

## Anatomical Studies of Raspberry Leaves of Cultivated Fig Specie in Riyadh, Saudi Arabia

Nora Naif Alqahtani (Corresponding Author)

Botany Department, College of Science, King Saud University, Riyadh, Kingdom of Saudi Arabia

Email: [noora221@gmail.com](mailto:noora221@gmail.com)

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### Abstract

The aim of this study is to identify the external and internal anatomical qualities of the leaves (blade and petiole) of three species of the *Ficus* L. Family Moraceae and cultivated in the city of Riyadh in Saudi Arabia: *Ficus carica* L., *Ficus religiosa* L., *Ficus elastica*. The plants under study were characterized as perennial trees with existing Stems, simple leaves exchanged, full edge or parchoned, long petiole, Hypanthodium inflorescence (female, male and gall) and Syconium fruits containing Achene seeds. Study results indicate similarity in external and internal anatomical qualities of leaves (Blade and petiole) species under study, all of which were characterized by anatomical qualities representing the environmental adaptation of the city of Riyadh, which may help to classify into groups within the specie of fig *Ficus* L. (Doubling epidermis, Glandular trichome and non glandular trichome, Lithocyte of different shapes, sizes and colors, druses or solitary crystals, two-bark beams, laticifers, tannin cells, multi epidermis palisade layers, characterizing the epidermis surface of leaf blade has deposition of cuticle with epicuticular wax were either platelets or granules forme).

**Keywords:** Anatomical; Raspberry leaves; Cultivated fig; Riyadh; Saudi Arabia.

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### 1. Introduction

The specie of fig *Ficus* L. belongs to the raspberry family Moraceae (Lindley, 1846), and the family belongs to the class Urticales [1, 2] and recent studies in molecular traits placed them under Rosales Berg et al., 2011; [3] that was proved by [4].

The Moraceae raspberry family was divided into four Subfamily factions: Concephaloideae, Artocarpoideae, Cannboideae, Morideae (England, 1889), and divided under the tribe into seven tribes which are: Artocapeae, Autiropsidae, Castilleae, Moreae, Porsteniaeeae, Ficeae, Soroceae (Berg et al., 2011) The specie of fig *Ficus* L. belongs to the species of Artocarpoideae and the tribe Ficeae (Rohwer et al., 1993). The specie of fig *Ficus* is divided into six Subgenus: Urostigma, Pharmacosycea, Sycomorus, Ficus, Synoecia, Syedium [5]. Subgen Urostigma is one of the largest groups and includes 280 species such as *F. elastica*, *F. altissima*, *F. benjamina*, *F. religiosa* [6], and Subgen. Ficus has 23 species, the most important of which is the ordinary fig plant *F. carica* L. [6].

The Moraceae family, called Fig Family or Mulberry Family, is one of the largest platoons of the platoon diodes, with 40 species and about 2,000 types of trees, bushes, epiphytes and semi-aerobic climbers where they possess air roots at the beginning of their lives. and often grow in tropical, subtropical and temperate tropics where they are prevalent in America, Australia, East Asian, African and Mediterranean countries [6-9]. The plants of the fig *Ficus* L. species are characterized by the unique appearance qualities of floral fluorescence type Hypanthodium, where they are installed from an enlarged straw in the form of a hollow meaty vessel and have ostiole pores that line the interior with masculine, feminine and sterile flowers and develop after pollination as the synthetic tenetic fruit Syconium [10].

In Saudi Arabia, the tribe was represented by three wild races, the species *Dorstenia* L. of which *Dorstenia foetida*, *Morus* L. of which there are three species, and *Ficus* L. of fig, which Chaudhary [10] mentioned with 16 species, while Collenette [11] mentioned eight wild species, and Migahid [12] mentioned Five wild species of fig *Ficus* L. were found in different regions of Saudi Arabia. One of the most prominent wild species in the Kingdom of Saudi Arabia is wild fig or so-called *F. palmata*, which is widespread throughout the Kingdom, especially in Asyr's Mountains, due to the transmission of its seeds with baboons and bird residues and the most prominent cultivated species is the ordinary fig *F. carica* L., As well as *F. microcarpa*, it is the most widely cultivated species in Riyadh as well as *F. vasta*, *F. salicifolia*, *F. religiosa*, *F. benghalensis*, where cultivation as outdoor ornamental plants is spread

in parks and around houses and as wind suppliers around villages and fields [10]. The cultivation of *F.benjamina* and *F.deltoidea*, *F.layrata*, *F.amplissima* is widespread as indoor decorative plants [10].

### 1.1. Objective of the Study

The study examined 3 cultivated species of fig *Ficus* L. in Riyadh, Saudi Arabia, and the purpose of the study is to highlight the most important anatomical qualities of the leaf (blade, petiole) such as (multi epidermis layers, cystolith, vesicles, lithocyte, laticifers) to monitor the extent of adaptations in external and internal anatomical qualities and to contribute to the addition of such information as anatomical evidence to correct the faction's partitional status.

### 1.2. Previous Studies

One of the most important previous anatomical studies on the specie of fig *Ficus* L. cited by both Metcalfe and Chalk [13] *Ficus* L. fig leaves were characterized as having epidermis of one or more layers The stomata s are found in the lower surface and are at the surface level of the epidermis , sometimes high, sometimes slightly overwhelming, Trichome found glandular with a stalk unicellular , oval head or spherical multicellular, The petiole are characterized by a single angioplasty beam in the form of a closed cylinder. The pith represents a parenchyma tissue with some bark tapes, crystals druse or groups in epidermis cells or in the basic and vascular tissue of the leaves, Lithocye also found in all kinds of fig *Ficus* L. and are in different sizes and shapes.

The study Klimko and Truchan [14] showed the external and internal characteristics of the epidermis of thirty-six types leaves (Type, under type, class) Different from the specie of *Ficus* L. Using a optical microscope and electronic microscope and confirmed epidermis characteristics in terms of the shape of epidermis cells and cell merit, the stomping on the lower surface of leaves and between veins of the irregular type Anemocytic auxiliary cells, and in most subgen types urostigma they are the stomata s surrounded by a thick dermis that takes the form of prominent edges as in *F.benjamina* and *F.elastica* also appeared stone vesicle cells, wax shapes where the form of granules takes the form of *F.elastica* or plate shape as in type *F.benjamina* and *F.religiosa* or cracked layers as in many studied species, in *F.carica* type, as well as in *F.pumila* type with an oval or circular head of (1-5) in some species.

Labunskaya, *et al.* [15] carried out an anatomical study of the type *F.benjamina* cv.Starlight and *F.benjamina* cv.Daneil since *F.benjamina* cv.starlight is a marker containing two different areas in color (White-green) In the leaf blade, the degree of discoloration varies to environmental conditions and anatomically shows that the first layer of palisade tissue is free of green chloroplasts and the second layer has chloroplasts. The *F.benjamina* cv.danielle class with green color in the whole leaf anatomically shows that all layers of palisade tissue have green Chloroplasts.

Other external epidemiological and anatomical studies were conducted on 20 types of fig faction *Ficus* L. scattered in Nigeria and showed that the shape, dimensions and texture of the leaf (blade, petiole) and external anatomical structures of the epidermis cell shapes, stomata types, and trichomes are used as classifications at the species level where subgen was found. *Ficus* L. has harsh little trichome that resemble thorns while subgen. Sycomorus contains dense glandular trichome and subgen. Urostigma contains little glandular trichomes [16].

The Chatarasuwan, *et al.* [17] study on the species *F.cornelisiana* of Urostigma in the Himalayan region of Asia has shown that this species is very similar to *F.orthoneura*, *F.hookeriana* and different from them in some external characteristics such as fruit shape and leaf petiole length and some internal characteristics as it is multi epidermis.

A phenomenal study of the species, *F.tubulosa*, under the type Urostigma, found in the Amazon region of America, also showed that it was very similar to the two species *F.pertusa* and *F.trachelosyce*, but different from them in the shape and length of fruit, and the length of the leaf (Pelissari and Romaniucneto, 2014).

The researcher Bercu [18] also carried out an anatomical study of cross section of leaf petiole of the type *F.lyrate*, *F.carica* and *F.benjamina* cv.danielle showed the thick or thin cuticle, and one layer of epidermis, but *F.lyrate* contain multi epidermis in petiole followed by the cortex contain laticifers, the vascular tissue in the petiole central , the blade is characterized by layered epidermis with cystolith and stomamta are anisocytic or anomocytic type and non glandular trichomes.

One recent study in this area is the study Mamoucha, *et al.* [19], which dealt with *F.carica* with an anatomical study using a light microscope and scanning electron microscope and recorded some characteristics such as that epidermis has a single layer and the vascular bundle extends to the abaxial and adaxial surface of the epidermis , and Cystolith are in the lower surface and have a short stalk and this stalk may come out of a fork-trailing component. The stomata in the lower surface of the anomocytic type and there are gaint stomata, there are non glandular trichomes unicellular with bladder like base surrounded by rosette of epidermis cells precipitated into it cystolith and glandular trichomes that short stalk with multicellular head.

