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USE OF LEAF ANATOMY FOR IDENTIFICATION OF *QUERCUS* L. SPECIES NATIVE TO KURDISTAN-IRAQ

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Abstract:

Anatomical features of the leaves of *Quercus* L. species are presented in this study for the first time. Leaves are bifacial and the palisade parenchyma of *Q. aegilops and Q. libani* is stratified into two layers, of nearly equal width, while that of *Q. infectoria* and *Q.macranthera* composed of only one layer. The cortex of both midrib and petiole is well developed with collenchyma starting just beneath the epidermis. The collenchyma of Q. *aegilops* is extremly thick compared with that of other species. Vascular bundles of the midrib and petiole are completely enclosed by the two pericycle layers of fibers and sclerenchyma. While the number of vascular bundles and sclerenchyma groups cupping them is 3 and 2 for midribs of *Q. aegilops* and *Q. libani* respectively, the number turns into 2 vascular elements of different appearance in their petioles. Petiole secondary vascular bundles are well developed and their sclerenchyma groups more lignified in *Q. infectoria* but less developed and reduced in *Q. macranthera*. From the results, it is concluded that the leaf blade and petiole anatomical features can provide diagnostic characters for distinguishing *Quercus* species of Iraq. Results also strongly support placing *Q. aegilops* and *Q. libani* in the section *Cerris* but *Q. infectoria* is more reliable in the section *Mesobalanus*.

Key words: *Quercus aegilops*; *Quercus libani*; *Quercus infectoria*; *Quercus macranthera*; Collenchyma; Sclerenchyma; Bifacial.

Introduction

Quercus species occur in the northern hemisphere in North America, Europe, Asia, and Africa (Axelrod, 1983), down to the Equator. Depending on the author's report, there are between 300 (Lawrence, 1951; Elias, 1971) and 600 (Soepadmo, 1972) oak species in the world. Recent counting of *Quercus* genus in America, Asia, and Europe amount to 320 to 354 species for the subgenus *Euquercus* and 76 species for the subgenus *Cyclobalanopsis* (Valencia, 2004; Menitsky, 2005; and Schwarz, 1964). According to Menitsky (2005), *Quercus* in western Asia grow in Iran and Iraq in the mountains of Zagros (*Q. brantii*, *Q.* libani) and Elbruz mountains in north Iran and southern coast of the Caspian Sea (*Q. castaneifolia*, *Q. macranthera*). European species namely *Q. petraea*, *Q. robur* and *Q. pubescens* extend in Caucasus where they meet western Asian species mainly *Q. macranthera*, and *Q. infectoria*. Lebanon and Palestine are regarded as the extreme Asian edge of the distribution of the widespread Iraqi species *Q. aegilops* and *Q. infectoria*.

Quercus grows in diverse habitats ranging from damp to relatively dry or desert, or from cool wet winter to hot dry summer, and from the sea level up to 4000 m. in the Himalaya Mountains (Wang, 1961; Menitsky, 2005).

Based on molecular analysis, the genus *Quercus* is estimated to have separated from *Castanea* about 60 million years ago (Hogan, 2012).

Because of the great number of *Quercus* taxa and its wide distribution and the frequent hybridization between members of the genus, taxonomists did not always agree for the method and characters used for classification of this genus (De Candolle, 1868; Nixon, 1993). Disagreements concentrate on the sub-genera and sections adopted, and species delineation. Moreover, due to the huge variation within species, Burger (1975) and Van Valen (1976) has suspected the concept of species in this genus.

Using numerical taxonomy, Peng *et al*. (2007) classified oak genus in China into different sections based only on qualitative and quantitative characters namely *Quercus aegilops*, *Brachylepides*, *Engleriana* and *Echinolepides*.

Mostly based on foliar and fruit characteristics, Camus (1936-1954) classified the genus *Quercus* (sensu lato) into two subgenera: subgenus Euquercus (Quercus sensu stricto) and subgenus Cyclobalanopsis, which exist only in South Asia. Moreover, Camus

(1936-1954) further divided the subgenus Euquercus (Quercus sensu stricto) into 6 different sections.

Recently, the genus *Quercus* is classified into subgenera *Quercus* and *Cyclobalanopsis* and the subgenus *Quercus* into5 sections (*Quercus*, *Mesobalanus*, *Cerris*, *Protobalanus*, *Lobatae*) on the basis of style length, acorns maturation period, acorn taste whether sweet or bitter, and the acorn inside shell whether hairy or glabrous. According to the later sub-division, species *Q. brantii* Lindl.-Persian oak (Synonym to *Q. aegilops* L. var. *brantii*), *Q. infectoria* Oliv.-Aleppo oak, and *Q. libana* Oliv. Lebanon oak belongs to the section *Cerris*, while *Q. macranthera* Fisch. et Mey. ex Hohen.-Caucasian oak to the section *Mesobalanus* (David,1987)

Four oak species in Kurdistan region-Iraq: *Quercus aegilops*, *Quercus libani*, *Quercus infectoria*, and *Quercus macranthera*. For Zohary (1973) the first 3 ones, are endemic to Kurdo-Zagrozian Mountains for these species exhibit large variability and extensive natural distribution in Kurdo zagros region while avoiding real Mediterranean climate.

