Tikrit Journal for Agricultural Sciences (2024) 24 (1): 105-129
DOI: https://doi.org/10.25130/tjas.24.1.10

ISSN:1813-1646 (Print); 2664-0597 (Online)
Tikrit Journal for Agricultural Sciences
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural

A comparative anatomical taxonomic study of the Species and cultivars of the genus *Juglans* L. growing in northern Iraq

Haees S. AL-Jowary* and Sharmeen A. AL-Zebari

Dept. Forestry Science, College of Agriculture and Forestry, University of Mosul

*Corresponding author: E-mail sharmeenzebari85@gmail.com

KEY WORDS:
wood anatomy, genus Juglans L. species

Received: 12/10/2022
Accepted: 06/12/2022
Available online: 31/03/2024

ABSTRACT
A comparative anatomical taxonomic study was conducted for (4) species and (8) cultivars belonging to the genus Juglans belonging to the family Juglandaceae, naturally grown and cultivated in northern Iraq, in (16) sites distributed over (5) governorates (Nineveh, Dohuk, Erbil, Halabja and Sulaymaniyah), These four species are (*Juglans regia* L., *J. microcarpa* Berl *J. australis* Gris .and *J. nigra* L) and the eight cultivars of the common walnut species *Juglans regia* L are(Denmarki, Afghani, clustered, lobed-3, Kirmashan1, Yahoodi Horaman1,and Horaman2) The study included two main aspects, namely the chemical separation of wood cells(Maceration), and the mechanical separation of wood cells using the Macrotom device. We found that the naturally grown species in northern Iraq, which is *J. regia* L., has long fibers compared to the other studied species, which gives it preference in wood industries, and due to the possession of trees of various species and cultivars of walnuts. Because the trees of species and cultivars of walnuts possess rather long container elements, they are suitable in various wood industries, and the results showed the variation of species and cultivars in the characteristic of the pitting type. Hence, it was found that this characteristic is of great importance in Identification the wood of the studied walnut species. With regard to the anatomical study of the mechanically separated wood cells, and after reviewing the research and sources, it was found that there is no anatomical and diagnostic study of the three aspects of wood (cross-section, tangential and radial) for species and cultivars of walnut at the level of the Iraqi country, as it is being conducted for the first time in it. The results also showed that the quantitative and qualitative characteristics of walnut trees growing in northern Iraq are of great diagnostic importance. Northern Iraq based on the evidence of Panshin and DeZeeuw (1980) to diagnose the wood of this studied species.

دراسة تصنيفية تشريحية مقارنة لأنواع واصناف جنس الجوز Juglans L. النامية في شمال العراق

هايس صايل جرجيس الجواري* , شرمين اسعد محمد طاهر الزيباري
***قسم علوم الغابات / كلية الزراعة والغابات / جامعة الموصل**

الخلاصة

أجريت الدراسة التصنيفية التشريحية المقارنة لـ (4) أنواع و (8) أصناف تنتمي إلى جنس الجوز Juglans التابع للعائلة الجوزية Juglandaceae نامية بشكل طبيعي ومزروعة في شمال العراق، في (16) موقعا موزعة على (5) محافظات هي (نينوى و دهوك وأربيل وحلبجة والسليمانية) ، وهذه الأنواع الأربعة هي (*Juglans regia* L. و *J. australis* Gris. Berl *J. microcarpa* و *J. nigra* L.) والأصناف الثمانية من أنواع الجوز الشائع *Juglans regia* L. هي (الدنماركي ، الأفغاني ، العنقودي ، ذو الثلاثة لفصوص، الايراني 1 ، اليهودي هورمان 1 ، وهورمان 2) اشتملت الدراسة على جانبين رئيسيين، وهما فصل خلايا الخشب كيميائيًا، والفصل الميكانيكي للخلايا الخشبية (باستخدام جهاز مايكروتوم.)، وتبين لنا أن الأنواع المزروعة طبيعيا في شمال العراق وهي J. regia L. لها ألياف طويلة مقارنة بالأنواع الأخرى المدروسة وهي مناسبة للصناعات الخشبية المختلفة وأظهرت النتائج تباين الأنواع والأصناف في الخصائص التشريحية وفي نوع التنقير. ومن هنا فقد وجد أن لهذه الخصائص أهمية كبيرة في التعرف على خشب أنواع الجوز المدروسة. فيما يتعلق بالدراسة التشريحية للخلايا الخشبية المفصولة ميكانيكيًا ، وبعد مراجعة الأبحاث والمصادر ، تبين أنه لا توجد دراسة تشريحية وتشخيصية للجوانب الثلاثة للخشب (المقطع العرضي ، العرضي والقطري) للأنواع والخشب أصناف في العراق، حيث تجرى فيه لأول مرة. كما أظهرت النتائج أن الخصائص الكمية والنوعية لخشب أشجار الجوز ذات أهمية تشخيصية كبيرة .

الكلمات المفتاحية: تشريح الخشب ، جنس الجوز، الأنواع

INTRODUCTION

The Juglandaceae belong to the order Juglandales and to the sub order Dicotyledonae, Angiospermeae, Department of Vascular Plants Tracheophyta. The sub kingdom of Embryophyta belongs to the Plantae kingdom .In view of the occurrence of similarities and similarities in the morphological characteristics of plants sometimes, these evidences may be supported by studying the anatomical characteristics and their relationship to classification; Modern taxonomy has proven that anatomical traits are on an equal footing in importance with other traits (Al-Jowary, 2017). It is also considered one of the most important criteria for the strength of wood. The mechanical strength of wood depends largely on the dimensions of the fibers (Domec and Gartner, 2002). The most important tissue components of wood are fibers, vessels, parenchymatous cells, and rays have often been reported. In the process of diagnosis and giving evidence of evolutionary trends (Al-Katib, 2000), the cells usually collect in the stems and branches of broad-leaved trees or the so-called hard wood in the form of vessel elements, fibers and rays, as vessels and fibers are the basic building block in hard wood) as well as the ray cells, so they have a great effect on the characteristics of wood (Kassir et al., 1985).Given the economic value of wood, and to enhance this great value, it is necessary to know its different properties and study them in detail, because of the great role they play in influencing its specifications in the areas of The various uses, as the various properties of wood such as anatomical, chemical, physical and structural are what determine its suitability for a particular use, any change that occurs in the properties of a wood will affect the Its uses such as drying, chemical treatments, and the manufacture of cellulosic pulp and paper, the mechanical strength of wood depends largely on the dimensions of the fibers (Domec and Gartner, 2002).