As well as Shakir and Baji (2016) study of three types of fig specie *Ficus* L. prevalent in Iraq *F.carica*, *F.religiosa* and *F.elastica* in which internal and external anatomical characteristics were studied as it proved that the epidermis cells are polygonal in shape and have straight to convex walls and have a stomach in the lower surface of Anicocytic type, It have Lithocyte Cystolith and prismatic crystal, It was stated that *F.religiosa* consists of single-layer epidermis cells and *F.carica* consists of two-layer epidermis and *F.elastica* consists of multi epidermis.

## 2. Materials and Methods

### 2.1. Plants Used

The plants studied according to Table 1 were collected in the flowering phase in Riyadh region in 1438 AH and the parts under study were preserved in 70% ethyl alcohol until they were used in the study. The plants under study were defined by the King Saud University Herbal Service (KSU).

**Table-1.** Plant sample collection site for species under study for fig specie *Ficus* L

Plant name	Collecting date	Collecting site
<i>Ficus carica</i> L.	1438/5/15	Research Center Arboretum in Riyadh
<i>Ficus religiose</i> L.	1438/5/24	King Saud University Garden
<i>Ficus elastica</i> Roxb.	1438/5/15	Research Center Arboretum in Riyadh

### 2.2. Working Methods

#### 2.2.1. Study of External Anatomical Qualities

**First:** The external anatomical characteristics of the epidermis of the leaves and petiole of the species and items under study were studied using a light microscope by making multiple epidermis in the leaves and petiole of both upper and lower surfaces according to the method of preparing plant samples for Daijie (1417 A.D.) By cutting the leaves and petioles and preserving them in 70% ethylic alcohol, then preparing a skin from the epidermis of the leaf and petiole very carefully using pointed tongs, then placing them on a glass slide and temporarily loading them with a drop of glycerin, then covering the slide and then examining with light microscope.

**Second:** Skins have been anatomically described in terms of cell wall type and shape, taking the measurement of cell dimensions (length and width), describing and measuring the dimensions of the stomata (length and width), calculating their number in the unit of estimated area of 1 millimeters at the strength of the lens enlargement (X40) using the Graticule mesh plate (Daijie, 1421), and description of the glandular and non-glandular trichomes and taking the dimensions of the trichomes (lengths).

**Third:** The cutical layer was studied for the leaves of species under study using a scanning electron microscope where the type and shape of the cutical were identified by preparing sustainable segments to study the plant surface in the Luckow and Grimmes method (1997) By taking pieces of 7 mm leaf separation and then drying the sample by removing the water by passing it into a series of ethanol solution with mounting concentrations. Then transfer to the sample holder and attach the dual-face adhesive tape and cover with a thin layer of gold and then inspect by electron microscope scanning JSM6060LV-scanning microscope.

#### 2.2.2. Study of Internal Anatomical Qualities

The internal anatomical characteristics of the cross sections of each of the leaves and petioles of the species and items under study were studied using a light microscope by the continuous stabilization method of the sectors using paraffin wax according to the foregoing (Al Khazrji and Aziz, 1989; Al- Daijie et al., 1417) and its summary as follows:

**Fixation:** Using Formalin-aceto-alcohol, this solution is prepared by blending the following primary solutions: (90 ml ethanol 70%, 5 ml formalin 40%, 5 ml snowy acetic acid) so that parts of leaves and necks are placed at length (0.5-1) cm for 12-24

**Dehydration:** To remove water from the sample, ethanol (ethanol alcohol) was used with 70% upward graded concentrations for two hours and then transferred to 80% for two hours and then to 90% for two hours and then to 100% for 24 hours.

**Clearing:** Xylene and ethanol were used the size/size, starting with 1 xylene: 3 ethanol for two hours, then transporting the sample to 1 xylene: 1 ethanol for two hours, then 3 xylene: 1 ethanol for two hours, and finally absolute xylene for 24 hours.

**Infiltration:** The grated paraffin wax was added to the absolute xylene containing the sample, then placed a heater at 40°, continuing to place the wax grated until saturation for 24 hours, then placed in the 60° oven for 24 hours or until the sample is saturated with wax and then changed with a fresh pure wax.

**Embedding:** Using the following materials and tools: paraffin wax, hot tongs, hot needle, typing sample name on small sheet, metal or paper mold, glycerin to grease the sides of the mold, the following processes are carried out: placing name under the mold, placing sample, molten wax casting, settling sample, cooling it in cold water and keeping in the fridge until use.

**Sectioning:** Using Rotary Microtome by fixing the wax mold on the sample holder and cutting at 10-20 micrometers thick for wax tape for a number of sheet and neck segments then placing the sampled wax segments in the water bath with heating at 40° and then singled out on the glass slides and placed on the heater for 24 hours, Then remove the wax by absolute xylene for 20 minutes, and then transfer the sectors to 1 xylene: 1 ethanol for 1 to 2 minutes and then to absolute ethanol for 1 to 2 minutes.

**Staining:** The paraffin wax-free sectors passed by a downward graded concentration of ethanol 100% 96%, 80%, 70%, 50%, 2 minutes per concentration, it then dyed with Safranin for half an hour, then passed on upward concentrations of 50% ethanol, 70%, 80%, 96%, then dyed Light green for 30 seconds, then pass to 96% then to 100% ethanol, and then to 1 xylene: 1 ethanol, and finally transfer the samples to absolute xylene.

**Mounting:** The segments were loaded using D.P.X. loading material which consists of 3 materials are Distrene, Plasticizier, Xylene.

### 2.3. Histological Tests

Segments for each of the leaves and petioles of the species and items under study were made at 20-25 micrometres thick using Hand Micrometer to detect the following contents:

- Cutical : Detection of the presence of cutin and suberin using Sudan III dye
- Lignin: Using solution Phloroglucinol (dissolved in alcohol) with the addition of HCL.
- Starch : Using Iodine Solution (Daiji et al., 1417).

### 2.4. Counting and measuring

The process of counting stomata was carried out in an area of 1 mm<sup>2</sup> at the power of the objective lens (X40) in the epidermis of leaves and petioles using a square graticule lens. The dimensions of the stomata, the dimensions of the epidermal cells (length and width), and the lengths of the glandular and non-glandular hairs were measured in each of the leaves and petioles at a power of the objective lens (X40) with the help of the eyepiece micrometer, where 25 random readings were taken for each of the anatomical characteristics studied, from which the smallest, largest, and average measurements were fixed, and the thickness of the walls and the thickness of the cutical were measured in each of the leaves and petioles according to Al-Hadidi et al. (1414) where it was considered very thick, greater than 12 µm, thick 12:6 µm, thin 2.5: 6 µm, and very thin less than 2.5 µm.

Epidermis, leaf segments and petioles were imaged using a LEICA DM750 light microscope equipped with an OPTIPLEX 9020 camera (Fig.1), and leaf surfaces were visualized using a JSM6060LV-scanning electron microscope.

**Figure-1.** Light microscope with LEICA camera DM750 with OPTIPLEX 9020 camera



## 3. Results

### 3.1. External Anatomical Characteristics of the Leaf

A- The midrib Area

**Upper epidermis:** The epidermis of *F.carica* plant is characterized as elongated, ribbed cells with thin and straight walls, cellulose, pitted, the dimensions of the cells are between (37.50 - 75.50 - 187.50) micrometers in length, and between (10 - 18.25 - 25) micrometers in width as in Figure (2a) non glandular trichomes unicellular, uniseriate, unbranched, with a round head and a broad base, thin and smooth walls, cellulose, ranging in length from (62.50-175-712.50) micrometers in length, as in Figure 2b, c, 6a. Glandular trichomes are few with unicellular stalk and multicellular round head (4-8), ranging between (55-63.25-72.50) micrometers in length, as in Figure 2c. The cutical is rough, and wax deposits appear in the scanning electron microscope in the form of granules as in Figure (6a).

**Lower epidermis:** *F.carica* plant skin is characterized by rectangular or ribbed cells with a thin and straight wall, cellulose, tap, cell dimensions between (37.50 - 75.75 - 150) mm tall, between (10 - 16.25 - 25) micrometres width, as in figure 3a, b non glandular trichomes, unicellular, uniseriate, unbranched, with a round head and a broad base, thin and smooth wall, cellulose, ranging in length from (82.50 - 236.25 - 412.50) micrometer length as in figure 3b, 6b Glandular trichomes are few with unicellular stalk and multicellular round head (4-8), ranging from (45 - 59.50 - 85) micrometer length as in figure 3b, 6c The cutical is rough, and wax deposits appear in the scanning electron microscope in the form of a platelets as in figure 6b.

