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Anatomical Characters in Three Oak Species (*Q. libani*, *Q. brantii* and *Q. infectoria*) from Iranian Zagros Mountains

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Abstract: Zagros Mountains have a rich variety of tree species. So the difference in wood structure and properties allow manufacturing of wood- based products with many different appearance and uses. Since wood is a popular and useful material, it is important for us to be able to distinguish the wood of one species from another. That is the reason why we studied anatomical features of *oak spp*.This paper provides information on how to identify the wood due to several common features as to *Quercus spp*. In other words the inter specific and intra specific variability of wood anatomy among the three major oak species: *Q. libani, Q. brantii and Q. infectoria* of Iranian mountains (Zagros) were evaluated.

Key words: Wood anatomy, Zagros Mountains, Wood structure, Inter specific & Intra specific, Variability.

INTRODUCTION

Scientifically rigorous accurate identifications require the wood to be sectioned and examined with a light microscope. With the light microscope even with only a 10X objective, many more features are available to use in making decision. Equally as important as the light microscope in wood identification, the reference Collection of correctly identified specimens is vital because unknown samples can be compared to it (Wheeler and Baas 1998).

Overall, wood anatomy indicates that growth and development of trees are dynamic Processes. All these aspects, which are commonly illustrated in two and three dimensions, (Wimmer .2002).

Microscopic wood anatomy is a scientific endure with a long, famous history. When microscopic wood identification is done properly, it also has a firm basis in science. In fact, species determination are empirical (straight from the anatomical characters, without assumptions) especially in *Quercus* genus .On the other side *Quercus* spp are large group of evergreen and deciduous trees and shrubs that are found in Europe (Schoch et al, 2004), Asia, northern Africa and North and South America.

To be more precise, the oak tree family includes as many as 600 species, found chiefly in north temperate zones and as wells in Polynesia. Oak is the wood for lumber: Oaks are as the major source of hardwood lumber and are durable. Furthermore Oaks are varied in their appearance, So it is hard to be classified,

Zagros: Geographic position

Zagros forests cover a vast area of Zagros mountain ranges stretching from Piranshahr (Western Azerbaijan Province) in the northwest of the country to the vicinity of Firoozabad (Fars Province) having an average length and width of 1,300 and 200 km, respectively (Ghazanfari et al 2004 and Erfanifard et al.2008). Classified as semi-arid, Zagros forests cover 5 million hectares and consist 40% of Iran's forests (Sabeti 2002 ,Sagheb -Talebi et al. 2003).

Zagros forests are one of the most important and sensitive ecosystems in Iran that are degraded because of various factors such as poverty, shortage of regional development opportunities, low literacy and high dependence of residents on forest resources for daily life (Pourhashemi *et al*. 2004). Because of this degradation and the influence of Zagros forests on water supply, soil conservation, climate change and socio-economical balance of the area (Sagheb-Talebi et al. 2003), conservation is the main aim of the Forest and

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Rangeland Organization (FRO) of Iran in these forests as one of the most important biologic Sources and genetic reservoirs of the country.

The central Zagros mountain globally is significant ecosystem species and genetic biodiversity. Actually extreme topographical relief and climatic condition have led to great diversity in ecosystems and habitats over small geographical areas. In turn, this has created a home for a vast range of species including over 2000 species of higher plants and several endangered and endemic mammal species.

As a matter of fact the Zagros region lies in the west part of Iran, stretching from close to the north-western border with Turkey, parallel to the border with Iraq down to the Persian gulf and stretching inwards the central desert of Iran. Basically, the Zagros ecosystem falls into the palaearatic realm.

In a quick view, the unique oak forests include three species of oak, one of which has two varieties (*Quercus brantii persica*, *Quercus brantii belangeri*, *Quercus infectoria*, *Quercus libani*). With a high genetic diversity e.g. 180 different kinds of acorn have been recorded in the area.

The forests of Zagros consist mainly of *Q. persica*, *Q. infectoria*, *Q. libani. In addition* the mountain forest steppe ecoregion supports oak- dominant deciduous forests .In fact Zagros Mountains forest steppe ecoregion is located primarily in Iran. Ranging northwest to southeast and roughly paralleling the country's western border.