Keys employed to separate between *Quercus* species using merely morphological characters has not been satisfactory and in some instances there is misidentification. Therefore, this study was planned to gain knowledge of the anatomical characteristics of *Quercus* leaf and use them in support of the morphological characters for identifying the Iraqi representative oak species.

Little is known about the anatomy of the oak leaf in Iraq. With the exception of the contribution of Shahbaz (1993) who investigated the leaf cuticular structure but not the leaf blade, midrib, and petiole cross section anatomy, no major contribution is to be observed as yet.

Material and Methods

The anatomical observations were based and carried out on 20 mature leaves from each species, collected from the Duhok and Erbil provinces during May 2015. Herbarium specimens made from trees used for anatomy investigation were deposited in the herbarium of the Faculty of Agriculture/University of Duhok (DPUH). The vegetal material was fixed in FAA (formalin: glacial acetic acid: alcohol 5:5:90). For the anatomical study, free-hand sections were made on the central parts of leaf blades and petioles. The cross sections samples were stained with Safranin and fast green (Al-Mukhtar, *et al*. 1982). Histological observations and micrographs were performed with Olympus CX2. Suitable images were photographed using Sony 18.2 mega pixel.

Results and Discussion

Leaf blade Anatomy

The range of leaf lamina thickness is 114.8-187.5 µm with the thickest in *Q. aegilops* and the thinnest in *Q. infectoria* (Table 1). The internal leaf structure of our native *Quercus* species shows both epidermises consist of single cell layer. As a mean value, the cuticle and the epidermal layer cells on the adaxial face is much thicker than the corresponding abaxial characters (Figure 1). The cuticle covering epidermis is relatively thick, especially on the adaxial face, but differences between species are insignificant from the stand point of taxonomic application. Leaves are bifacial with the mesophyll tissue clearly differentiated into palisade parenchyma cells and spongy parenchyma cells.

In *Q. aegilops and Q. libani*, the palisade parenchyma is stratified in to two layers, and contains many more chloroplasts than the spongy cells (Figure 1-A, B), while in *Q.infectoria and Q.acranthera* it consists of only one palisade layer (Figure 1-C, D). The first layer is longitudinal shape and in direct contact with the adaxial epidermal layer , arranged perpendicular to it, the second layer comes directly below the first one. While the first layer cells are densely packed leaving no or very few air spaces between cells, mainly because stomata are only confined to the abaxial epidermis (Shahbaz, 2010), the second layer cells are shorter and poorly arranged with more air spaces compared with the first one. The palisade parenchyma (both layers) of *Q. aegilops and Q. libani* are nearly equally thick (the ratio of approximately 1:1) and forming nearly half of the blade thickness (48.53, 49.03% respectively). The difference between species is mainly showed as a result of a thicker palisade parenchyma layer due to an additional second layer of cells. The spongy tissue is made of cells which are round, isodimetric, or irregular in shape, some are elongated and poorly arranged in 3-5 layers, with very wide lacunae or air spaces which increase rapidly towards the abaxial epidermis. Spongy layer width greatly differs between species, but the differences are insignificant in taxa delimitation because of high degree of data overlapping (Table 1). Using the average value for all species, the spongy parenchyma tissues are found to occupy a range of 31.91-36.98% of the total width of the leaf blade.

The secondary vein vascular bundles are interspersed in the mesophyl tissue, enclosed by bundle sheaths with their mechanical tissue of collenchyatic nature located under both epidermises.

The measurements presented in this study are comparable with those of Nikolić, *et al*. (2005) on *Q. robur* L. genotypes, and Ashton and Berlyn (1994) on sun leaves of *Q. velutina* Lam., *Q. rubra* L., and *Q. coccinea* Muenchh.