**B- Area between midrib:**

**Upper epidermis:** The skin of the *F.carica* plant is characterized by ribbed cells with thin and humped merit, cellulose, tap, cell dimensions between (45 - 61 - 85) Micrometer length, between (22.50 - 26.75 - 37.50) micrometers width as in figure 4a non glandular trichomes, unicellular, uniseriate, unbranched, with a round head and a broad base, thin and smooth wall, cellulose, ranging in length from (17.50 - 44.50 - 87.50) tall as in figure 4b, 7a, c Glandular trichomes are few with unicellular stalk and multicellular round head (4- 8), ranging in length from (52.50 - 58.25 - 65) micrometer tall as in figure 4b, 7d, The cuticle is rough, and wax deposits appear in the scanning electron microscope in the form of a platelets as in figure 7a, c.

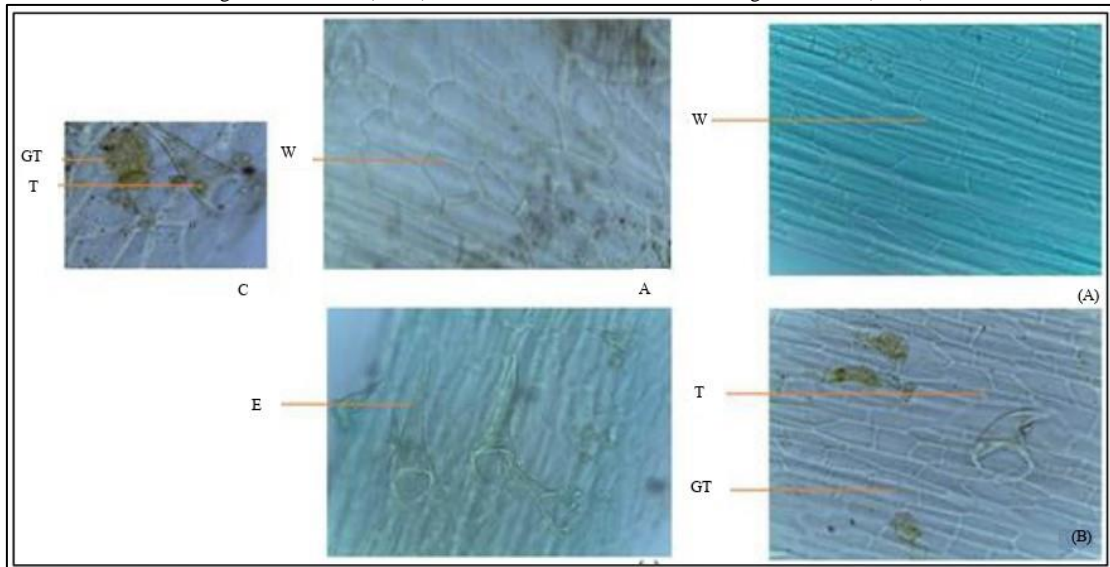
**Lower skin:** *F.carica* plant skin is characterized by irregular-shaped cells, with thin wall, convex, cellulose, pecking, cell dimensions between (22.50 - 43.50 - 62.50) micrometer length, between (17.50 - 23.75 - 32.50) micrometers width as in figure 5a, b non glandular trichomes, unicellular, uniseriate, unbranched, with a round head and a broad base, thin and straight wall, cellulose, ranging in length from (35 - 107.25 - 250) mm long as in figure 5b, 7b, Glandular trichomes with a unicellular stalk and multicellular round head (4- 8), ranging in length from (55 - 57.50 - 60) micrometer length as in figure 5d, 7e and oval-shaped stomachs with chiropractic cells, scattered, individually, in the surface level of the epidermis, which are anomocytic cells, the dimensions of the stomach range between (20 - 23.75 - 30) Micrometer Length, between (17.50 - 21.50 - 32.50) Micrometers incidentally, and between (200 - 312.50 - 450) loophole/mm<sup>2</sup> as in figure 5a, 7b There are giant stomata larger than the rest of the stomata, as in figure 5a Cystolith Lithocyteare visible from the surface view of the abrasion and surrounded by 6-7 radial epidermis cells, as in figure 5C. The cuticle is rough, and wax deposits appear in the scanning electron microscope in the form of a platelets as in figure 7b.

### 3.2. External Anatomical Characteristics of the petiole

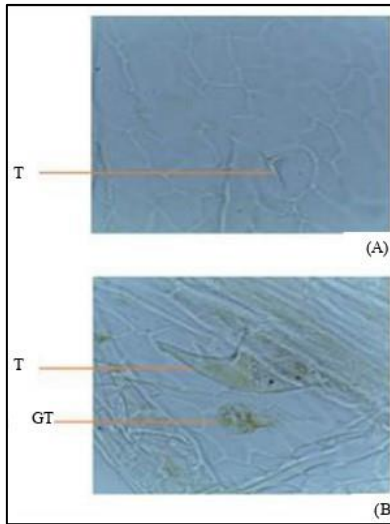
*F.carica* skin of petiole is characterized by rectangular or ribbed cells, with thin and straight wall, cellulose, tap, cell dimensions between (15 - 25.25 - 35) Micrometer Length, between (7.50 - 13.75 - 20) Micrometer incidentally in figure 8a, b, non glandular trichomes, unicellular, uniseriate, unbranched, with a round head and a broad base, thin and straight wall, cellulose, ranging in length between (42.50 - 175.50 - 447.50) mm tall as in figure 8a, c Glandular trichomes with a unicellular stalk and multicellular round head (4- 8), ranging in length between (50 - 56.25 - 62.50) micrometer, The cuticle is rough and there Druses crystals as in figure 7b.

**Figure-2.** Paradermal section of the upper epidermis of *F.carica* leaf. The midrib region: A - B - C - (400X)

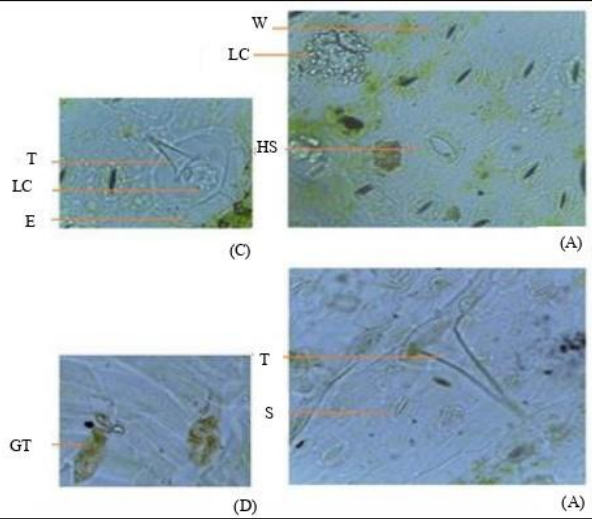
**Figure-3.** Paradermal section of the lower epidermis of *F.carica* leaf. midrib region: A - B - (400X)



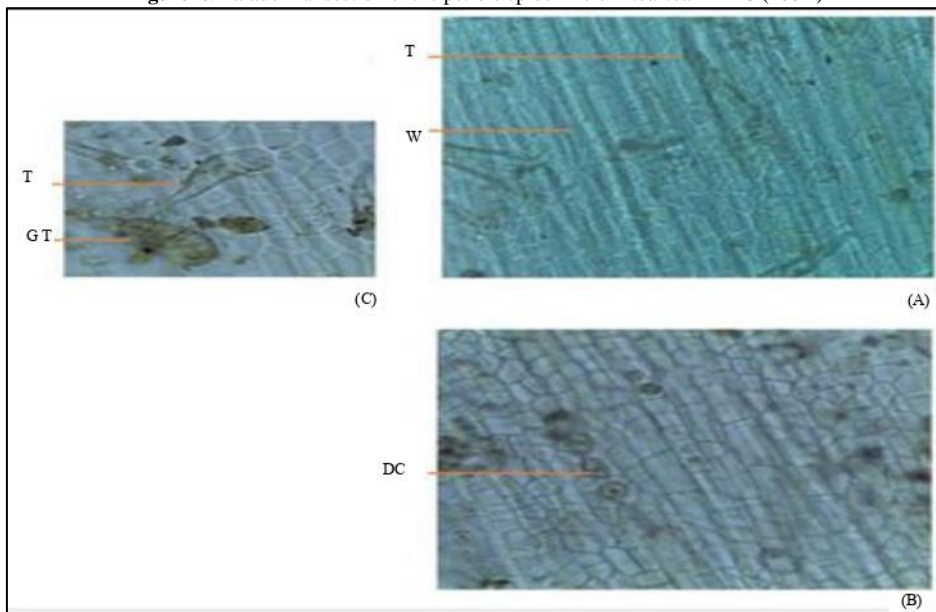
**Figure-4.** Paradermal section of the upper epidermis of *F.carica* leaf. between veins region: A - B - (400X)