The forest and steppe forest areas of the Zagros mountain range have a semi-arid temperate climate, with annual precipitation, from 400-800 mm. falling mostly in winter and spring as characterized by Zohary (1973). Actually, This forest consists mainly of deciduous, broad leaf trees with dominant species of *Quereus spp*.

MATERIAL AND METHODS

All wood samples in disk form had been taken take from Zagros Mountain and were available as dried sample in laboratory. This research was done between 2008 and 2009. The microscopic cellular structure of wood, including annual rings and rays, produces the characteristic grain patterns in different species of trees. The grain pattern is also determined by the plane in which the logs are cut at the saw mill. In transverse or cross sections, the annual rings appear like concentric bands, With rays extending out ward .Basically, Wood was cut longitudinally in two different planes: tangential and radial. tangential sections are made perpendicular to the rays and tangential to the annual rings and face of the log. A block of *Oak* wood shows the tangential plane (T) and the radial plane (R). In fact, The parallel lines on the radial side are annual rings. The blotches of cells at right angles to the annual rings are rays (ribbon like aggregations of cells extending radially through the xylem tissue). Cross section of a pair of oak bookends showing the prominent rays. they are composed of bands of thin-walled parenchyma cells that conduct nutrients and water laterally in a stem.

Because their walls are not heavily lignified like the surrounding xylem cells, ray cells disintegrate in dead wood and often result in radial splits in the wood. One notable comment about these bookends is that they are made of petrified oak Millions of years ago, the original cells in this trunk were completely replaced by minerals. this piece of oak has literally turned into stone.

Besides, all three planes of section are important to the proper observation of wood (Rowell .2005), and only by looking at each in turn can create a holistic and accurate understanding of the three-dimensional structure of wood. The three planes of section are Determined by the structure of wood.

Scientifically rigorous accurate identifications require that the wood be sectioned and examined with a light microscope. Also, with the light microscope even with only a 10X objective, many more features are available to use in determination. Equally as important as the light microscope in wood identification is the reference Collection of correctly identified specimens to which unknown samples can be Compared (Wheeler and Baas 1998). If a reference collection is not available , books of photomicrographs or books or journal articles with anatomical descriptions and dichotomous keys can be used (Schweingruber 2007). In addition to these resources, several computer-assisted wood identification packages are available and are suitable for every one with a robust wood anatomical background (Bowyer, 2003).

Systematic position
Quercus libani(Olivier)
Common name: Lebanon oak/ Family: Fagaceae
Range: W. Asia-Turkey, Iran, Iraq
Habitat = Zagros
Habitats and Possible Locations: Woodland, Canopy

Quercus infectoria (Olivier)
(Dyer's Oak, Nut-Galls)
Family : *Fagaceae*
Range: most abundant in Asia minor, and extended to middle Asia

Quercus brantii (Lindley)
Synonyms: *Querus persica* jaub & spach
Common Names: Brant's oak

Hierarchical Position of Genus *Quercus*
Regnum: Plantae (the plant kingadom)
Division: Angiospermophyta synomy/ Magnoliophyta Cronquist
Sub Division: *Magnoliophytina*
Class: *Rospsida*
Sub class: *Hamamelideae*
Superordo*: Juglandanae*
Order: *Fagales*
Family: *Fagaceae*
Subfamily: *Quercoideae*
Tribe: *Querceae*
Genus: *Quercus (Oak)*

Wood samples were prepared in form of disk from three species of *Querus spp.* and transferred to laboratory and cut in $2_* 2_*$ 2 cm dimension and before preparation for microscopic slides, the following process were done.

1. Softening: dry wood of *Querus spp* with average hardness was softened by immersion in slightly warm dilute water for 2-3 days.
2. Cutting wood samples in three section by microtome. By the way, all section presented in this paper. Cut with a Jung model microtome general were 14 for observing pore and vessel and ring pours. For the structure of ray wall in radial section with 16μ thicknesses and for tangential section were 16μ.

Staining Processes:
3- Immerse in javal water for 15-45 minute
4- Rinse once with water contains 2-3 drops acetic acid
5- Staining by safranin solution for 10 minute
6- Rinse once time with water.
7- Rinse 1-2 times with 50% alcohol.
8- Rinse once with 70% alcohol
9- Rinse once with 96% alcohol
10- Rinse once with 100% alcohol
11- Immerse in xylol few moment.
12- Mount in Canada balsam on slide microscope
13- Applying approximately 50 gr of pressure on the cover-slips and setting in 50-60 ºc oven for 24 hours
14- After 24 h, slides were studied by microscope.