Leaf midrib Anatomy

Midribs of different species are subglobose or elliptic (*Q. aegilops*) in shape; usually the adaxial face is in the form of a hump, while the abaxial is a semicircle (Figure 2). Like the leaf blade, both the cuticle and the epidermal layers of the adaxial surfaces show greater thickness than the abaxial surfaces. A layer of collenchyma tissue starts beneath the epidermis of the midrib. Data presented in table (1) shows very thick collenchyma layer for *Q. aegilops* (45.5-58.5µm) which differs significantly from the collenchyma layers of the other species. Beneath the collenchyma, the parenchyma layer tissue of variable width starts; this layer in all cases is thicker in the abaxial face than the in adaxial one with the narrowest of all in *Q. aegilops*. Vascular bundles of the midrib are completely enclosed by the two pericycle layers of fibers and sclerenchyma. The outer layer constitutes more or less thick-walled fibers of 15.74 to 26.62 µm width; the fiber walls of *Q. aegilops* midrib and petiole is exceptionally thick. The part of Sclerenchyma facing the adaxial side is nearly straight or slightly convex but the part that facing the abaxial face is more or less convex in shape. One of the distinctive features of the midrib and petiole cross sections is the presence of secondary vascular tissue within the pith region of each species. In contrary to the primary vascular bundles, the phloem and the sclerenchyma cupping it is produced towards the abaxial face and not towards the adaxial face as in primary bundles (Figure 2, 3). The midrib secondary vascular tissue of *Q. aegilops* and *Q. libani* shows high similarity in appearance; both are born nearly at the center of the midrib, running parallel to the adaxial and abaxial strips of primary vascular bundles. The only difference between them is in the number of separate bundles and their Sclerenchyma, which are 3 in *Q. aegilops* and 2 in *Q. libani* (Figure 2-A, B). On the other hand, the secondary vascular tissue produced by *Q. infectoria* and *Q. macranthera* is quite different from vascular tissue of *Q. aegilops* and *Q. libani* in structure, shape and arrangement. In *Q. infectoria* the secondary vascular tissue is unique; its xylem is produced in direct contact to the xylem of the corresponding primary vascular bundle but with its sclerenchyma facing the abaxial side, thus forming what appears to be a single large characteristic bundle (Figure 2-C). In *Q. macranthera* the secondary vascular tissue is greatly reduced to a very small vascular tissue or merely to a small group of sclereids (Figure 2-D). The sclerenchyma tissue does not form a continuous layer but bands or strips directly cupping the vascular bundle and is usually separated by parenchymatous cells. These Sclerenchyma bands are prominent and well developed in any *Q. aegilops* midrib preparation, while appear to be poorly developed or lignified in other species.

The collateral vascular bundles of the midribs are arranged in elliptic or ovate forms with the long axis in the direction of the leaf blade.

Petiole Anatomy

The petiole is spherical (*Q. libana*, *Q. macranthera*) or semispherical (*Q. aegilops*, *Q. infectoria*) in cross section with two small wings which are prominent only in *Q. infectoria* (Figure 1-C). Both petioles and midribs of Oak species share similar major cells and tissues types. The cross sections through the petioles (Figure 3) also reveal a single layer of epidermal cells covered by a relatively thick layer of cuticle. The cortex is well developed and just inside the epidermis of the petiole lays the collenchyma layer which differs according to species. Like the midrib, the collenchyma petiole layer of *Q. aegilops* much exceeds that of other species in thickness (53.75-80.62 µm) (Table 1), thus providing a significant taxonomic tool for identification. Below the collenchyma there starts the layer of parenchyma tissue of varying width; in all species this layer is also wider towards the abaxial face where the physiological activity is more compared with adaxial face. Data indicate thicker petiole parenchyma layer for *Q. macranthera* (120-212.5 µm) and thinner for *Q. aegilops* (33.59-73.9 µm). Immediately below the cortex there also appears a more or less thick- walled fibrous layer. The *Q. aegilops* petiole has the thickest of this layer (75-132 µm). Sclerenchyma tissue adjacent to phloem and cupping the vascular tissue is well developed in oak, especially in *Q. aegilops* (Figure 3-A). The fibrous layer together with the sclerenchyma tissue offer structural support while still allowing for flexibility in the petiole.

The collateral vascular tissue is arranged in a semi-cylinder in the petiole forming an arc of vascular bundles on the abaxial side while flattening or slightly convexes towards the adaxial face (slightly depressed in *Q. aegilops*). While the number of vascular bundles and sclerenchyma groups cupping them is 3 and 2 for midribs of *Q. aegilops* and *Q. libani* respectively, in their petioles the number turns into 2 bundles or sclerenchyma of different sizes (Figure 3-A, B). Moreover, while the midrib secondary vascular tissue of *Q. infectoria* and to some extent of *Q. macranthera* is connected to the corresponding petiole primary vascular tissue with no tissue separating them becomes quite separated in their petioles (Figure 3-C, D). Anatomical features of the petiole primary vascular bundles exhibit high similarity between *Q. infectoria* and *Q. macranthera*, but differences are apparent in their secondary vascular bundles which are highly developed and their sclerenchyma groups more lignified in *Q. infectoria*, but more reduced and less lignified in *Q. macranthera*.

In general, there is always found thicker layers or strips and cells of collenchyma, fibers, and sclerenchyma towards the adaxial face compared to the abaxial face, providing maximum mechanical support for this side.

Results of leaf anatomical features strongly support placing *Q. aegilops* and *Q. libani* in the same section (section *Cerris*) but evidences are not in favour of placing *Q. infectoria* in the same section. The later species shows more similarity with *Q. macranthera* (in section *Mesobalanus*), not only in leaf anatomical features but also in leaf and acorn morphological characters and even in the shape of their gall produced by the same insects from the *Cynips* spp. (Maryam *et al*. 2012).

Druses and prism crystals are occasionally found in the leaf preparations of all the four species. Crystals occur in parenchymatous and collenchymatous cells and vessel elements, usually in blade mesophyll and midrib. More druses and fewer prisms are present in leaves of *Q. aegilops* and *Q. libani,* but more prisms and fewer druses in *Q. infectoria* and *Q. macranthera*; in all cases crystals do not form a common feature of the leaf anatomy.