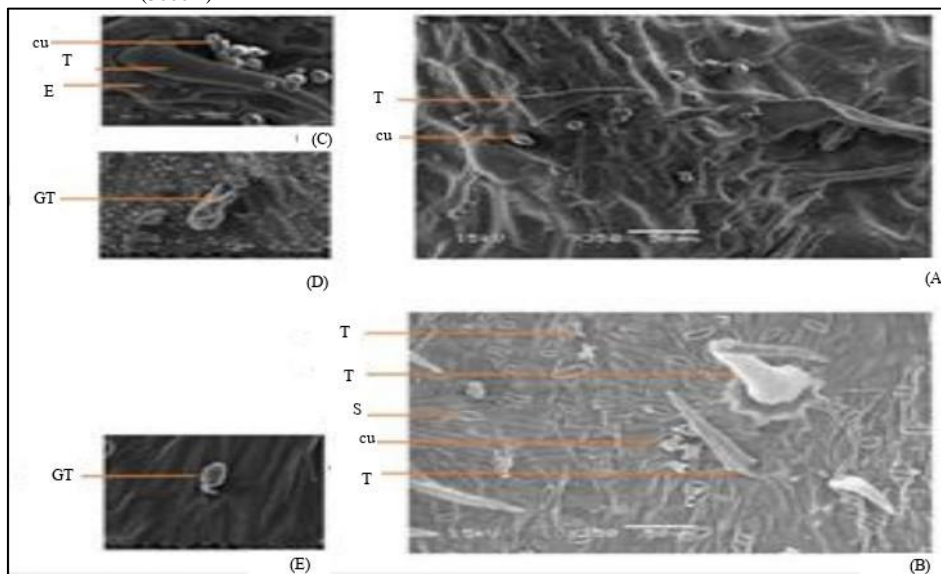
**Figure-5.** Paradermal section of the lower epidermis of *F.carica* leaf. between veins region: A - B - C - D - (400X)



**Figure-6.** Paradermal section of the petiole epidermis of *F.carica* A-B-C (400X)



**Figure-7.** Surface of *F.carica* leaf. between veins region by SEM: A – adaxial side (3500X), C - (8500X) D - (3000X), B - abaxial side (3500X), E - (3000X)



### 3.3. Internal Anatomical characteristics of the Leaf

The cross-section of the *F.carica* plant leaf as in [figure 9a](#) shows that leaves with a single blade with a main midrib have a small prominence from the adaxial and the large from the abaxial has one triangular central vascular bundle and a number of secondary side veins with smaller vascular bundle.

#### 3.3.1. Midrib region

**Upper epidermis :** Consisting of unicellular small cells, rectangular-shaped cells, with thin cellulosic wall, covered with a thin layer of cuticle as in [figure 9a](#)

**Basic tissue:** consisting of 3 - 10 layers of collenchyma cells with thickened angular cellulose walls, followed by 5 - 11 layers of thin cellulosic wall parenchyma cells and further expanding the center, containing the Laticifers as in [figure 9a](#).

**Vascular tissue:** consists of a separate ring of bicollateral bundles of phloem consisting of xylem fabric consisting of the columns of each column consisting of 2-5 of lignin xylem vessels and xylem parenchyma followed outside by cambium followed by phloem fabric to the outside consisting of sieve tube and companion cells and fiber with thin cellulose wall, and there Druses crystals.

**Lower epidermis:** Consisting of unicellular small cells, rectangular-shaped cells, with thin cellulosic wall, covered with a thin layer of cuticle as in [figure 9a](#)

#### 3.3.2. Between Veins region

**Upper epidermis:** Consisting of a unicellular large cells, rectangular-shaped cells, with thin cellulosic wall, covered with a thin layer of cuticle as in [figure 10a](#)

**Intermediate tissue:** consists of parenchymal cells with thin cellulosic wall and characterized by the palisade tissue that under upper epidermis and consists of 1-2 row of vertical-shaped cells containing many green plastics, and contains Druses crystals as in [figure 10a](#) The spongy tissue follows the palisade tissue and consists of irregular cells with large intersection distances and contains green plastics as in the figure (10b), the side vascular bundle consisting of xylem are spread upwards and surrounded by phloem from the bottom and phloem tissue extending to the upper and lower epidermis as in [figure 10b](#).

**Lower epidermis:** Consisting of a unicellular small cells, rectangular-shaped cells, with thin cellulosic wall, covered with a thin layer of cuticle, containing Lithocytes spindle-shaped cells extending to spongy tissue with as in [figure 10c](#).

### 3.4. Internal Anatomical characteristics of the petiole

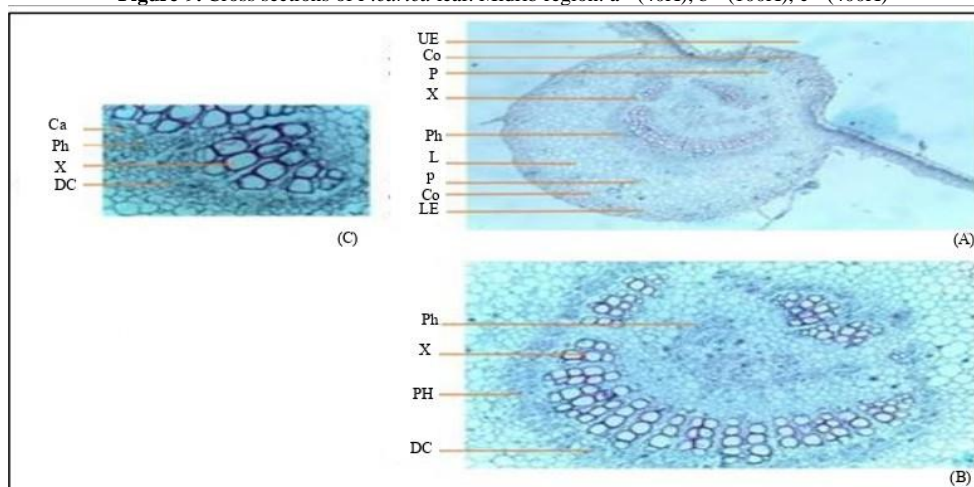
It is clear from the cross-section of the *F.carica* leaf petiole that the oval have one central vascular as in [figure 11a](#).

**Epidermis :** Consisting of unicellular small cells, rectangular-shaped cells, with thin cellulosic wall, covered with a thin layer of cuticle, as in [figure 11a](#).

**Basic tissue:** consisting of 7 - 8 layers of collenchyma cells with thickened angular cellulose walls, followed by 9 - 11 layers of parenchymal cells with thin wall that are expanding at the center, containing Laticifers and Druses crystals as in [figure 11a, c](#).

**Vascular tissue:** It consists of a separate ring of bicollateral bundles of phloem each package consisting of xylem consisting of the columns of each column consisting of 3-5 lignin xylem vessels and xylem parenchyma followed to the outside by cambium phloem fabric to the outside consisting of sieve tube and companion cells and fiber with thin cellulose wall as [figure 11b](#).

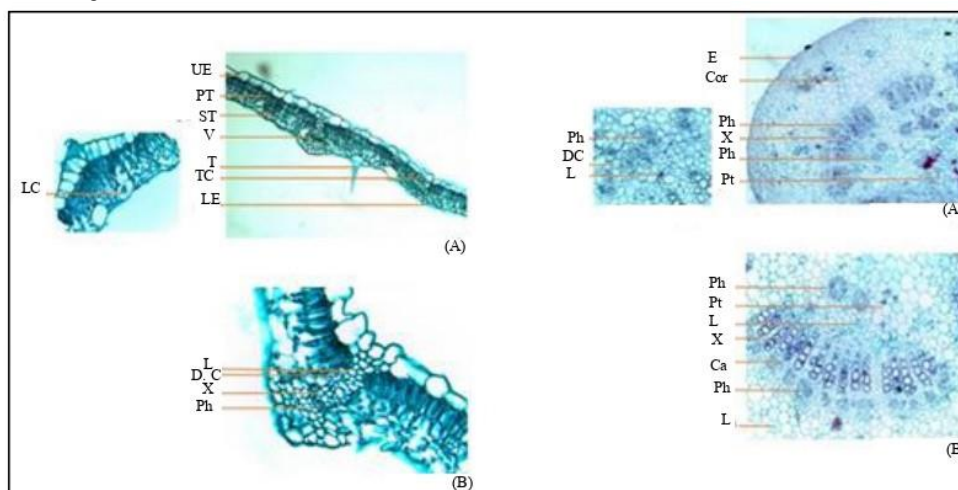
**Figure-9.** Cross sections of *F.carica* leaf. Midrib region: a - (40X), b - (100X), c - (400X)



**Figure-10.** Cross section of *F.carica* leaf between**Figure-11.** Cross section of *F.carica* petiole, A-

veins region, A-(100X), B-C-(400X)

(40X), B- (100X), C-(400X)



### 3.5. Ficus Religiosa External anatomical characteristics of the leaf

#### 3.5.1. Midrib region

**Upper epidermis:** *F.religiosa* plant epidermis is characterized by rectangular cells with thin and straight wall, cellulose, tap, cell dimensions between (10 - 30.25 - 50) micrometer length, between (12.50 - 17.75 - 25) Micrometer width, with Druses crystals as in figure 12a, the cuticle is rough, and wax deposits appear in the scanning electron microscope in the form of granules as in figure 14a.

