinders and the first annual ring. The thickness of the vascular bundle reached (104.8) µm at a minimum in *(Albizia julibrissin)* and (353.4) µm at a maximum in *(Mimosa pudica).*

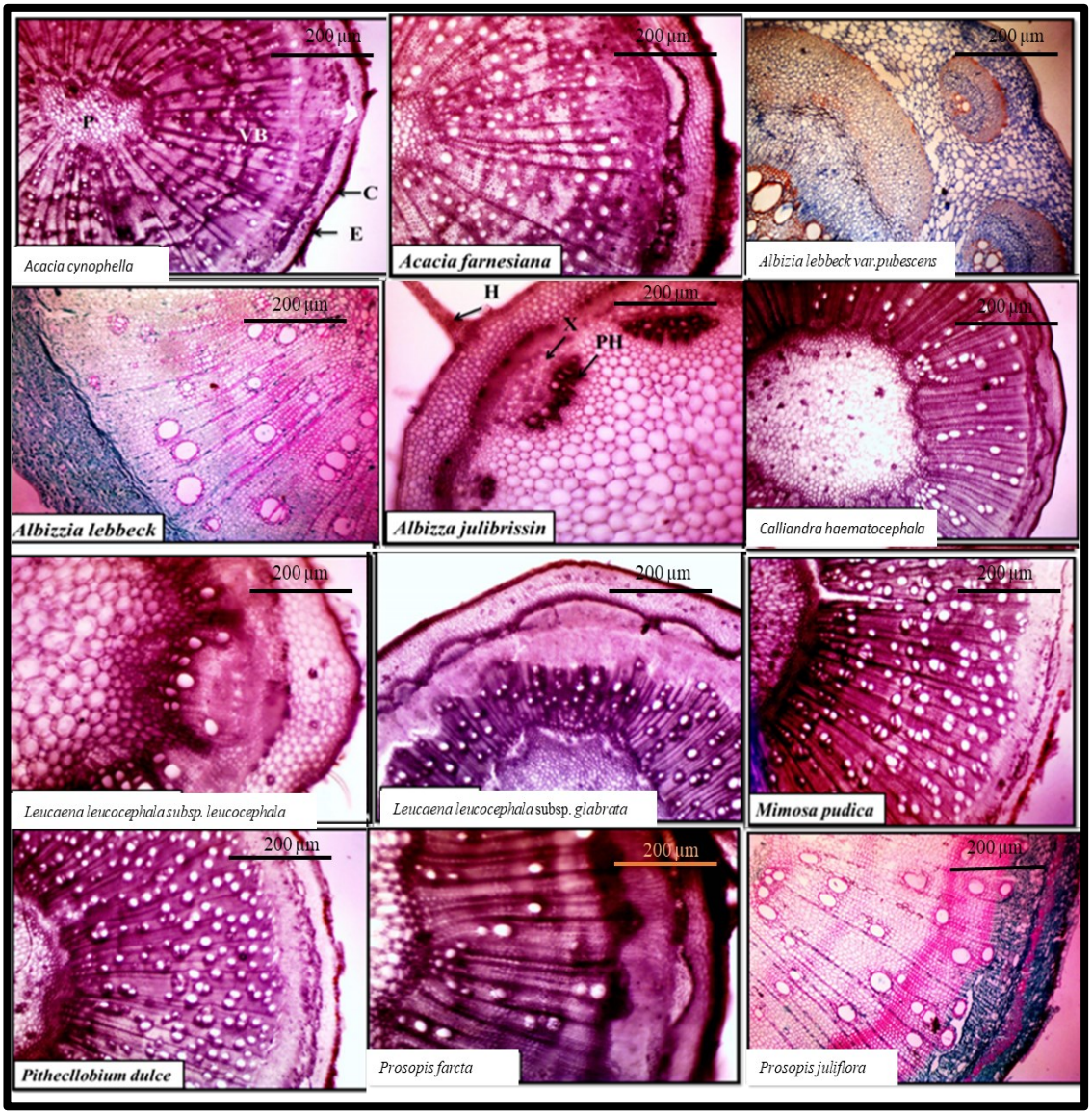


**Plate 4. Cross sections of stems in the species, where are the E: epidermis, C: cortex, VB: vascular bundle, P: pith, H: hair, X: xylem, PH: phloem. 10X (all photo scale bar of 200 µm)**

The epidermis is the outermost layer of leaves and comprises tabular and convoluted cells in Magnoliopsida (Mauseth, 1988; Fahn, 1990). In contrast to this pattern, *Acacia podalyriifolia* and other species have epidermal cells with polygonal anticlinal cell walls in surface view. In addition, it has not shown hemispherical papillae in the lower epidermal cells, frequently reported in the genus Acacia (Metcalfe and Chalk, 1950, 1988).The appearance of a thick cuticle is usually typical of plants growing in arid habitats (Fahn, 1990), and wax is a universal complement to the outer wall of the epidermis