Wiedenhoeft (2010) Structure and Function of Wood stated that the function of fibers in hardwoods is mechanical support. The acceptable range of fiber wall thickness for hardwoods suitable for paper industry is between (3-7) µm, and the normal range of fiber diameter For hardwoods, it is between (20-40) µm(Atchison, 1987), while Panshin and Dezeeuw (1980) except for fibers whose diameters fall within the range (15-25) µm of medium diameter. The elements of the vessels mean the porous, and that is why the hardwoods are called the porous woods, which are overlapping tubular structures of indeterminate length that are connected internally in light of the perforation plate and sideways between one bowl and another in light of the bordered pits and the function of the conducting vessels, and the elements of the vessels are found only in Hard Wood, while Mono et al. (2017) emphasized that a difference in fiber length is desirable according to the purpose of its manufacture. Dalal Bashe (2022) used the anatomical characteristics separated by chemical and mechanical methods to diagnose hawthorn wood, *Crataegus azarolus* L. growing in Akrae district. These two methods gave important results in Identification the studied hawthorn wood. Outside Iraq, there have been several studies of some anatomical properties of walnut wood, including: Merev (1998) showed that the average length of the vessel element of the common walnut *Juglans regia* L. was (621.1)µm, and the rate of the bowl pit was (10.1 µm). The average length of the fiber was (1452.6) µm, while the average diameter was (29.6)µm, and the average thickness of the fiber wall was (4.6) µm, in good the number of rays / mm was (8.1). Yaman (2008) studied the effect of environmental factors on the anatomical characteristics of the common walnut *Juglans regia* L. in the western Black Sea region, including the diameter of the vessel in the tangential and transverse directions, and the number of vessels / mm^2, and it was found that the diameters of the vessel element in the tangential direction ranged between (114.0 - 152.8) µm and an average of (135.3) µm, in h The diameters in the radial direction ranged between (152.0 - 214.8) µm and an average of (177.1) µm, while the number of vessels/mm^2 was (9.1). The importance of this research can be summarized in the following points, identification the species and cultivars of the genus *Juglans* L. growing in northern Iraq using anatomical characteristics. Setting an anatomical diagnostic key for the studied walnut species and wood species. Determining the suitability of the studied species and cultivars of walnuts in the pulp and paper industry. Shedding light on the anatomical characteristics of the studied species and cultivars of walnuts.

In the absence of any local taxonomic study in Iraq for these species, it was necessary to conduct this study on the species of the genus that are naturally widespread in the north of our country, in the light of shedding light on the anatomical properties of these species.

MATERIALS AND METHODS

Anatomical features include: two basic aspects:

1- Chemical dissection of wood Maceration.
2- Mechanical dissection of wood using a rotary (Macrotom).

Chemically dissecting wood (separating the cells chemically):

This method is called maceration. By taking samples at diameter breast height (d.b.h) for the stem of the studied trees, where all samples are taken from the same interface from the north side of trees at (d.b.h) For the stem according to the method mentioned by Schweingruber (2007) and followed by (Yaman, 2008, Al Jowary (2017) and Dalal Bashe, 2022). The method of (Franklin, 1945) and (EL-Juhany, 2011) were used to separate the wood cells and obtain single cells. How to install cells: The separated cells are fixed on temporary slides using a clean steel bar and without a cap to prevent any distortion of the separated cells dimensions (Adamopoulos and Volgaridis, 2002). As for the anatomical characteristics that were studied in the light of chemical anatomy, they are:(vessel length (mm), vessel diameter (mm), vessel wall thickness (mm), number of vessels/mm^2, type of perforation plate, perforation plate length, plated perforation diameter, Types of pits between vessels, type of wall thickenings (lamellar, reticular, pits or spirals), presence or absence of tyloses and chalk deposits, distribution of laminated pits, fiber length, fiber diameter).

Second: Mechanical dissection of wood: Preparation of microscopic wood sections:

Fourteen trees were selected for all study sites, by sampling at (d.b.h) for the stems of the studied trees. It was cut into cubes with dimensions (1 x 1 x 2) cm. The samples were softening by boiling them in distilled water until they dipped under their own weight. Then microscopic slides with a thickness of (15-20) (µm) were made for the three sections (transverse, tangential longitudinal, radial longitudinal) using a rotating microtome (microscope) (Yaman, 2007). An advanced Motic Image plus2 type equipped with a camera and connected to a laptop. It takes (25) readings or measurements, and studies the properties of the three sides of wood (transverse, tangential and radial). The work was carried out in the laboratory of wood sciences in the Department of Forestry / College of Agriculture and Forestry. As for the mechanical anatomical characteristics (the three sections of the wood faces) they are (number of ray cells in height/mm^2, height of rays in the tangential face, number of rows of rays cells in the tangential face, height of transverse ray cells, type of vessels (porous), types of wood rays (homogeneous or heterogeneous), number of rows of ray cells (Uniseriate, Biseriate, larger ray seriate), types of parenchyma cells (Strand parenchyma) used to diagnose hardwoods.

Figure (1) shows the method of taking samples for the anatomical study at chest height (d.b.h) for the walnut trees under study.

Figure (1) The method of taking wood sample from the tree at (d.b.h.).

Table (1) Study sites and Spread ratio of the studied species and cultivars of *Juglans* L. growing in northern Iraq.

.species and cultivars of *Juglans* L												الموقع		
J. regia Horaman2	*J. regia* Horaman1	*J. regia* Yahoodi	*J. regia* Kirmashan1	*J. regia* 3-lobed	*J. regia* clustered	*J. regia* Afghanii	*J. microcarpa*	*J. regia* Denmarki	*J. australis*	*J. nigra*	*J. regia*			
Spread ratio %6.25	Spread ratio %6.25	Spread ratio %25	Spread ratio %12.50	Spread ratio %12.50	Spread ratio %25	Spread ratio %6.25	Spread ratio %6.25	Spread ratio %6.25	Spread ratio %12.50	Spread ratio % 6.25	Spread ratio %100			
											+	(1) Kani Mase	Dohuk, governorates	1
											+	(2) Diz-o Baidila		
		+									+	(3) upper Beydod		
		+									+	(4) Lower Bedol		
											+	(1) Akrae Center	Nineveh Governorates	2
				+							+	(2) Akrae Shoosh		
		+							+		+	(3) Akrae Khorki		
					+			+			+	(4) Akre Dinarta- Center		
				+		+	+				+	Akre Hechtek (5) (Dinarta)		
									+		+	(1) Erbil Shaqlawa	Erbil Governorates	3
											+	(2) Erbil Wadi Tiran		
			+		+						+	(3) Erbil Malakan		
					+						+	Sulaymaniyah,1 Sit Ka	Sulaymaniyah Governorates	4
										+	+	2 Sulaymaniyah Serjnar		
					+						+	(3) Sulaymaniyah Qara Dagh		
+	+	+	+								+	Halabja Horaman	Halabja Governorates	5

RESULTS AND DISCUSSION

The anatomical study included two main aspects:
Anatomical study of chemically separated wood cells Maceration

- Fibers length

The results of table (2) and Figure (1 and 2) showed a noticeable discrepancy between the species and cultivars of walnut studied in the rates of fiber length and vessel elements. With regard to the species, it was found that the black walnut *J. nigra* L. fibers are shorter than those of the regular walnut *J. regia* L., The average length of the fibers for them reached (0.750 and 0.848) mm, respectively, and it was noted that the fibers of ordinary walnuts in the Kani Mase area located on the Turkish border, which recorded the lowest fiber length for this species, which reached (0.548) mm, and the reason for this may be attributed to the significant decrease at temperatures in this region, which works to delay growth, the other two species are *J. microcarpa* Berl. And *J. australis* Gris, the average length of the fibers in them reached (0.513 and 0.610) mm, respectively, and thus it became clear to us that the naturally growing species in northern Iraq, which is the ordinary walnut *J. regia* L., has long fibers compared to the fibers of the other studied species, and this characteristic gives This species has an advantage in wood industries compared to other species of walnuts studied. The longer the fibers, the more they are preferred in the wood industries as a result of their positive effect on the mechanical properties of wood, and in the paper industry (Kassir et al., 1985 and Dalal Bashe, 2022) .