**Lower epidermis:** *F.religiosa* plant epidermis is characterized by rectangular cells, with thin and straight wall, cellulose, tap, cell dimensions between (7.50 - 42.50 - 110) micrometers tall, and between (5 - 11 - 15) Micrometer incidental, with Druses crystals as in figure 12b, the cutical is rough, and wax deposits appear in the scanning electron microscope in the form of platelets as in figure 14b.

#### 3.5.2. Between veins region

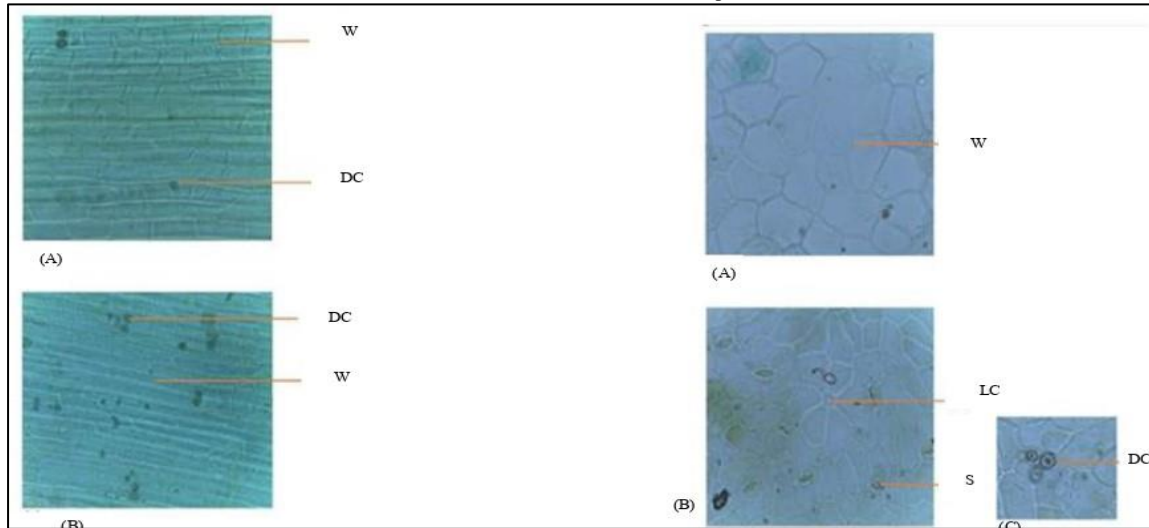
**Upper epidermis:** *F.religiosa* plant skin is characterized by ribbed cells, with thin and convex wall, cellulose, tap, cell dimensions between (27.50 - 53.50 - 60) micrometer length, between (25 - 35.50 - 50) micrometers width, as in the figure 13a, the cuticle is smooth, and wax deposits appears in the scanning electron microscope in the form of smooth, regular deposits as in figure 15a.

**Lower epidermis:** *F.religiosa* plant skin is characterized by ribbed cells, with thin and convex wall, cellulose, tap, cell dimensions between (25 - 40.75 - 55) micrometer length, and between (25 - 31.50 - 52.50) Micrometer width as in figure 13b, with oval-shaped stomata with kidney guard cells, scattered, individually, in the surface level of the epidermis, which are anomocytic stomata, ranging from the dimensions of the gaps between (27.50 - 28.50 - 30) micrometer length, between (22.50 - 25 - 27.50) micrometer width, while the number varies between (100 - 140.38 - 175) Loophole/millimeter 2 as in figure 13b, 15b, with radial-shaped epidermis cells surrounding the base of the Lithocys cystolith ranging from 4-7 cells as in figure 13b, with Druses crystals as in the figure 13c, the cuticle is smooth, and wax deposits appear in the scanning electron microscope in the form of platelets as in figure 15b.

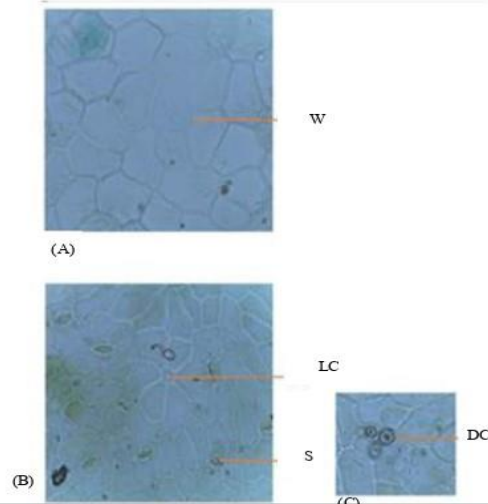
- External anatomical characteristics of the petiole**

The petiole epidermis of the *F.religiosa* plant is characterized by rectangular or ribbed cells, with thin and straight wall, cellulose, tap, cell dimensions between (27.50 - 61 - 112.50) micrometer length, between (17.50 - 26.25 - 37.50) micrometers incidentally, the cuticle is smooth, abundant in Druses crystals in pairs or single as in figure 16.

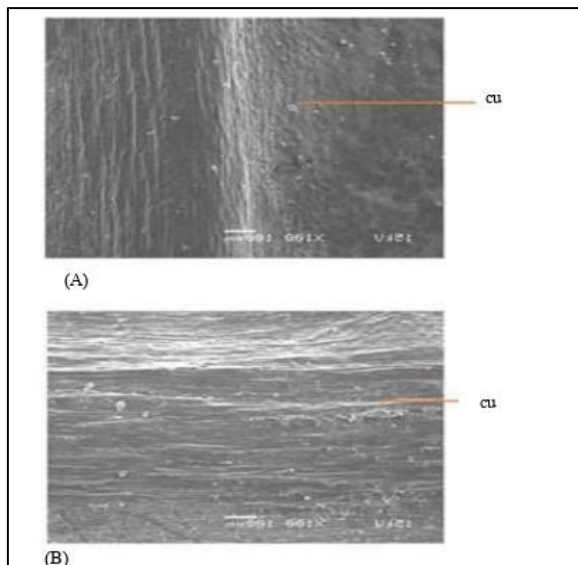
**Figure-12.** Paradermal section of *F. religiosa* leaf, Midrib region, A - the upper epidermis (400X), B - the lower epidermis (400X).



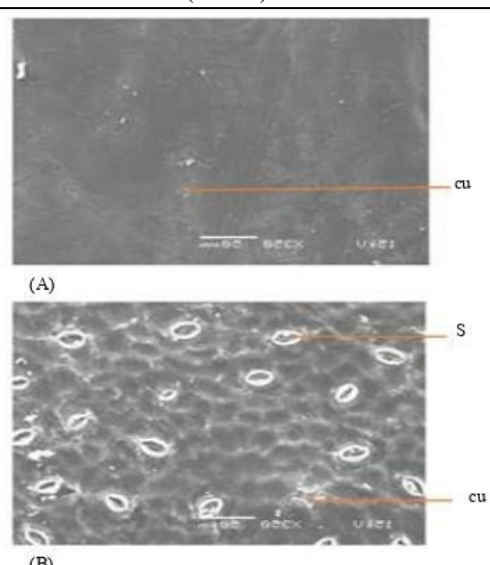
**Figure-13.** Paradermal section of *F. religiosa* leaf, between veins region, A - Upper epidermis (400X), B - C - Lower epidermis (400X).



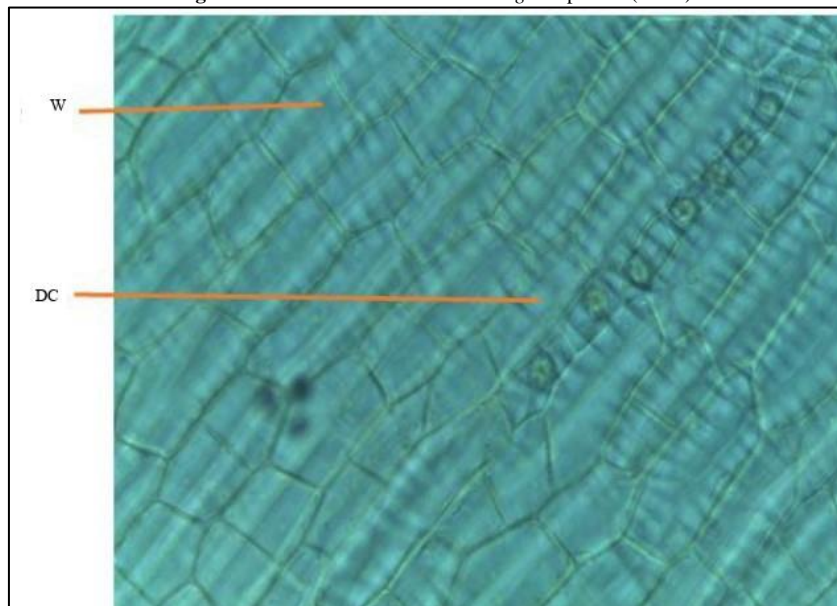
**Figure-14.** Surface of the midrib of *F. religiosa* leaf, by SEM, A - adaxial side (1000X), B- abaxial side(1000X).