All our oak species populations inhabit steep mountain slopes exposing them to warm sunlight during a long period of drought. For Townsend and Guest (1980) and Shahbaz (2010) the widespread species *Q. aegilops* occurs in low mountain elevations ranging less than 600 up to 1200m and it may cope very well with the dry warmer climate and low winter temperature. According to Dickison (2000), the plant organ that reacts most to the environmental factors, especially the amount of sunlight is the leaf. Therefore, some xeromorphic anatomical modifications are readily observed in leaf anatomy of our oak species; they produce relatively thick cuticle, strongly developed palisade tissue and hypostomaty. Furthermore, palisade tissue cells are elongated and narrow, mostly tightly packed. The presence of two layers of packed palisade cells, increased amount of sclerification, size and development of vascular tissue, and the very thick fiber layer surrounding the vascular bundles are xeromorphic features in *Q. aegilops* and *Q. libani* (Cao, 2000). Single palisade layer, reduced thickness of collenchyma and sclerenchyma layers, reduced vascular tissue size (*Q. macranthera*) are characters more indicative of adaptation to mesic conditions for both *Q. infectoria* and *Q. macranthera*.

According to the results anatomical features provide useful characters for distinguishing species of the genus.

Anatomical Key to the species:

1. Palisade parenchyma two layers -------------- 2

    2. Midrib number of sclerenchyma of secondary vascular bundles three and well-developed. Collenchyma layer: midrib up to 58.5 µm thick, petiole up to 80.62 µm thick. Petiole fibrous layer up to 132 µm thick ------------- *Q. aegilops*

    2. Midrib number of sclerenchyma of secondary vascular bundles two and poorly-developed. Collenchyma layer: midrib up to 32.4 µm thick, petiole up to 16.8 µm thick. Petiole

fibrous layer up to 67.2 µm thick ------------- *Q. libani*

1. Palisade parenchyma one layer -------------- 3

3. Petiole secondary vascular tissue and its cupped sclerenchyma strongly developed; petiole secondary vascular bundle up to 67.18 µm thick; petiole sclerenchyma of secondary bundle forms a continuous band of up to 94.06 µm thick ------------- *Q. infectoria*

3. Petiole secondary vascular tissue and its cupped sclerenchyma poorly developed and reduced: petiole secondary vascular bundle up to 53.75 µm thick; petiole sclerenchyma of secondary bundle not continuous and forms two separated groups of up to 64.5 µm thick ----------- *Q. macranthera*

Table (1): Cells and tissues measurements in cross section of leaf blade, midrib, and petiole, in µm.

Character	Statistics	*Quercus aegilops*	*Quercus libani*	*Quercus infectoria*	*Quercus macranthera*
Leaf blade cross section					
Leaf blade thickness	Mean	178.42	171.36	120.4	144.65
	Range	165-187.5	142.8-176.4	114.8-128.8	120-160
Upper cuticle thickness	Mean	4.83	5.39	3.58	4.0
	Range	2.5-7.5	3.6-7.0	2.8-4.2	2.5-5.0
Lower cuticle thickness	Mean	2.50	3.33	3.04	2.16
	Range	2.2-2.9	2.8-4.2	2.8-3.6	1.25-2.5
Upper epidermis thickness	Mean	11.66	17.54	14.74	15.33
	Range	10.0-15.0	14-22.4	8.4-19.6	12.5-17.5
lower epidermis thickness	Mean	8.33	11.38	6.4	6.16
	Range	7.5-10.0	8.4-16.8	5.6-8.4	5.0-7.5
Upper palisade layer height	Mean	49.8	49.93	57.12	63.5
	Range	47.5-54.3	47.6-54.4	47.6-71.6	47.5-72.5
Lower palisade layer height	Mean	36.8	34.1	--------	---------
	Range	32.5-40.0	28-39.2	--------	---------
Spongy parenchyma width	Mean	64.5	54.69	38.82	53.5
	Range	32.5-72.5	44.8-70.0	28.0-44.8	37.5-62.5
Midrib cross section					
Upper cuticle thickness	Mean	3.92	3.193	3.16	3.753
	Range	2.5-5.0	2.8-4.2	2.8-4.2	2.5-5
lower cuticle thickness	Mean	2.51	2.87	3.08	2.34
	Range	1.3-5	2.27-3.82	2.4-3.92	1.3-2.5
Upper epidermis thickness	Mean	9.66	12.32	9.893	12
	Range	7.5-12.5	8.4-16.8	5.6-16.8	10-15
Lower epidermis thickness	Mean	8.833	10.79	9.23	8.66
	Range	7.5-12.5	7.61-14.85	4.92-15.37	5-12.5
Collenchyma layer width	Mean	54.46	26.62	19.24	19.6
	Range	45.5-58.5	16.2-32.4	16.2-26.1	16.2-23.4
Parenchyma layer width	Mean	28.16	63.88	44.89	48.2
	Range	19.4-39	52.2-71.5	26.6-58.2	29-55.3
Fibrous layer width	Mean	32.03	27.26	34.12	32.24
	Range	26.62-39	15.74-32.51	26.2-42.23	26.3-39.4
pericycle Sclerenchyma width	Mean	26.66	39.92	19.88	26.1
	Range	12.5-32.5	28-56	12.8-28.2	21.2-36.5
Primary Vascular bundle width	Mean	49.83	65.0	44.77	44.41
	Range	39-65	52-78	26.4-71.5	26.4-65
Pith diameter	Mean	98.58	124.31	124.58	107.83
	Range	65-130	84.5-136.5	97.5-149.5	75-125