Result:
Qualitative characters were determined by examining transverse and longitudinal Section by a light microscope (Fig 1-12). In fact, presence of a qualative character was scored as (*) for each species (Table 1) .Quantitative character was measured using a light microscope .Vessels were observed in transverse section at ×40 magnification, whereas rays and its structure and perforation plate were viewed in tangential longitudinal sections at × 40 or × 100 and perforation plate were viewed in radial section (Figs).Moreover, wood in three species were ring porous and growth ring boundaries were distinct and pattern of arrangement of vessel were radial in multiple with the except of *Q.brantii* that had solitary vessel in radial and angular. While, Perforation plates were simple and pits were vestured .Finally helical thickening in vessel observed.

Table 1: Anatomical and non Anatomical characters of three species of Quercus.

Name	Q.libani	Q.brantii	Q.infectoria
Growth rings			
1. Growth ring boundaries distinct	×	×	×
Vessels			
3. wood ring-Porous	×	×	×
Vessel arrangement			
7. Vessels in diagonal and/or radial pattern	×	×	×
Vessel groupings			
9. Vessels exclusively solitary (90% or more)	-	×	-
10. Vessels in radial multiples of 4 or more common	×		×
Solitary vessel outline			
12. Solitary vessel outline angular		×	
Perforation plates			
13. Simple perforation plates	×	×	×
Intervessel pits: arrangement and size			
22. Intervessel pits alternate	×	×	×
25. Small - 4-7 mm	6.22		
26.Medium 7-10 mm		8	7.6
28. Range of intervessel pit size	4_10	7_9	4_10
Vestured pits			
29. Vestured pits	×	×	×
Vessel - ray pitting			
31. ray pits with much reduced borders to apparently simple : pits rounded or angular	×	×	×
Helical thickenings			
37. Helical thickenings throughout body of vessel element	×	×	×
Tangential diameter of vessel Lumina			
Mean tangential diameter of vessel elements			
42. 100-200 mm	182.05		182.08
43. >200 mm		250	
44. Mean +/- Standard Deviation, Range. n=x	37 n=220	20 n=30	26 n=120
Vessels per square millimeter			
47. 5-20 vessels per square millimeter	11.68	15	16.91
51. Mean, +/- Standard Deviation, Range, n=x	2.2	2	1.2
Mean vessel element length			
54. > 800 mm	1615.5	2046	1578.5
55. Mean,+/- Standard Deviation, Range, n=x	94 n=220	50 n=30	54 n=120
Tyloses and deposits in vessels			
56. Tyloses common	×	×	×
Ground tissue fibres			
61. Fibres with simple to minutely bordered pits	×	×	×
65. Septate fibres present	×	×	×
Fibre wall thickness			
69. Fibres thin- to thick- walled	×	×	×
Mean fibre lengths			
71.-≤900	670.55		812
72. 900-1600 mm		1280	
74. Mean, +/- Standard Deviation, Range, n=x	50 n=220	100 n=100	35 n=120
Axial parenchyma			
77. Axial parenchyma diffuse- in aggregates	×	×	×
Axial parenchyma cell types/strand length			
93. Eight (5-8) cells per parenchyma strand	×	×	×
Ray width			
98. Larger rays commonly 4 to 10 seriate	×	×	×
99. Rays with multiseriate portion(s) as wide as uniseriate portions	×	×	×
Ray height			
102. Ray height >1mm	×	×	×
Rays of two distinct sizes	×	×	×
Rays: cellular composition			
104. All ray cells procumbent	×	×	×
Perforated ray cells			
112. Perforated ray cells	×	×	×
Rays per millimeter			
115. 4-12/mm	7	6	6
APENDIX- Non-anatomical information			
Geographical distribution			
168. Central South Asia (Brazier an Franklin region 75)	×	×	×

Table 1: Continue

Habit			
189. Tree	×	×	×
Wood of commercial importance			
192. Wood of commercial importance	×	×	×
Heartwood color			
197. Heartwood basically brown or shades of brown	×	×	×

Statistical Results:

Duncan**s** Multiple Range test and The ANOVA procedure for quantity measurement of the anatomical used characters. (Alpha = 0.05)

Table 2: : Duncan grouping in treatments

Duncan grouping	Mean	N	treat
		Intervessel pits	
A	8	30	2
A	7.4167	12	3
B	6.1818	22	1
		Mean fibre lengths	
A	1280.633	30	2
B	812	12	3
C	670.545	22	1
		Vessel per square millimeter	
A	16.4167	12	3
A	15	30	2
B	11.6818	22	1
		Tangential diameter of vessel Lumina	
A	249.933	30	2
B	182.083	12	3
B	182.045	22	1
		Rays per millimeter	
A	6.9091	22	1
B	6.0833	12	3
B	6	30	2

Treatment 1:Q.*libani* Treatment 2:*Q.branti* Ttreatment 3:*Q.infectoria* *

Table 3: Comparison Duncan grouping for above character

Species	Intervessel pits	Mean fibre lengths	Vessel per square millimeter	Tangential diameter of vessel Lumina	Rays per millimeter
Q.libani	B	C	B	B	A
Q.branti	A	A	A	A	B
Q.infectoria	A	B	A	B	B

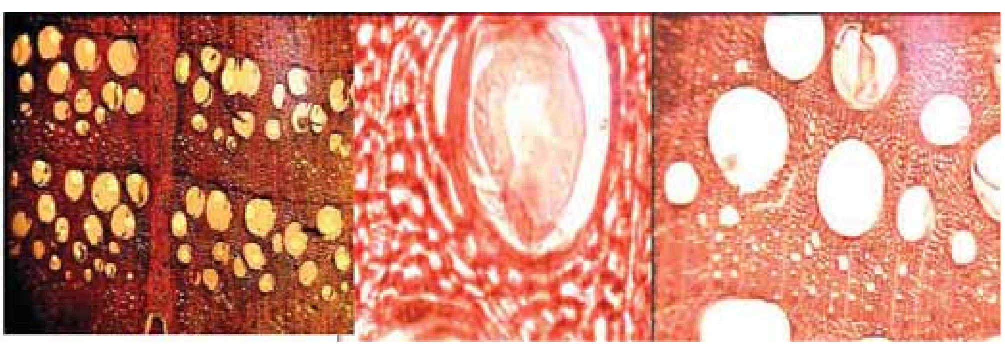

Fig. 1-3: Transverse section, tylose formation in vessels in *Q.infectoria.*

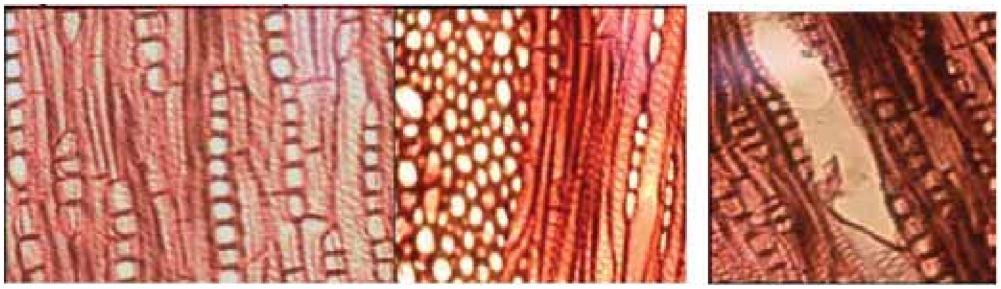

Fig. 4-5: Trangential section of ray Cells. Single-multi serate. Fig. 6: Vessel element in radial section *(Q.infectoria)*.