The *J. regia* cultivars also varied in fiber length, and this helped isolate those cultivars from each other in light of their fiber lengths. As shown in Table (2). Thus, the species were isolated from each other; The Yahoodi cultivars was distinguished by the longest fiber, which reached (1.173) mm, while the cluster cultivars was distinguished by the shortest fiber, with an average of (0.868) mm. It was also found from the results of the study that trees have an effect within the same species, due to the influence of genetic factors on the length of cells (1000 - 2000) µm (Al-Sharefy, 2020), as well as the results of the study of Wani and Amina (2013) for the common walnut *J. regia* L. in India, where the average length of the fiber was (1108.67) µm. These results also agreed with what Wiedenhoeft (2010) mentioned that the length of the fiber ranges between (0.2 - 1.2 mm) As for Iraq, these results are close to what was reached by Abd al-Qadir et al (2016), as they found that the length of the fiber of the ordinary walnut growing in Dohuk governorate was (1.585 mm) In terms of locations, it had no effect. In fiber length, and that there is no significant effect of locations in the fiber length characteristic, but there is a clear difference and influence of the species factor in this trait.(Anthonio and Antwi, 2017, Al-Mashhadani, 2020 , AL-Sharefy, 2020, and Dalal Bashe, 2022) indicated that the increase in the length of the fibers It has a positive effect on the mechanical properties of wood and these qualities are related to the arrangement a direct link to the industrial benefit of wood.

-Walnut Wood Fiber Diameter: Fibers diameter

The results of Table (2) show a noticeable discrepancy between the studied species and cultivars in the character of the fiber diameter. With regard to the species, they showed a discrepancy between them, in particular between the two species, black walnut and regular walnut. The regular walnut was distinguished by a larger diameter compared to the black walnut, so the average fiber diameter reached For ordinary walnuts (31.054 (µm)), while the average diameter of the black walnut fibers was (16.999 (µm)), while the diameters of the fibers of the two species were *J. microcarpa* Berl. and *J. australis* Gris. Their average was (34,462 and 21.404) (µm), respectively. From the results it was found that the type *J. microcarpa* Berl. It was distinguished by the largest fiber diameter compared to the other studied species.

As for the regular walnut cultivars, they also differed in the fiber diameter characteristic. The Iranian cultivars Kirmashan1 was distinguished by the lowest average fiber diameter, which reached (21.332) (µm). The largest average of the fiber diameter of the studied cultivars was distinguished by the 3-lobed cultivars , which averaged (51.342) (µm), and with this result, the species and cultivars were isolated from each other in light of the variation in the diameter of the fiber. These results came with high values compared to the results of the study of Wani and Amina (2013) for regular walnuts *J. regia* L. in India; The average fiber diameter was (23.66) (µm); While in this study it reached (31.054) (µm). The reason may be due to the availability of suitable environmental conditions for the growth of this natural species in Iraq; While these results were consistent with the study of Abd al-Qadir et al. (2016), who found that the average fiber diameter of an ordinary walnut grown in the Dohuk governorate in northern Iraq was (34,000) (µm), and it also agreed with the results of Merev (1998), where the average fiber diameter was For the common walnut grown in the Black Sea region of Turkey (29.6) (µm). The reason for this discrepancy may be attributed to genetic factors, or as a result of the surrounding environmental conditions and their effect on the diameter of the fiber, which in turn is affected by the diameter of the crown, and this was confirmed by Kiaei et al. (2013). The researcher Larson (1973) stated that the diameter of the fiber and the diameter of the vessel may develop with the development of the crown of the tree with age, and this is due to the increase in the production of the hormone IAA with an increase in the size of the crown, and thus leads to an increase in the diameter of the cells.

-Walnut Wood Fiber Wall Thickness

The results of Table (2) showed a clear discrepancy in the thickness of the fiber wall between the studied species and cultivars. The wood of black walnut trees was distinguished by its possession of fibers with a greater wall thickness compared to the wood of the other three studied species, while the wood of ordinary walnut growing naturally in northern Iraq was distinguished by the lowest thickness For the wall, the average thickness of the walls of walnut fibers for the four species (*J. regia*, J. *microcarpa*, *J. australis* and *J. nigra*) studied was (10,038, 15,973, 10,634, and 23.122) µm, respectively. It is noted that the values of the average values of the thickness of the wall of the fiber are similar between the two species, the common walnut and the Australian walnut. These results agreed with the mechanism of cell wall formation, as the greater the cell diameter, the smaller the wall thickness, and vice versa (Dalal Bashe, 2022). It also agreed with the rule that states that the large diameters of the spaces produce bronchioles, vessel elements, or fibers with thin walls, and vice versa. As for the studied cultivars , they showed a difference in the thickness of the fiber wall; The cultivars Horaman2 was characterized by the lowest wall thickness, with an average of (6.650) µm, while the Horaman1 cultivars was distinguished by the largest wall thickness compared to the rest of the trampled cultivars , with an average of (18.712) µm. This result was in agreement with the study of Abd al-Qadir et al. (2016), who found that the average thickness of the fiber wall of the regular walnut grown in Dohuk reached (8.60) (µm).

In view of the presence of a significant influence of the species on the thickness of the fiber wall, it differs and differs in use in the pulp and paper industry in light of the characteristic of the fiber wall thickness (Al-Takay, 2012, Al-Jowary, 2017, and Dalal Bashe, 2022).

-Vessel element Length

In light of the results of Table (2), it is clear that there is a clear discrepancy in the length of the bowl between the two species of black and ordinary walnuts. (0.286) mm, while the average length of the vessel element for ordinary walnut was (0.531) mm, and the average length of the vessel element of the two species *J. microcarpa, J. australis* (0.321, 0.724) mm respectively. This result shows the distinction of the Australian species with the longest vessel element compared to the rest of the studied species, as the lengths of its vessel elements ranged between (0.520- 0.816) mm. It ranged between (515 - 812) µm As for the length of the elements of the vessels of the studied regular walnuts, the values were somewhat close, and it was possible to distinguish the 3-lobed cultivar in light of its possession of the longest vessel element, which averaged (0.501) mm, and the shortest element Cultivars container, characterized by the cultivars Horaman2 (0.305) mm, and these results are in agreement with the findings of Abd al-Qadir et al. (2016) for ordinary walnuts growing in Dohuk, in which the average length of the vessel reached (0.545) mm. The results of the study of Akkemik and Barbaros (2012) who found that the length of the receptacle component of the common walnut grown in Turkey ranges between (0.350 - 0.800) mm, and with the study of Merev (1998) who found that the average length of the receptacle component was (0.621) mm.

With this result, it was found that the length of the vessel elements of the studied common walnut *J. regia* L. grown in northern Iraq possesses vessel elements of less length than the vessel elements of the same species of walnut in other countries. It was found that the lengths of cells and vessel elements differ from one species to another in the same genus, which is a diagnostic characteristic of plant species according to (Al-Jowary, 2017, Al-Sharefy, 2020 and Dalal Bashe, 2022). Given that the trees of species and cultivars of walnuts growing in northern Iraq possess rather long container elements.