Secondary vascular bundle width	Mean	29.23	32.5	29.25	16.35
	Range	19.4-39.2	26-39	19.5-39	13-19.5
Sclerenchyma width of Secondary vascular bundle	Mean	21.12	28.17	13	32.166
	Range	13-32.5	19.5-32.5	6.5-19.5	25-47
Petiole cross section					
Upper cuticle thickness	Mean	4	5.53	6.35	4.83
	Range	2.5-5	2.8-7	5-8.4	2.5-7.5
Lower cuticle thickness	Mean	2.67	5.36	6.12	2.67
	Range	1.3-5	2.64-6.43	4.87-7.06	1.3-5
Upper epidermis thickness	Mean	8	14.74	11.38	10.33
	Range	5-10	11.2-19.6	8.4-14	7.5-12.5
lower epidermis thickness	Mean	6.33	12.79	10.95	10.33
	Range	5-10	9.86-19.23	7.66-14.8	7.5-12.5
Collenchyma layer width	Mean	65.84	15.3	12.29	31.24
	Range	53.75-80.62	14-16.8	8.4-14.8	20-50
Parenchyma layer width	Mean	47.60	161.25	123.2	176.01
	Range	33.59-73.9	134-188.13	94.06-174.69	120-212.5
Fibrous layer width	Mean	98.5	55.25	49.72	52.83
	Range	75-132	44.8-67.2	40.31-53.75	30-65
Pericycle Sclerenchyma width	Mean	50.25	43.46	53.49	46.41
	Range	30-70	39.2-47.6	44.4-61.6	40-55
Primary Vascular bundle width	Mean	76.66	98.56	86.8	86.16
	Range	32.5-100	92.4-103.6	78.4-95.2	57.5-117.5
Pith diameter	Mean	203.83	159	230.12	172.77
	Range	175-255	120-188.13	134.37-282.19	100-202.5
Secondary vascular bundle width	Mean	60.5	53.74	56.43	37.62
	Range	42.5-80	40.31-67.18	40.31-67.18	26.87-53.75
Sclerenchyma width of the secondary vascular bundle	Mean	53.0	43.67	75.02	51.87
	Range	42.5-62.5	33.59-53.75	53.75-94.06	40.31-64.5

The value in the table represent the mean of 25 observations for each quntitative character.