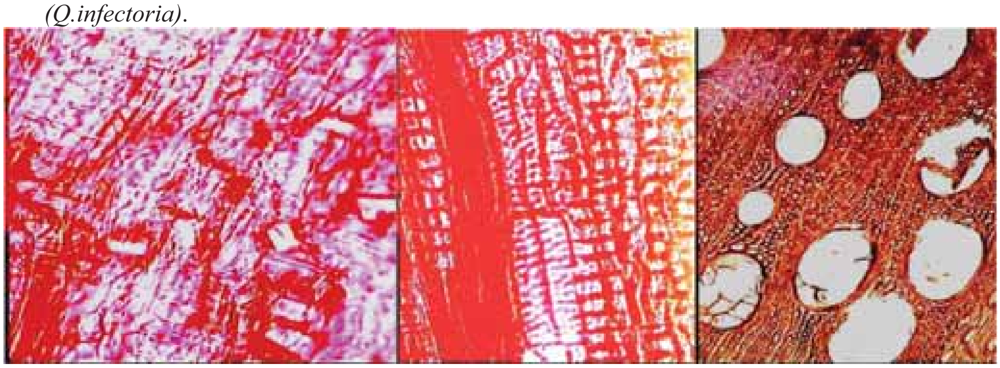

Fig. 7: Primatic crystals in ray cells. Fig. 8: sepatate fibre Fig. 9: vessel-ring porous wood (*Q.libani*).

Fig. 10: Ray cells, single-multi serrate. Fig. 11: rays and vessel with simple terminate plate. Fig. 12: ring porous woods and tylose in vessel in *Q.libani*.

Discussion:

Tables 1 listed anatomical and non-anatomical characteristic of three Iranian oak. The analysis of variance was summarized in table 2 ,3 .In fact the comparison of the characters showed significant difference in some character among the three studied oak. Despite some minor differences in wood anatomy, all of the three species are entirely within the range of wood anatomical variation of Quercus (qualitative character). for instance every three species have ring porous wood anatomy like other oaks. On the other side, ring porous anatomy allows sap movement in large diameter rapidly, early –wood vessels when soil water plentiful and slower, but sustained water movement in narrower late wood vessel which are more resistant to cavitations, during drought(Boura and De Franceschi , 2007 , yilmaz et al 2008)) .in Quercus brantii , Vessels are exclusively solitary, therefore its resistance seems to be low. Similarly yilmaz et al (2008) found significant correlation between soil variable and wood anatomical traits in *Q.pantica* .and suggested that wood anatomical features in tree-rings can be used as indicators of environmental changes.

Early wood vessels are a bit larger than that of late wood vessel and they do not continuous ring but constitute to radial and oblique serials towards the end of annual have rings.In fact perforation plate is simple .vessel- ray pits with reduced borders or apparently simple , rounded or angular or horizontal to vertical and tylose in vessel are present.

Thin walled liked the other quercus species, ray, both broad and narrow. Broad rays are very evident on both the tangential and cross sections and appear as a very conspicuous fleck on the radial surface like the other Quercus species.Here, porosity patterns has been weakly expressed. Ray width and height are very noticeable within in three species and even genus. Ray were uniserrate or biserrate,while uniserrate rays were abundant. However, lower numbers of multiserrate rays were observed in contrast the other oak species.

Bordered pit was also observed between vessel and parenchyma like in other fagaceae members .Inter vessel pitting and cavitations were seen as wheeler etal assayed in 2005 in Rosaceae and other vesselled plants and Holbrook et al in 2005 in vascular plants in general. However, in oak species simple pits were present between vessel and parenchyma were bigger than that of the simple pits of Apo-tracheal parenchyma. Nevertheless, detailed studies dealing with intra and inter specific variation In intervessel pit with respect to pit membrane remain scarce.

The vessels were considerable various in size, shape of perforation plates (simple, Scalariform) and structure of cell wall. In ring-porous species, the big vessels of the early wood provide enhanced sap conduction during the beginning of the growth season. These vessels are usually embolised before the growth stops. Little vessels, of less efficiency for sap conduction, provide conductive safety during the end of the growth season. Ring Porosity is thus considered as an adaptation to seasonal climates, providing the reversibility of vessel diameter and vessel density in a single season (Carliquest, 2001). Thus, initial wood provides conductive efficiency, final wood conductive safety. According to the IAWA Committee in 1989, the ring-porous wood was defined as a "wood in which the vessels in the early wood are distinctly larger than those in the latewood of the previous and of the same growth ring. So an abrupt Change in the size and density of vessels between early wood and latewood enables us to distinguish, In fact.

Conclusion:

This study confirms that *Q.branti* can be reliably distinguished from *Qlibani* and *Q.infectoria* due to solitary vessel and angular arrangement and fibre lenght.*Q.libani* in addition Q.infectoria were relatively similar specially in quality character. Therefore,anatomical character can be used as one of taxonomic means along with other environmental factors that affect internal character.

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