**Figure -15.** Surface of the between the veins of *F. religiosa* leaf. by SEM, A- adaxial side (3500X), B – abaxial side (3500X).



**Figure-16.** Paradermal section of *F. religiosa* petiole (400X)



- **Internal anatomical characteristics of the leaf**

The cross-section of the *F. religiosa* plant leaf as in figure (17a) shows that the leaves with a flat blade and a main midrib flat on the adaxial and prominent on the abaxial, with a single round-shaped central vascular bundle, and a number of secondary side veins with smaller vascular bundle.

- A- midrib region**

**Upper epidermis:** Consisting of one row of small-sized rectangular cells, with thin cellulosic wall, covered with a thick layer of cuticle as in figure 17a.

**Basic tissue:** consisting of 2 - 4 layers of collenchyma cells with angular thickening, followed by 4 - 5 layers of parenchyma cells with thin cellulosic wall that are expanding center-wide, containing Laticifers as in figure 17a.

**Vascular tissue:** It consists of a separate ring of bicollateral bundles each package is made up of xylem fabric consisting of columns of each column consisting of 2-5 of lignin xylem vessels and xylem parenchyma followed outward by cambium, followed outward phloem tissue consisting of sieve tube, companion cells and phloem parenchyma with thin cellulosic wall has Solitary Crystals, surrounds the bundle from the outside part of lignin phloem fiber as in Figure 17b.

**Lower epidermis:** consists of a single row of large, rectangular-shaped cells, with thin cellulosic wall, covered with a thick layer of cuticle as in figure 17a.

- B- Between veins region**

**Upper epidermis:** Consisting of a single row of large, rectangular-shaped cells, with thin cellulosic wall, covered with a thick layer of cuticle as in figure 18a.

**Intermediate tissue:** Parenchyma cells with thin cellulosic wall are made up and characterized by a palisade tissue located beneath the upper epidermis, It contains many chloroplast, and spongy tissue following the palisade tissue consists of irregular cells with large intersection distances and contains chloroplast spread by side vascular bundle consisting of xylem vessels up and phloem down and surrounded by outside the phloem fiber as in figure 18b.

**Lower epidermis:** Consisting of one row of small, rectangular-shaped cells, with thin cellulosic wall, covered with a thin layer of cuticle as in figure 18a, containing Lithocytes extending to spongy tissue and with spherical Cystolith in figure 18a.

- **Internal anatomical characteristics of the petiole**

It is evident from the cross-section of the *F. religiosa* leaf that the petioles have a round shape with one round central vascular bundle as in figure 19a.

**Epidermis:** Consisting of one row of small, rectangular-shaped cells, with thin cellulosic wall, covered with a thick layer of cuticle as in figure 19a.

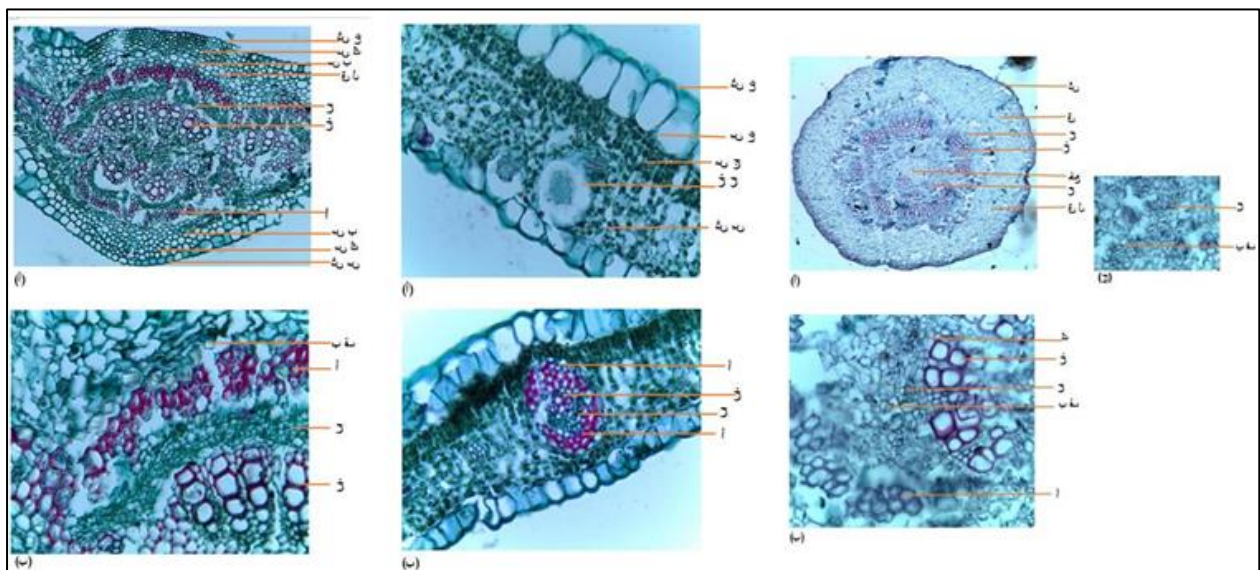
**Basic tissue:** 5 - 7 layers of collenchyma cells with angular thickness followed by 7 - 10 layers of parenchyma cells with thin cellulose wall that are expanding at the centre, containing for the Laticifers and Solitary crystals as in figure 19a, c

**Vascular tissue:** It consists of a separate ring of bicollateral bundles, each bundle consists of xylem to the inside consisting of columns, each column consists of 2-5 lignified xylem vessels and xylem parenchyma rays, followed by the cambium to the outside, and then the phloem tissue to the outside consisting of sieve tube, companion cells, and phloem parenchyma with thin cellulosic walls, and there are solitary crystals around it, and there are intermittent bands of fibers outside the phloem with lignin walls, as in Figure 19b.

**Figure-17.** Cross sections of *F. religiosa* leaf. Midrib region: a - (100X), b - (400X).

**Figure-18.** Cross sections of *F. religiosa* leaf, between veins region: a - b - (400X).

**Figure-19.** Cross sections of the petiole of *F. religiosa* plant: a - (40X), b - c - (400X).



### 3.6. *Ficus Elastica* Roxb

- **External anatomical characteristics of the leaf**

#### A - midrib region

**Upper epidermis:** *F.elastica* plant epidermis is characterized by rectangular cells with thin and straight wall, cellulose, tap, cell dimensions between (7.50 - 22.25 - 40) Micrometer Length, between (2.50 - 8.50 - 12.50) Micrometer accidentally, there are Druses crystals as in [figure 20a](#), the cuticle is rough, and the scanning electron microscope shows deposition of the wax in strips as in [figure 22a](#).

**Lower epidermis:** *F.elastica* plant skin is characterized by ribbed cells with low-thickness, straight, cellulose, tap (with elementary tap fields), cell dimensions between (10 - 20.50 - 30) micrometer length, between (2.50- 7 12.50) Micrometer width with Druses crystals as in [figure 20b](#), the cuticle is rough, and the scanning electron microscope shows deposits of wax in a platelets form as in [figure 22b](#).

#### B- Between midrib region

**Upper epidermis:** The epidermis of the *F.elastica* plant is characterized by rectangular cells, with thin and straight wall, cellulose, tap, cell dimensions between (20 - 23.83 - 27.50) micrometers long, and between (10 - 15.50 - 20) micrometers wide as in [figure 21a](#). The cuticle is smooth, and the scanning electron microscope shows regular deposits of wax as in [figure 23a](#)

**Lower epidermis:** *F.elastica* plant epidermis is characterized by rectangular cells with thin and straight wall, cellulose, tap, cell dimensions between (25 - 29.83 - 35) micrometer length, and between (15 -18.66 - 22.50) micrometers width as in [figure 21b](#), there are oval-shaped stomata with guard cells, scattered, individual, and sunken as in [figure 26d](#), an anomocytic stomata, the dimensions of the stomata range between (30 - 35.75 - 37.50) micrometer length, and between (30 - 35.25 - 37.50) micrometers incidentally, and between (150 - 203.57 - 225) stomata/millimeter 2 As in [figure 21](#), the cuticle is rough, and appears the scanning electron microscope shows wavy deposits of wax are abundant a around the stomata as in [figure 23b](#).