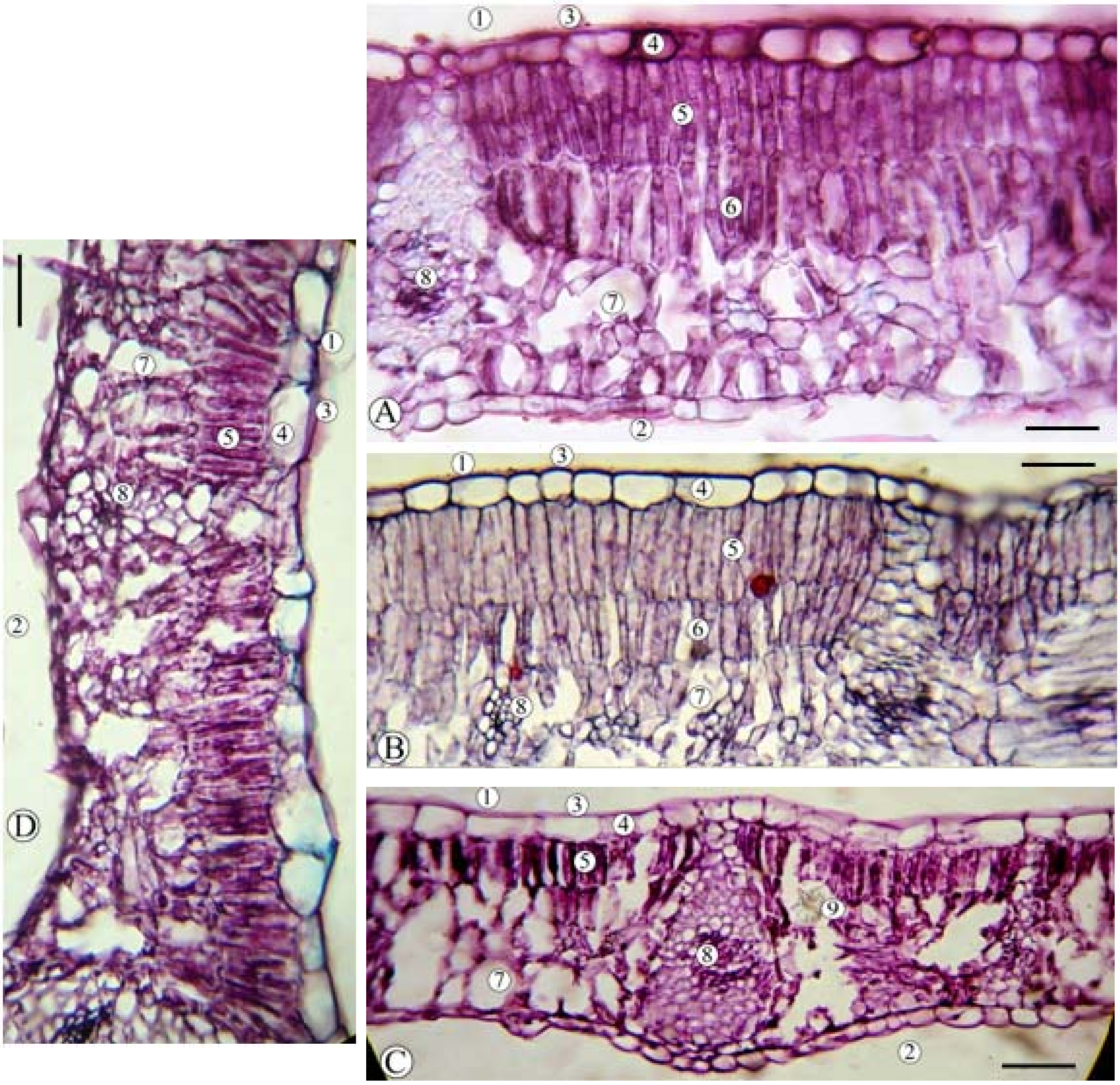

Figure (1): Cross section through the leaf blade of A. *Q. aegilops*, B. *Q. libana*, C. *Q. infectoria*, D. *Q. macranthera*: 1. Adaxial face, 2. Abaxial face, 3. Cuticle, 4.upper epidermis, 5. First palisade parenchyma layer, 6. Second palisade parenchyma layer, 7. Spongy parenchyma, 8. Vein, 9. Druses crystal. Bar = 34 µm.