(Mauseth, 1988), and both traits are consistent with the arid origin of this species. Similarly, a white deposit of a waxy substance has been reported for other acacia species (Metcalfe; Chalk, 1950), and epicuticular wax has been described for *Acacia greggii* and *A. Gray* var. *Arizona* (Bleckmann et al., 1980). Consequently, the mesophyll is classified as centric, and its central part contains relatively little chlorophyll. In this study, the smaller bundles embedded in the mesophyll and the larger bundles of the midrib are accompanied by perivascular fibres corresponding to phloem-attached sclerenchyma cells of pericyclic origin. Based on Fahmy's (1997) results, the reduction in leaf area, the presence of trichomes, amphistomases, isobilateral leaf structure and palisade parenchyma of two to four layers represent xeromorphism and are ecophysiological adaptations of desert plants to their habit compatible with this species origin. At the level of the stem analyzed, the epidermis persists in *Acacia podalyriifolia*, as seen even in barks of considerable thickness in *Acacia*. The wood of the subfamily species differs according to the species as proposed previously (Miller, 1989). On the other hand, the phloem of *Mimosa pudica* was examined in light of some reports that the sieve elements of this plant exhibit features not previously described for these cells in other Fabaceae taxa. Leaflet anatomy of taxa in *Mimosa* sect. Batocaulon, series Quadrivalves, is described for the first time using cleared leaflets and light microscopy. Members of the series have obliquely asymmetrical, linear-oblong, narrowly elliptical, or narrowly oblanceolate leaflets with an eccentric main vein. The venation pattern is brochidodromous with basal lateral veins. Based on the size and width of the primary vein and the nature of the loops, the taxa in the series are divided into two groups, one with innervated loops and a markedly thickened (massive) primary vein and the other with anisonervated loops and a moderately thickened thick or primary vein; the primary vein and secondary veins can be tortuous or straight, and these revealed the importance of leaves venation studies. Idioblasts were observed in association with the ends of the veinlets. There are three types: polymorphic sclerides, osteosclerosis, and tracheoidal elements. Calcium oxalate prisms are present in most taxa in this study. The former is assigned to the vascular bundles. The systematic value of anatomical features of the leaflets is discussed, and it was found that leaflet anatomy provides significant features for distinguishing groups and individual taxa in the four-leaf series (Flores-Cruz *et al.,* 2004).The paravenal mesophyll (PVM) in Leguminosae, subfamily Mimosoideae, was first described in 1894 but never described in detail. We cleaned and dissected leaves of *Calliandra tweedii* and *C. emarginata* (Tribe Ingeae) in resin. The anatomy of the lamina is very similar in both species: a palisade layer, two or three spongy layers, and the horizontal venous network with its connected PVM in the middle. PVM is a fungistatic cellular spike that extends between veins and joins medially along each flank of all veins. PVM cells have a normal complement of typical chloroplasts, similar to other mesophyll cells. Fibres surround most veins except for an extensive lateral cleft along each flank where the MVP joins; therefore, a parenchymal sheath is absent. All vein terminals lack phloem, although the tracheal elements of some vein terminals are flanked by one or two long, slender, and undifferentiated cells. Occasionally, small gaps occur between the PVM cell wall and the adjacent tracheal elements, exposing the xylem directly to the intercellular space of the mesophyll. The anatomy of the *Calliandra* MVP, including its physical relationship to the various venous orders, differs in several important aspects from the MVP of the few legume and non-legume species studied anatomically in detail (Lersten and Curtis, 1993).The anatomical structures of the main pulvinus and common petiole of *M. pudica* differed from those of *A. julibrissin*. Upon stimulation, the volume of *M. pudica* protoplasts in the lower cortical parenchyma cells becomes smaller than in the upper ones, a feature found in *A. julibrissin*. Many web-like lacunae were found on either side of the adaxial petiole of *M. pudica* but none in *A. julibrissin*. Similarly, some poorly developed lacunae in the pulvinus of the rachis and the leaf of M. pudica are absent in *A. julibrissin*. It appears that the net-like gaps in the common petiole of *M. pudica* are responsible for its vigorous nasal movement. The main sensitive position is at the base of the common petiole, where the lower cortex is more sensitive than the upper cortex, and the ordinal sensitive positions are the spindle and leaflets (Ming-Lin*et al.,* 2013). The transverse mesophyll consists of a palisade of two or three layers of elongated cells below the adaxial surface and a palisade of one or two layers of adjacent cells on the abaxial surface, corresponding to ¾ of the mesophyll. The lacunar parenchyma consists of about 2 to 3 layers of cells, the elements of which are rounded and thin-walled. The intercellular spaces are fairly small with irregular borders and variable sizes. Vascular collateral bundle shave vascular elements up to 4 times larger in diameter than phloem cells and a sclerenchymal sheath composed of 1 or 2 cells surrounding the entire bundle. The species has xeromorphic characteristics with palisade tissue and reduced lacunar tissue with sparse and small intercellular meatus (Simões*et. al*., 2003).

## Conclusion

It can be concluded that anatomical studies are considered supplementary and significant tools to categorize species. Where the twelve species significantly differed in anatomical leaf and stem markers. therefore, these species could be characterized using anatomical properties. The anatomical image analysis represented an efficient tool for categorizing these species. Furthermore, numerical properties were of considerable value to study Mimosoids taxa. Moreover, these taxa could possess environmental value to cure desertification and increase the biodiversity in the region as a west desert of Iraq.

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