-Vessel element Diameter:

The diameters of the vessel elements in walnut trees varied remarkably among the studied species and cultivars, which contributed a lot to distinguishing and diagnosing walnut wood of great economic value. The diameters ranged between(141.373-283.351) and an average of (241.682) µm. When the normal walnut cultivars growing naturally in northern Iraq was distinguished with the lowest diameter of the vessel element at a rate of (137.764) (µm), the average diameter of the elements of the vessel of the small-fruited species *J. microcarpa* was (167.197) µm, and the average diameter of the black walnut vessel element was *J. nigra* (205.367) (µm). Thus, it was found that the walnut trees growing naturally in northern Iraq possessed vessel elements with small diameters compared to the other introduced species. This result was consistent with the results of Yaman (2008) study, which found that the diameter of the element of the vessel of ordinary walnut naturally grown in the Black Sea region of Turkey was (135.3) µm. The results were also close to those of Abd al-Qadir et al. (2016); The average diameter of the vessel element was (179.806) µm. It also agreed with the results of the study of Akkemik and Barbaros (2012), who found that the average diameter of the walnut vessel elements ranges between (100-200) µm. With regard to the diameters of the elements of the containers of the cultivars of the studied ordinary walnut, they also showed a noticeable difference in their diameter rates. The Horaman1 cultivars was distinguished by the largest diameter at a rate of (286,365) µm, while the Afghanii cultivars was distinguished by the elements of containers with few diameters compared to the rest of the cultivars and species in general. As shown in Table (2); The reason for this discrepancy in the diameter of the vessel elements is due to the different growth conditions. Woodcock et al. (2000) found that the diameter of the vessel element depends on the abundance of water, so the diameter increases in its abundance and decreases in its scarcity. Panels (1 and 2) show the elements of the vessels of the studied species and cultivars .

- Parenchymal Cell Length

The results of Table (2) did not show a large variation in the length of the parenchyma cells of the wood of the studied walnut species. This trait did not show a taxonomic importance for diagnosing the wood of the studied walnut species; The average length of parenchymal cells of *J. nigra* L., *J. microcarpa* Berl, *J. australis* Gris *and J. nigra* L. (51, 60, 45, 49) µm respectively, while this trait showed taxonomic importance in diagnosing the wood of the studied walnut cultivars, the Iranian cultivar that had the longest parenchymal cells at an average of (85) (µm) was isolated, while the cultivar Horaman2 was isolated by having the hortest parenchymal cells with an average of (37) µm. As for the rest of the studied cultivars of the common walnut, the average length of its parenchymal cells ranged between (38-78) µm.

- The type of pitting in the walls of the vessel elements: Perforation Type

Table (2) shows that the species *J. regia* L. was characterized by vessel elements with a Scalariform-diffuse, while the perforation type was of a simple type, and this result agreed with Akkemik and Yaman (2012); They found that the perforated plate was in the ordinary walnut of the simple type, while the pitting in the walls of the elements of the containers of the other studied species was Scalariform in the two types with small fruits and the black walnut species, while the Australian walnut was distinguished and unique by alternate pitting and these results agreed. With the findings of Richter and Dallwitz (2000) who showed that the type of pitting in the wall elements of Australian walnut vessels was mutual. I also agreed with Simon (2019) who showed that the pitting in some types of nuts is alternate. Hence, it was found that this characteristic (type of pitting) is of diagnostic importance in diagnosing the wood of the studied walnut species.

With regard to the type of pitting in the walls of the containers of the studied cultivars , the results showed their variance in this characteristic. It was found that the cluster cultivars was distinguished from the other studied species and cultivars in the opposite order, which is a very important diagnostic characteristic for diagnosing its wood. Dalal Bashe (2022) confirmed that the type of pitting has a diagnostic importance that helped a lot in the diagnosis of wood, as it was diagnosed and isolated hawthorn wood growing in northern Iraq, *Crataegus azarolus* L. It was characterized by vessels with alternate pits, an anatomical characteristic that distinguishes it from other types of hawthorn.

Table (2) Anatomical characteristics of the studied species of the genus Juglans L.

type of pitting	**Parenchymal Cell Length (µm)**	**Vessel element Diameter (µm)**	**Vessel element Length(mm)**	**Fibers Wall thickening (µm)**	**Fibers - diameter (µm)**	**Fibers length(mm)**	**Species & cultivars**	
Scalariform –Diffuse	(59- 41) 51	-137.148) (139.013 137.764	-0.421) (0.745 0.531	-9.513) (11.101 10.038	-29.044) (32.111 31.054	-0.548) (0.869 0.848	---	
Pitting- Scalariform	(92 -43) 38	-81.792) (308.368 222.457	-0.417) (0.517 0.453	-5.378) (10.841 7.141	-34.132) (36.741 35.193	-0.806) (1.028 0.893	Denmarki	
Scalariform- side	(65 -55) 60	-91.860) (105.815 78.218	-0.350) (0.394 0.374	-6.750) (8.963 7.635	-27.203) 33.248) 29.817	-0.847) (1.180 0.965	Afghanii	
opposite	(91 - 41) 62	-276.396) (293.701 283.832	-0.355) (0.402 0.378	-10.932) (14.639 12.190	(29.963- 34.277) 32.883	-0.760) (0.988 0.868	clustered	
Scalariform- alternate	(93 -57) 75	-247.698) (252.981 249.465	-0.402) (0.565 0.501	11.400) (14.363- 13.995	(43.396- 65.065) 51.342	0.863)- (1.105 0.913	3-lobed	***Juglans regia* L.**
Scalariform –Diffuse	(90 -72) 85	-119.329) (170.935 141.375	-0.294) (0.357 0.322	-15.212) (18.756 16.474	(20.886- 26.637) 21.332	0.915) - (1.085 0.981	Kirmashan1	
Scalariform- alternate	(87 -72) 78	-122.164) (125.547 123.570	-0.487) (0.492 0.476	-6.166) (8.899 7.464	(46.001- 51.038) 47.902	1.101)- (1.158 1.173	Yahoodi	
Scalariform- side	(83 -50) 64	-272.629) (298.365 286.365	-0.307) (0.339 0.326	-17.235) (20.006 18.712	(25.055- 33.047) 27.493	(0.925- (1.095 0.982	Horaman1	
Scalariform- side	(51- 29) 37	-192.926) (202.802 200.246	-0.268) (0.360 0.305	-5.516) (8.838 6.650	(34.618- 39.533) 37.606	0.810) - (0.967 0.873	Horaman2	
Scalariform	(95 -39) 60	-154.548) (175.274 167.197	-0.303) (0.318 0.321	-12.713) (17.007 15.973	(33.428- 35.419) 34.462	-0.303) (0.815 0.513	***J. microcarpa* Berl.**	
alternate	(52 -34) 45	-141.373) (283.351 241.682	-0.520) (0.816 0.724	-9.533) (12.836 10.634	(21.178- 26.528) 21.404	-0.574) (0.703 0.610	***J. australis* Gris.**	
Scalariform	(79 - 34) 46	-192.496) (227.606 205.367	-0.199) (0.319 0.286	-21.573) (24.083 23.122	(14.869- 18.160) 16.999	-0.581) (0.872 0.750	***J. nigra* L.**	