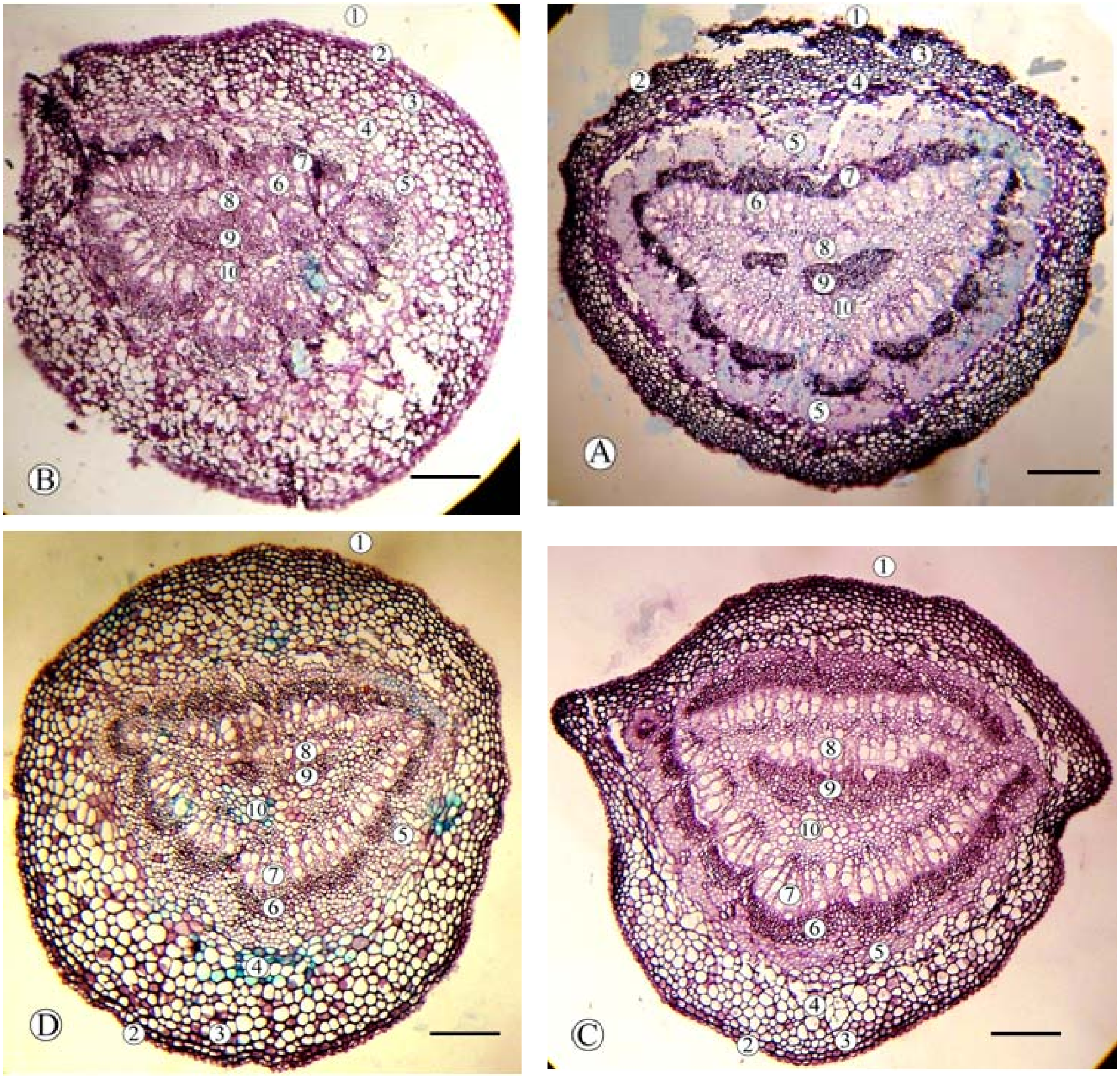

Figure (2): Cross section through the midrib. of A.*Q. aegilops*, B. *Q. libana*, C. *Q. infectoria*, D. *Q. macranthera*: 1. Adaxial face, 2. Epidermis, 3. Collenchyma, 4. Parenchyma of the cortex, 5. Fibrous strip, 6. Primary vascular tissue, 7. Sclerenchyma of the Primary vascular tissue, 8. Secondary vascular tissue, 9. Sclerenchyma of the secondary vascular tissue, 10. Pith. Bar = 62 µm

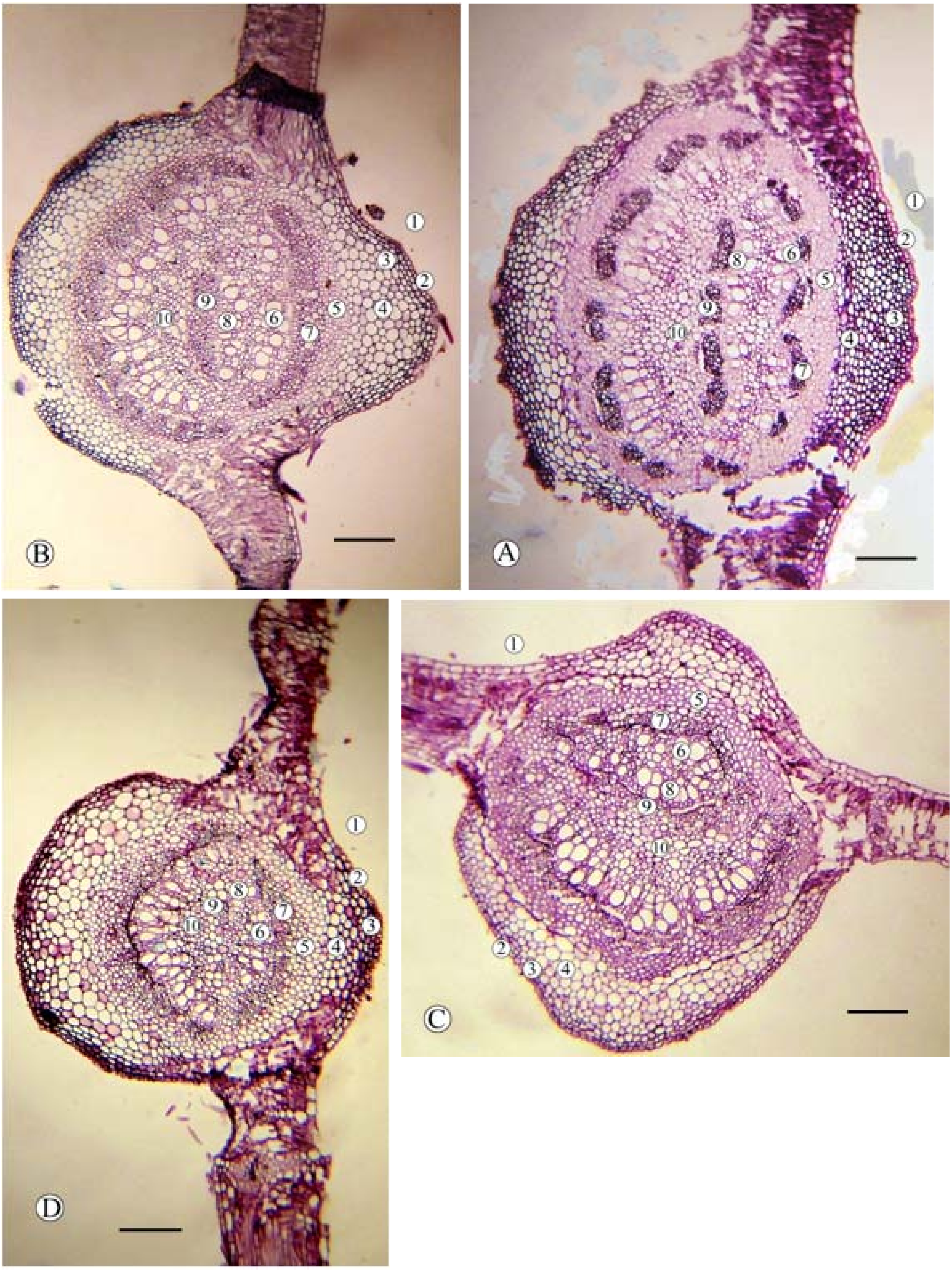

Figure (3): Cross section through the petiole of A. *Q. aegilops*, B. *Q. libana*, C. *Q. infectoria*, D. *Q. macranthera*: 1. Adaxial face, 2. Epidermis, 3. Collenchyma, 4. Parenchyma of the cortex, 5. Fibrous strip, 6. Primary vascular tissue, 7. Sclerenchyma of the Primary vascular tissue, 8. Secondary vascular tissue, 9. Sclerenchyma of the secondary vascular tissue, 10. Pith. Bar = 129 µm.