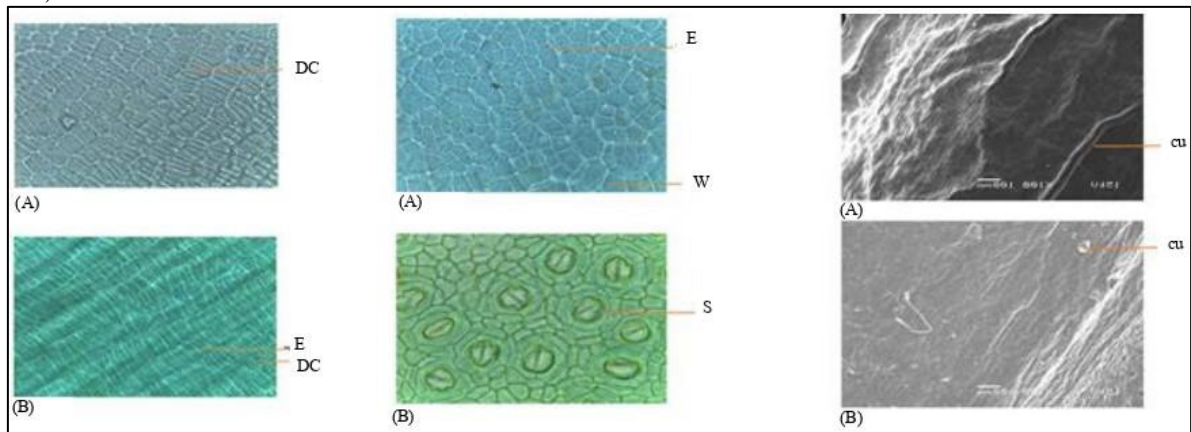
- **External anatomical characteristics of the petiole**

The petiole epidermis of the *F.elastica* plant is characterized by rectangular cells with thin and straight wall, cellulose, tap, cell dimensions between (12.50 - 26.75 - 42.50) micrometer length, and between (2.50 - 7 - 15) Micrometer accidentally, there are Druses Crystals and Solitary Crystals , rough cuticle as in [figure 24](#).

**Figure-20.** Paradermal section of *F.elastica* Roxb. leaf, Midrib region,A - the upper epidermis (400X), b-lower epidermis (400X).

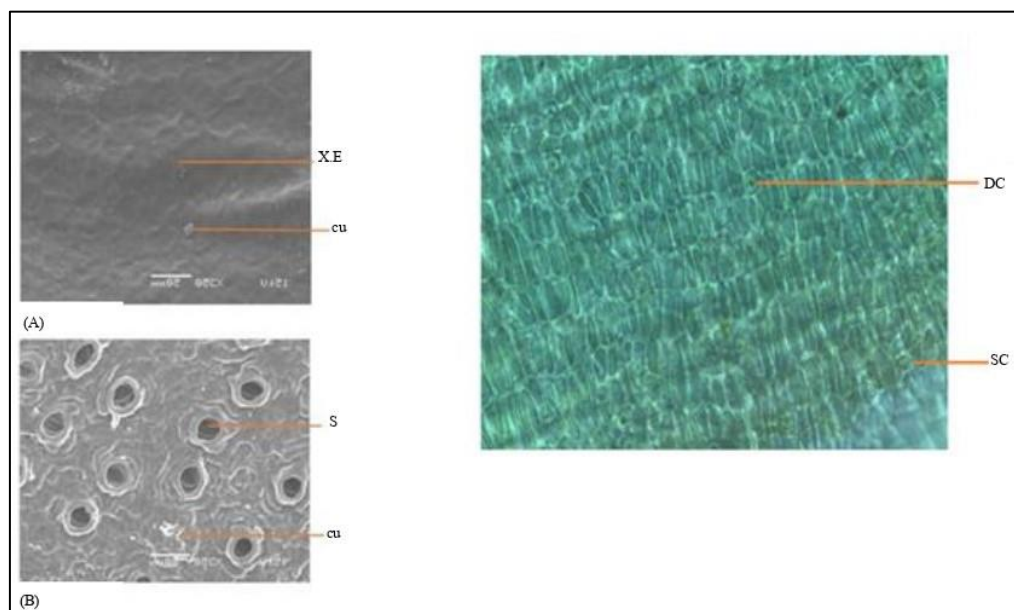
**Figure-21.** Paradermal section of *F.elastica* Roxb. leaf, between veins region.: A - Upper epidermis (400X), B - Lower epidermis (400X).

**Figure-22.** Surface of the midrib of *F.elastica* Roxb. leaf,by SEM, A - adaxial side.. (1000X).B – abaxial side.



**Figure-23.** Surface of the between veins of *F.elastica* Roxb. leaf, by SEM, A - the upper epidermis (3500X), B - the lower epidermis (3500X)

**Figure-24.** Paradermal section of *F.elastica* Roxb. leaf, petiole region. (400X).



- **Internal anatomical characteristics of the leaf.**

The cross-section of the *F.elastica* plant leaf as in figure 25a shows that the leaves with an open blade with a main midrib are flat from the top and have a visibility from the bottom with a single central oval-shaped vascular bundle and a number of side veins with smaller vascular bundle.

**A - Midrib region:**

**Upper epidermis:** Consisting of a single row of small-sized, rectangular-shaped cells, with thin cellulosic wall, covered with a very thick layer of cuticle followed inward by 1-4 layers of large-sized, rectangular multi epidermis , with Druses crystals as in figure 25a, c.

**Basic tissue:** consists of 4-8 layers of collenchyma cells with angular thickening, followed by 6-12 layers of parenchyma cells with thin cellulosic wall that are expanding on the center side, containing for the Laticifers as in figure 25a.

**Vascular tissue:** It consists of a separate ring of bicollateral consisting of columns each column consisting of 2-4 xylem vessels and xylem parenchyma beams followed to the outside by cambium and then phloem-to the outside consisting of sieve tube, accompanying cells and phloem parenchyma with thin and cellulose wall have Druses crystals and solitary crystals, and in the center it there is strap of phloem as in figure 25b, d

**Lower epidermis;** contains 1-3 row of small-sized, rectangular-shaped cells, with thin cellulose wall, covered with a very thick layer of cuticle as in figure 25a.

**B - between midribs region:**

**Upper epidermis:** consists of one row of small-sized, rectangular-shaped cells, with thin cellulosic wall, covered with a thick layer of cuticle followed inward by 2-4 rows of rectangular multi epidermis as in figure 26a, contains Lithocysts between multi epidermis with it cluster shape Cystolith as in figure 26b.

**Intermediate tissue:** consists of parenchyma cells with thin cellulose wall that characterize the palisade tissue located under the epidermis cells and consist of 1-2 cylindrical cells, containing many chloroplast, the spongy tissue follows the palisade tissue consists of irregular cells with large intersection distances and contains chloroplasts as in figure 26a, with side-vascular bundle consisting of xylem upward and phloem downward and with tannic cells as in figure 26c.

**Lower epidermis:** Consisting of one row of small-sized, rectangular-shaped cells, with thin cellulosic wall, covered with a thick layer of cuticle, followed by 2-3 large-sized, rectangular multi epidermis as in figure 26a, contains Lithocysts between multi epidermis, cluster shape Cystolith as in figure 26e.

- **Internal anatomical characteristics of the petiole**

It is clear from the cross-section of the *F.elastica* plant leaf that the oval petiole have one oval central vascular bundle as in figure 27a.

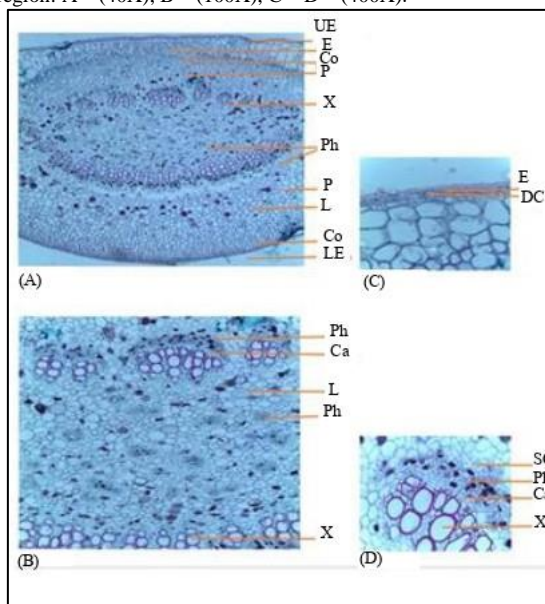
**Epidermis :** Consists of one row of small, rectangular-shaped cells, with thin cellulosic wall, covered with a very thick layer of cuticle and followed to the inside by 1-2 row of multi epidermis cells, with Druses crystals and Solitary crystals as in figure 27c.

**Basic tissue:** Consisting of 4 - 7 layers of collenchyma cells with angular thickening, cellulose wall , followed by 10 - 20 layers of parenchyma cells with thin cellulose wall, which are expanding on the centre, containing for the Laticifers as in figure 27a.