Anatomical study of mechanically separated wood cells (Macrotom:(

After reviewing the research and sources, it was found that there is no anatomical and diagnostic study of the three wood faces of the mechanically separated cells for species and cultivars of walnut at the level of the Iraqi country, as it is being conducted for the first time in this field. The results of the current study, which are shown in Table (3), showed the quantitative characteristics of the wood of walnut trees growing in northern Iraq. With regard to the number of rays/mm rows, the results of the studied species showed that they ranged between (8-30) rows/mm, and the regular walnut was distinguished by the highest number of rays/mm rows, ranging between (15-30) As for the smallest number, the Australian Species was distinguished, which ranged between (8-11), as for the studied cultivars belonging to the species of ordinary walnut(*J. regia* L.), the number of rows of rays ranged between (10 - 30), and the results showed that there are few differences between the cultivars belonging to the ordinary walnut. As for the species, this characteristic showed that there are differences between the studied species. The results are in agreement with the results of Akkemik and Yaman (2012) and with the results of Richter and Dallwitz (2000). These researchers confirmed that the number of rows of ray cells / mm for the Australian species is between (7-11) rows of rays / mm.

With regard to the height of the rays in the tangential High of Rays of the studied species, the values shown in Table (3) showed a discrepancy between the species. This characteristic contributed to distinguishing and isolating the studied species from each other; The species of ordinary walnut was distinguished by the largest rate and reached (392.341) µm. While the small-fruited species *J. microcarpa* was diagnosed and isolated with the lowest rate of (252.777) µm, the rate of radiation height of the Australian walnut was (339,028) (µm), and the black walnut had a rate of (283.011) µm in the tangential face. Thus, it was possible to isolate the species from each other in the light of this characteristic, and this result agreed with the findings of Richter and Dallwitz (2000), who found that the radiation height of some species of nuts may reach (500) µm. Dalal Bashe (2022) showed that the characteristic of high rays in the tangential face contributed to the identification and characterization of the wood of hawthorn species growing in northern Iraq. As for the cultivars of the studied ordinary walnut, this trait did not show any differences of diagnostic value. The values were close, except for the Iranian cultivars Kirmashan, which was distinguished by the lowest rate of (199.579) µm.

As for the height of the cells of the High of Rays in the radial face (transverse rays) of the wood of the trees of the studied walnut species, Table (3) shows that there is a discrepancy between the studied species in the values of this trait; The Australian walnut *J. australis* Gris can be distinguished and diagnosed. It possessed the highest rate of transverse ray height which reached (334.992) µm, while the small-fruited species *J. microcarpa* Berl was distinguished. The lowest average, which reached (92.812) µm, while the two species of ordinary walnut and black walnut were close in values, reaching (276.400 and 279.299) µm, respectively. As it was possible to diagnose the wood of the Iranian cultivars Kirmashan1 by being distinguished by the lowest cross-sectional rays rising at a rate of (92,328) µm, while the three-lobed cultivars was distinguished by the highest cross-sectional rays by (202.048) µm, and the rest of the cultivars also varied in their values, where they were similar except for the cluster cultivars. It was also a low value with a rate of (101.733) µm.

Concerning the number of rows of rays cells in height in the tangential face, Table (3) shows that this characteristic has shown a noticeable difference between species and cultivars . With regard to species, two types of cells can be distinguished:

1- Uniseriate-Multiiseriate cells, characterized by (the two species of *J. regia*, and *J. microcarpa*).
2- Uniseriate Biseriate-–Multiiseriate cells, two species of Australian walnut and black walnut were distinguished. By comparing this result with the results of Akkemik and Yaman (2012), it is found that the studied local species growing in northern Iraq (*Juglans regia* L.) may agree with the results with the common walnut grown in Turkey, as the cell species was also single-row to multiple).

As for the cultivars of the common walnut, the cultivars (clustered , Yahoodi and 3-lobed) were characterized by multi-row cells (Multiiseriate), the Afghani cultivar was distinguished by bi-row cells (Biseriate), and the Iranian Kirmashan1 cultivars was distinguished by single-row to two-row cells, and the two cultivars Horaman1 and Horaman2 were distinguished by single cells. Row, double and multi-row, and the fig. (2and 3) show the types of cells of the studied species and cultivars .

Table (3) also shows the variation of the studied species and cultivars in terms of the diameter of the rays in the tangential section. Regarding the species, it was possible to distinguish and diagnose the wood of the Australian type by having the lowest rate of tangential ray diameter at a rate of (40.227) µm, and the largest diameter of rays in the tangential section was distinguished by *J. microcarpa* averaged (97.457) µm, while the local type, the ordinary walnut, was distinguished by cells that were wider than the cells of the black species. The average diameter of cells for each of them reached (80.463 and 42.134) µm.

As for the diameter of the rays in the tangential section of the studied cultivars , the Yahoodi cultivars was distinguished by the highest rate of (85,236) µm, and the Danish cultivars was distinguished by the lowest rate, which reached (40.453) µm, while the rest of the cultivars were somewhat close in values.

As for the porous gathering in the cross section, it was possible to distinguish two types of porous gathering, which are:

1- Single porous , characterized by the small-fruited nut type J. microcarpa Berl.
2- Single, double and triple porous , which were distinguished by the species (*J. regia*, *J. australis* and *J. nigra*).

As for the porous grouping of species, three types of porous were distinguished. The Danish and Iranian cultivars were distinguished by (single) porous, and the Afghani and 3-lobed cultivars were distinguished by porous (single to bilateral), while the cultivars (clustered, Horaman1 and Horaman2) had porous grouped together (singly, double and triple).

Table (3) Quantitative characteristics of studied walnut wood cells separated by mechanical method.

Gathering of porous in cross section	Diameter the rays in the tangential (section)	The number of rows of ray cells in height in the tangential face	Height of transverse ray cells in the radial face (um)	The height of the rays in the tangential face (um)	Number of rows of ray cells/mm in tangential section	Species & cultivars	
Single, Double and Triple	85.586 – 77.661 (80.463)	Uniseriate-Multiiseriate	– 248.871 309.613 (276.400)	– 265.000 512.506 (392.341)	30 -15	---	***Juglans regia* L.**
Single	44.211- 38.789 (40.453)	Uniseriate-Biseriate-Multiiseriate	142.562-112.201 (185.041)	– 129.718 258.927 (201.722)	22-12	Denmarki	
Single-Double	61.997-55.902 (59.829)	Biseriate	– 127.941 156.093 (136.046)	– 225.204 241.599 (233.721)	20 – 10	Afghanii	
Single, Double and Triple	62.916 – 52.911 (59.885)	Multiiseriate	197.218 – 69.029 (101.733)	– 112.093 376.092 (243.317)	20-12	clustered	
Single-Double	59.116-54.910 (57.661)	Multiiseriate	238.248-142.338 (202.048)	- 150.712 308.007 (239.609)	35-20	3-lobed	
Single	89.581 – 77.778 (81.732)	Uniseriate - Biseriate	121.000-50.160 (92.328)	-174.187 247.587 (199.579)	28-22	Kirmashan1	
Triple	87.992 – 83.117 (85.236)	Multiiseriate	237.876-119.101 (177.648)	-185.043 240.104 (209.975)	25-19	Yahoodi	
Single, Double and Triple	81.970 – 75.831 (78.998)	Uniseriate-Biseriate-Multiiseriate	– 113.931 209.976 (167.890)	- 177.901 212.993 (204.671)	28-21	Horaman1	
Single, Double and Triple	84.771 – 81.976 (82.911)	Uniseriate-Biseriate-Multiiseriate	– 110.491 188.937 (167.884)	-211.810 228.886 (224.185)	30- 20	Horaman2	
Single	– 91.625 100.615 (97.457)	Uniseriate - Multiiseriate	-95.033 83 .442 (92.812)	– 210.000 307.500 (252.777)	13 - 8	***J. microcarpa* Berl.**	
Single, Double and Triple	47.762- 35.227 (40.227)	Uniseriate-Biseriate-Multiiseriate	359.461-320.038 (334.992)	-330.354 443.354 (393.028)	11-8	***J. australis* Gris.**	
Single, Double and Triple	42.573 – 41.331 (42.134)	Uniseriate-Biseriate-Multiiseriate	280.179-265.047 (279.299)	-222.514 347.500 (283.011)	14-11	***J. nigra* L.**	