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أستخدام تشريح الورقة في تشخيص أنواع نبات البلوط *Quercus* L. المحلي في كورستان العراق

الخلاصة:

تعد هذه الدراسة هي الأولى في أستخدام الصفات التشريحية لأوراق نبات البلوط .لوحظ وجود وجهين للأوراق ذي نسيج برنكمي عمادي مؤلف من طبقتين في الأنواع *Q. aegilops and Q. libani* وبعرض متقارب فيما لوحظ تمايزه الى طبقة واحدة في النوعين *Q.infectoria and Q. macranthera* لوحظ تطور طبقة القشرة في كل من العرق الوسطي وسويق الورقة فضلا عن طبقة الكولنكيما التي تلت أسفل البشرة – طبقة الكولنكميا في النوع *Q.aegilops* سميكة بدرجة كبيرة مقارنة بالأنواع الأخرى . تحاط الحزم الوعائية في كل من العرق الوسطي والسويقة بطبقتي الدائرة المحيطة المؤلفة من الألياف والنسيج السكلرنكميا . أظهرت النتائج أيضا ان عدد الحزم الوعائية ومجاميع النسيج السكلرنكيما المغلفة لها قد بلغت 3 في العرق الوسطي للنوعين *Q. aegilops and Q. libani* بينما بلغت 2 وبأشكال مختلفة في سويقاتها . الحزم الوعائية الثانوية لسويقة الورقة أظهرت تطورا جيدا وذات مجاميع سكلرنكمية أكثر تلكننا في النوع *Q.infectoria* في حين كانت أقل تطورا ومختزلة في النوع*Q. macranthera* . ومن خلال النتائج يستنتج امكانية أستخدام الصفات التشريحية لكل من نصل الورقة وسويقها للتمييز بين أنواع البلوط في كوردستان العراق . وقد دعمت هذه النتيجة بقوة وضع *Q. aegilops and Q. liban* في قسم *Cerris* بينما النوع *Q.infectoria* يعد أكثر قبولا في القسم *Mesobalanus.*

بكارئينانا تويكاريا به لكى بو ده ست نيشان كرنا جوريت رووه كى *Quercus* L. ل هه ريما كوردستانا عيراقى.

بو يه كه م جار د فى ليكولينى هاته دياركرن رووخسارين تويكارى بو به لكين كه له ك جورين دارا *Quercus* L. .
به لكين ل جورين Q.aegilopsو Q.libani دارى ز دوو روويا بيك هاتيه و هه ر وه سا شانه ى ناوه راست ز دوو جينا بيك هاتيه ل سه ر يه كن،به لى با ل جورين ,Q.macrantheraو Q.infectoria ته نها ز يه ك جينى شانه ي بيك هاتيه.
له شانه ى بن تويز ل ناوجه ى ده مالاى ناوه راست له به لك دا و هه لكرى به لك شانه كه بيك هاتيه له شانيه كى كولنكيمي به ره سه ندى و ده ستبيكا فى شانى راسته وخو ل زير تويزى.
و شانه ى كولنكيمى ل جورى Q.aegilops كه له ك ستويره به راورد د كه ل جورين دى.
كورزى لوله ى له ناوجه ى ده مارى ناوه راست له به لك دا وه ناوجه ى هه لكرى به لك به شيوه يه كى ته واو هاتيه ربووشكرن به دوو جينين جيوه يى ز ريشالا كان وه شانه ى سكلرينكايما .
به لام زمارين كورزين لوله يى وه كروبين شانه ي سكلرينكايما له ناوجه ى ده مارى ناوه راستى به لك ز دوو ا بو جورى Q.libani وه سا بو Q.aegilops بيك هاتيه.
وه ئه ف زماره تيته كوهارتن بو دوو بيكاتيين جياوازين د شيوى بيك هاتين كورزه يى د هه لكرى به لكى دا.
هه ر وه سا جهى ئامه زه يه كو كورزين لوله زور به ره ساندوه وه شانه ي سكلرينكايما كه ى ته را ده كى زور مادى لكنين زورتره لهم جوره Q.infectoria له جورى Q.macrakthera .
ل ئه نجامين فى ليكولينى بو مه ديار بيه كو ب كارئينانا رووخسارين تويكارى ين روى به لكى وه هه لكرى به لك يبين دارى به رى دياره ب كار ئينانا فان رووخسارا د شين ب شيوه يه كى ئاسان دارا به رى ل ئيراقى جيا ب كه ين ز جورين دي ين دارين به رى ل جيهانى.
د ده ر ئه نجامدا ديار بيا بو مه كو بيتفيه جورين دارين Q.libani وه Q.aegilops بيته بولين كرنى د كه ل بشكا Cerris به لى با جورى دارا Q.infectoriaجالاكتره ل به شى .Mesobalanus