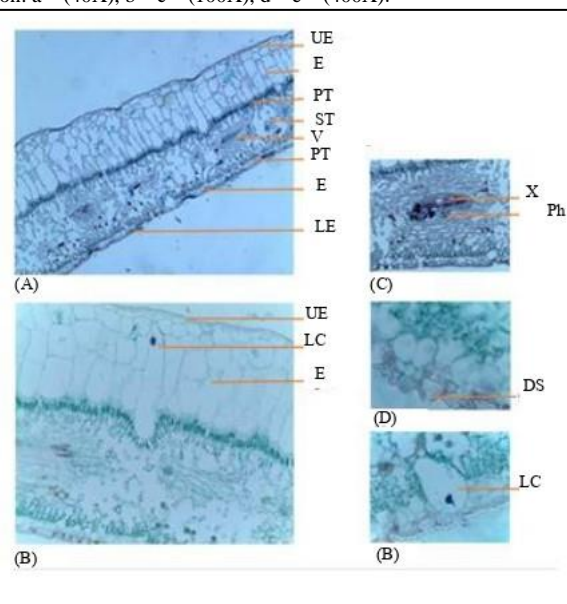
**Vascular tissue:** consists of a separate ring of bicollateral consisting of xylem tissue to the inside consisting of the columns of each column consisting of 2-4 of lignin xylem vessels and xylem parenchyma beams followed to the outside by cambium and then phloem tissue to the outside consisting of sieve tubes, accompanying cells and

parenchyma phloem with thin cellulose wall consisting of druses crystal, solitary crystals and Laticifer, and in the center it there is strap of phloem as in figure 25b.

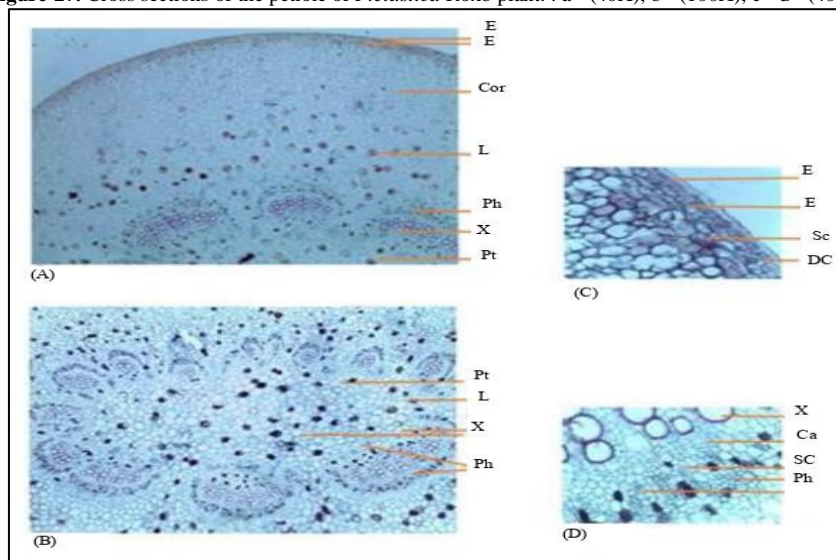
**Figure-25.** Cross sections of *F.elastica* Roxb leaf. Midrib region: A – (40X), B – (100X), C – D – (400X).



**Figure-26.** Cross sections of *F.elastica* Roxb leaf. Between veins region: a – (40X), b – c – (100X), d – e – (400X).



**Figure-27.** Cross sections of the petiole of *F.elastica* Roxb plant. : a - (40X), b - (100X), c - d - (400X)



## 4. Discussion

The plants under study were phenomenally characterized as perennial trees with aerial roots at the beginning of their lives with the exception of *F.carica*, a perennial bush with branching existing stems, simple leaves hugged, full-rim or frosted, flowers in Hypanthodium, moemory and feminine and sterile, and fruit is Syconium and poor seeds Achean. [12].

The results of the study of the external anatomical characteristics of species under study showed that the leaf is divided into a midrib region and between veins region, a middle midrib with ribbed or rectangular epidermis cells, with thin, straight cellulose wall, and an area between the midrib characterized as having ribbed epidermis cells, with straight cellulosic in the species *F.elastica*, or convex in species *F.carica*, *F.religiosa* and a thin thickness wall, these external characteristics of epidermis cell forms mentioned in previous research [13, 20-22].

The study of the scanning electron microscope showed that the epidermis in the midrib region had rough, sheets or granular-shaped, but the region between veins had smooth at the upper surface in the species *F.elastica*, *F.religiosa* and rough platelets or granular shape as in the type *F.carica*, and it was observed that wax deposition increased around the stomata cells. [14]

The petiole are characterized as having ribbed or rectangular cells, with straight cellulose, thin with rough cuticle in all species under study, this is consistent with mentioned in previous research [22-24]

The results of the study in all species under study also showed that oval stomata in the form of kidney-shaped guard cells are individually scattered in the lower skin in an area between veins and are in the surface level of the epidermis in type *F.carica*, *F.religoisa* and sunken with the surface level of the epidermis in type *F.elastica*. Stomata type Anomocytic guard cells in all species under study and this is consistent with [13, 14, 20, 22, 23, 25]

Research monitored [24, 26] Chantarasuwan et al., 2016 ; Shakir and Baji, 2016 Other types of stomata such as Anisocytic, Paracytic, actinocytic guard cells in fig species *Ficus L.*, *F. carica* showed the presence of large and small stomata side by side as in shape. These stomata were observed in other species belonging to this specie [22], where they were described as Giant stomata.

Trichoms in species under study were characterized as of two types of glandular trichoms and non glandular trichoms, the non glandular trichoms consist of two forms, first is unicellular, uniseriate, unbranched in leaves blade and petiole of *F. carica*, and second is unicellular, uniseriate, unbranched with bladder like base surrounded by rosette of epidermal cells consist by cystolith occur in abaxial epidermis of intercostal region of *F. carica*, glandular trichoms consist of stalk unicellular with multi cellular round head (4-8) occur in leaves blade and petiole of *F. carica*,

The results of the study also showed that all species under study contained many stone vesicle cells, a calcium carbonate excretion deposited from the epidermal cell wall into the cell cavity and later known as the Lithosyst. [27] was found on the lower and upper surface, while the *F. carica*, *F. religiosa* type was limited in the lower surface, and its shape in the surface view was characterized by its surroundings of radial epidermis cells [22, 25].

The species under study were characterized by the frequent presence and diversity of crystals. It was crystalline substances of calcium oxalate or carbonate take different geometric forms, including Druses in the epidermis of an area between the veins and the midrib in *F. religiosa*, *F. elastica*. Solitary crystals in *F. carica*, *F. elastica*, *F. religiosa*, v. starlight, this is consistent with [13, 22]; Shakir and Baji, 2016.

The results of the study of internal anatomical characteristics in the cross section of species under study also showed that the epidermis cells in the midrib region of the leaf blade consist of a single row of small rectangular cells barrel-shaped covered with thin cuticle in type *F. carica* and very thick in type *F. elastica* and the cuticle is thickened around the stomata to give prominent edges on the surface of the leaf and around the base of the trichoms. Type *F. elastica* is characterized by 1-4 layers of multi epidermis in the midrib area and this is consistent with Shakir and Baji, 2013; [14, 22].

The results of the study also demonstrated the internal anatomical characteristics of plant petiole under study in cross-section that the petiole of the species under study take the rounded, oval or rounded form of concave from the bottom side. The epidermis in the petiole consists of a single row of rectangular cells covered by thin cuticle in *F. carica* and thick in *F. religiosa*, The type is very thick in *F. elastica*, it is characterized by a 1-2 layer of multi epidermis, the basic tissue in the petiole is characterized by 4-10 layers of collenchyma tissue cells with angular thickness cellulose wall and followed by 3-10 layers of parenchyma tissue cells and with Latex. [28] The vascular tissue in the petiole consists of one round central bundle in *F. religiosa* and oval shape bundle in *F. carica*, *F. elastica*, the vascular bundle in the form of a separate ring of bicollateral where fibers appear outside the phloem and take the shape of a ring with straps of sclerenchyma cells intermittent in *F. religiosa*, we did not distinguish its presence in *F. elastica*, *F. carica* [22, 25].

## 5. Conclusion

This study indicates the similarity in the external and internal anatomical characteristics of the leaves (Blade and petiole) species under study, all of which were characterized by anatomical qualities representing the environmental adaptation of the city of Riyadh, which may help to classify into groups within the specie of fig *Ficus L.* (Multi epidermis, Laticifers, cystolith, Lithocyte different shapes, sizes and colors, druses and solitary crystals, bicollateral bundle, lactic ducts, tannin cells, palisade tissue plate number, characterizing the cuticle with platelets or granular shape motifs).

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