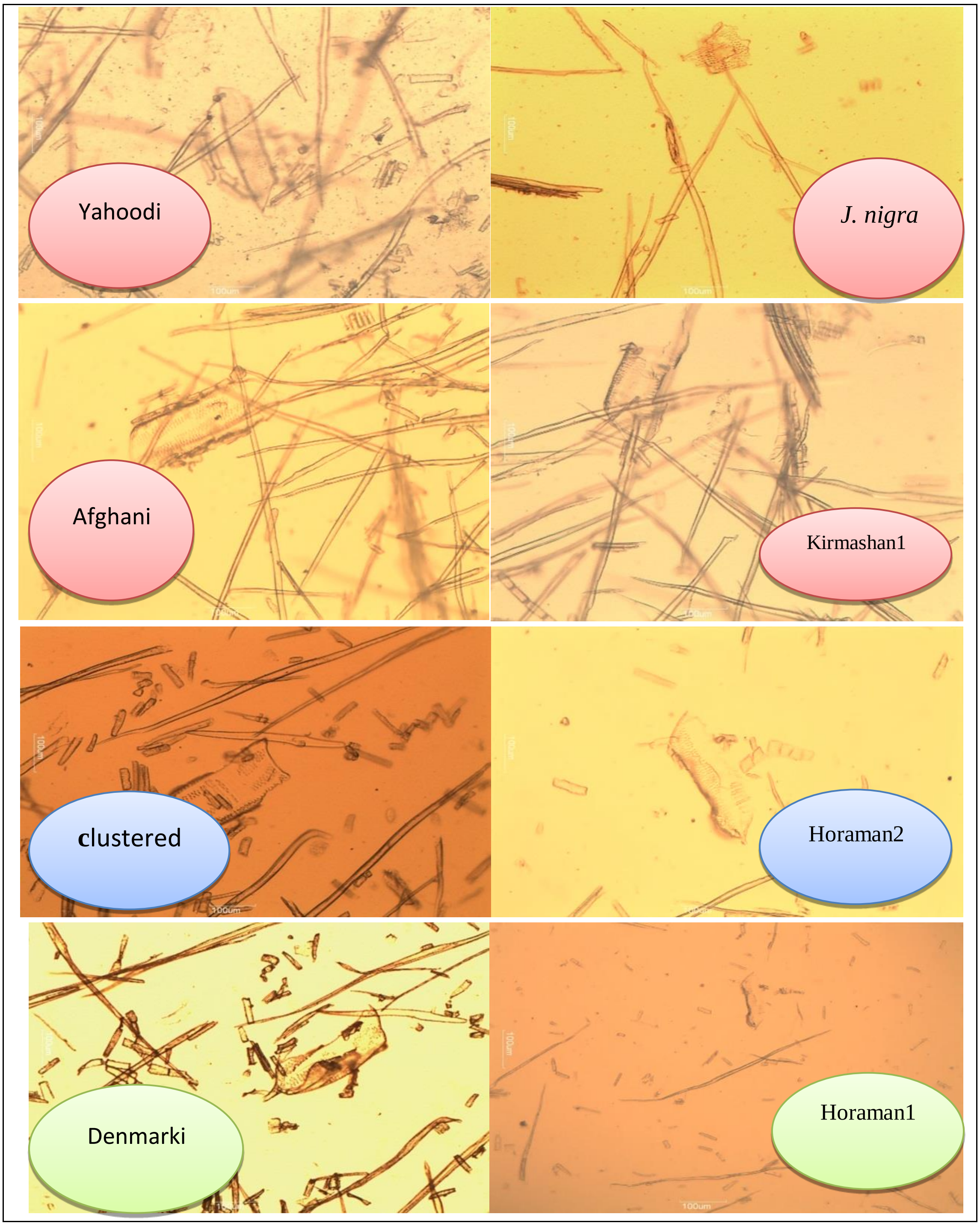

Figure (2) Vessel elements and fibers for black walnut and seven cultivars of *J. regia* (magnification x 10).

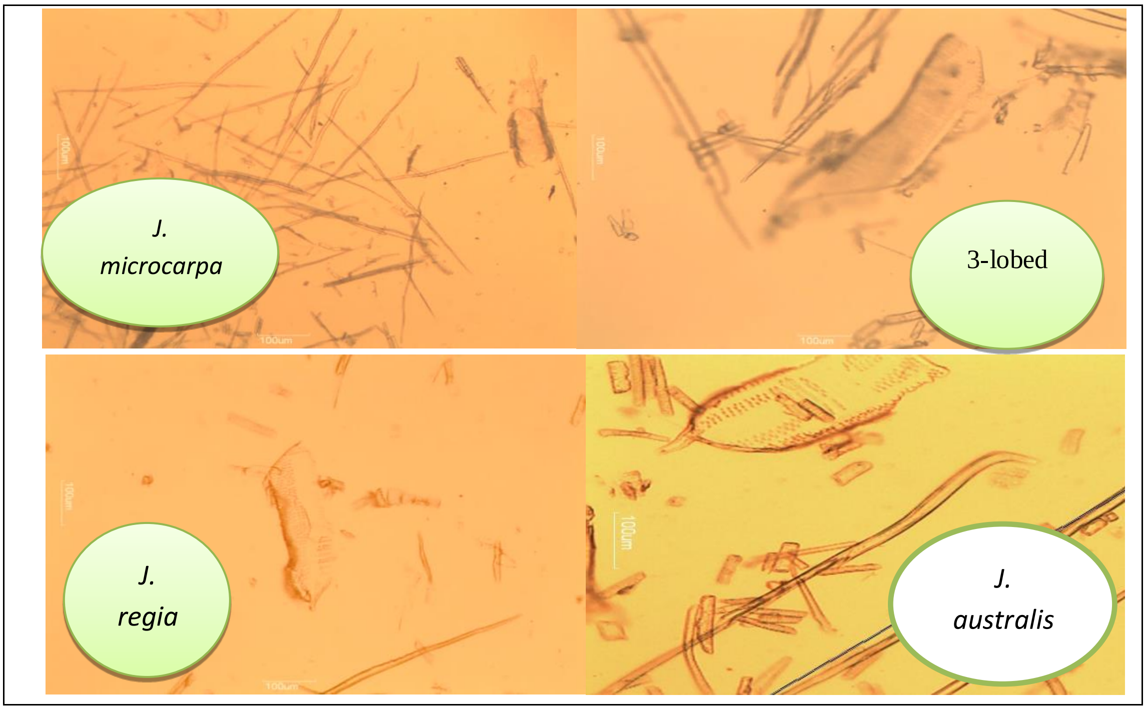

Figure (3) Vessel elements and fibers for the 3-lobed cultivars and three species of walnut with a magnification of (10 x).

With regard to the qualitative characteristics of the wood cells separated by the mechanical method using the microtome, Table (4) shows the most important diagnostic characteristics of the wood of this walnut species and cultivars studied. In the light of Table (4), it was possible to diagnose two types of porous distribution, namely: 1- Semi-ring porous , which is distinguished by the two species (*J. regia* and the *J. microcarpa*). 2- Semi-diffuse porous, distinguished by the two species (Australian walnut and black walnut). What is as shown in fig. (4 and 6). Concerning the distribution of porous for species, three types of porous distribution were diagnosed. The cultivars (Denmarki, Afghani and Kirmashan1) were characterized by semi-ring porous, and the cultivars (Clustered, Yahoodi, Horaman1, and Horaman2) were characterized by semi-diffuse porous fig. (4-15) show the distribution of porous for the studied species and cultivars, while the 3-lobed cultivar had widespread porous compared to the studied species and cultivars . These results are in agreement with the results of Akkemik and Yaman (2012) and with the results of Richter and Dallwitz (2000). Concerning the type of leukocytes, two types of cells could be diagnosed: 1- Homocellular (one type of cell) and was characterized by all studied species and cultivars except for the black walnut 2- Heterocellular (two types of cells) characterized by the black walnut .With regard to the annual growth rings, the results of Table (4) showed that the growth rings of all the wood of the studied species and cultivars were distinct, and with this result it was found that this characteristic has no diagnostic importance for walnut wood: but it contributed to the indication of the clarity and distinction of the limits of the annual growth rings of this genus.

As shown in Table (4), two types of parenchymal cells were distinguished in the pulp rays, which are: 1- Procumbent cells, which included all species and cultivars except for the black walnut type 2- Procumbent and upright cell, which included black walnut only. Thus, it was found that this trait has a diagnostic importance that contributed to isolating the black walnut from the rest of the species. Concerning the pitting in the walls of the vessel elements, the results of Table (4) showed that all species and cultivars are of the alternate type, and this is a characteristic that distinguishes the wood of the studied walnut species, as it is mutual in all species and cultivars and has no diagnostic significance for walnut wood to compare between those species and cultivars . It was also found in the light of the results that there was no diagnostic significance for the characteristic of the perforated plate type, as it was simple in all species and cultivars studied. As for the presence or absence of tyloses in the studied species, it was found that it was absent in the two species, the common walnut and the Australian walnut, while it was found in the other two species, as shown in fig. (4, 5, 6, 7). Thus, this trait contributed to isolating and identifying species from each other. This characteristic was in agreement with the results of Richter and Dallwitz (2000) and with the results of Akkemik and Barbaros (2012). As for the cultivars, tyloses were found in the two cultivars (the 3-lobed and Yahoodi), while it was not seen in the wood vessels of the rest of the studied cultivars. Regarding the presence of crystals in parenchymal cells, the results showed their absence in all species and cultivars except for the Australian walnut and black walnut, as shown in Table (4) and fig. (4 and 6). These results are in agreement with the results of researchers Richter and Dallwitz (2000) and with the results of Akkemik and Barbaros (2012). In light of the results of examining wood samples for the studied types and cultivars of walnut, it was found that there were no helical thickenings in all species and cultivars . Regarding the presence of Septate fibers, it was found only in *J. regia*, as shown in fig (5). It is a diagnostic characteristic of this species. This was also confirmed by researchers Akkemik and Barbaros (2012) in the presence of split fibers in the species of ordinary walnut (*J. regia* L.).

Table (4) the qualitative characteristics of the wood of the studied walnut species and cultivars, separated by mechanical method

Septate Fibers	**helical thickenings**	**The presence of crystals In parenchyma cells (crystals)**	**Tyloses**	**perforated plate type**	**The type of pitting in the walls of the vessel elements**	**Type of parenchymal cells in pulp rays**	**Annual growth rings**	**Types of endodontic rays**	**porous distribution**	**Species & cultivars**	
+	–	–	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi-ring porous	---	
–	–	–	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi- ring porous	Denmarki	
–	–	–	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi- ring porous	Afghani	
–	–	–	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi- ring porous	clustered	
–	–	–	+	Simple	Alternate	Procumbent	Distinct	Homocellular	Diffuse Porous	3-lobed	***Juglans regia* L.**
–	–	–	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi- ring porous	Kirmashan1	
–	–	–	+	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi- diffuse porous	Yahoodi	
–	–	–	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi-diffuse porous	Horaman1	
–	–	–	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi-diffuse porous	Horaman2	
–	–	–	+	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi-ring porous	***J. microcarpa* Berl.**	
–	–	+	–	Simple	Alternate	Procumbent	Distinct	Homocellular	Semi- diffuse porous	***J. australis* Gris.**	
–	–	+	+	Simple	Alternate	Procumbent & Upright	Distinct	Heterocellular	diffuse porous	***J. nigra* L.**	

The sign (+) indicates the presence of the adjective, and the sign (-) indicates the absence of the adjective.

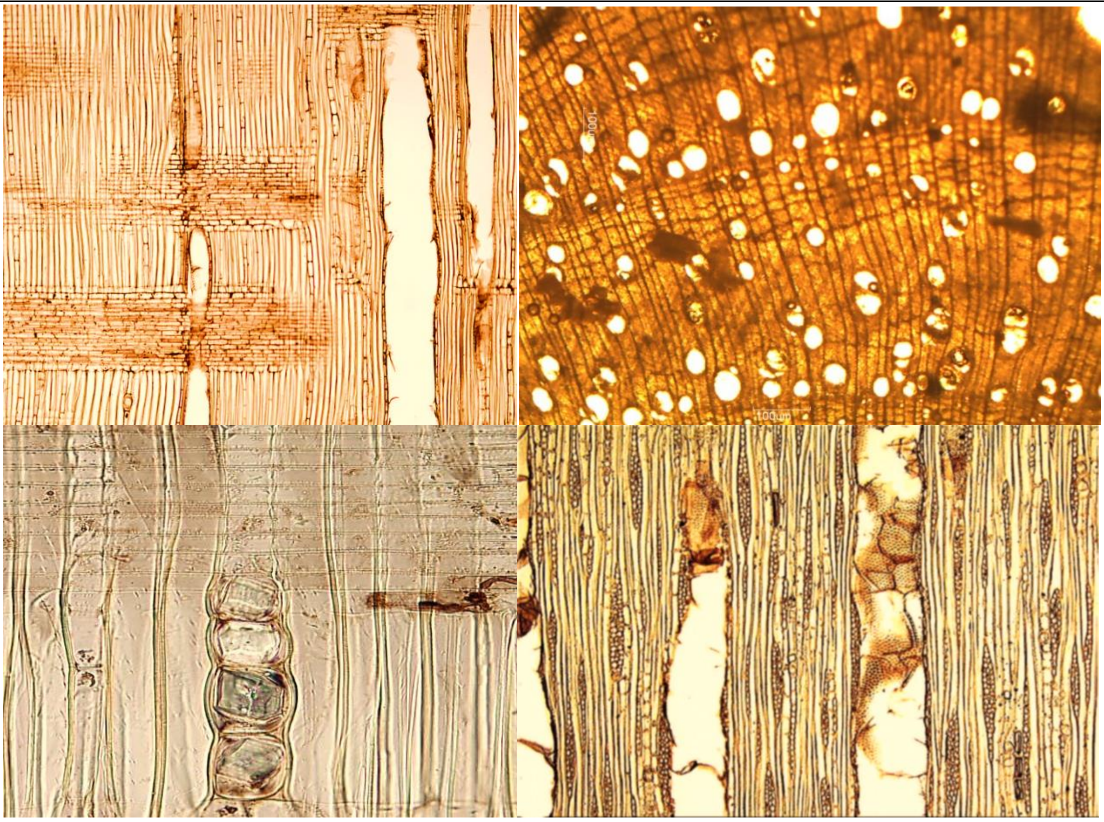

Figure (4) Wooden sections of the three faces (transverse, radial and tangential) with the presence of *J. nigra* crystals and tyloses.

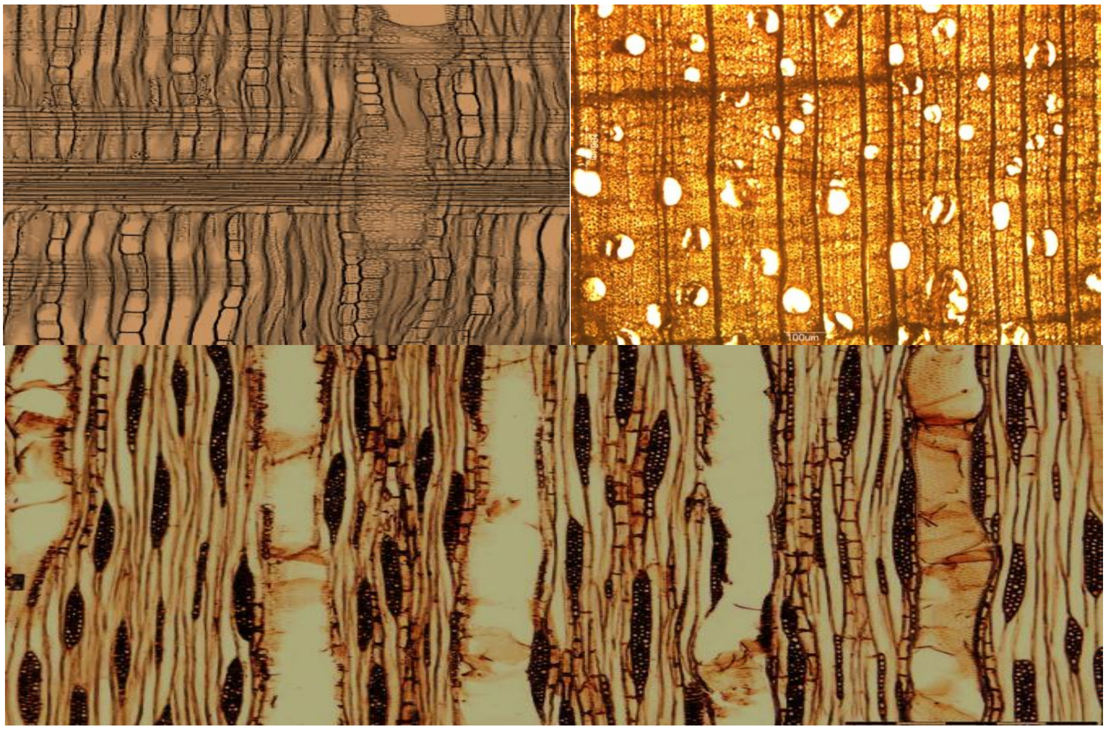

Figure (5) The three wooden sections (transverse, radial and tangential) of common walnut *J. regia* L.

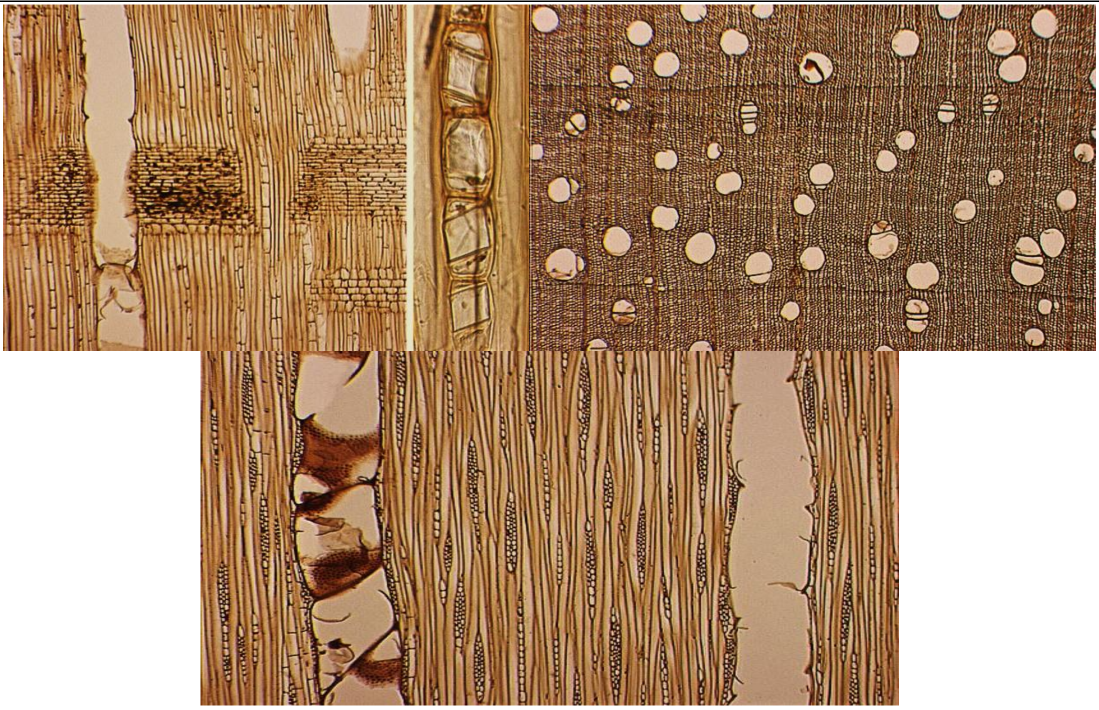

Figure (6) The wooden sections of the three faces (transverse, radial and tangential) with the presence of crystal and the absence of tyloses in the *J. australis* .

Figure (7) The three woody sections (transverse, radial and tangential) of the small-fruited walnut *J. microcarpa*.

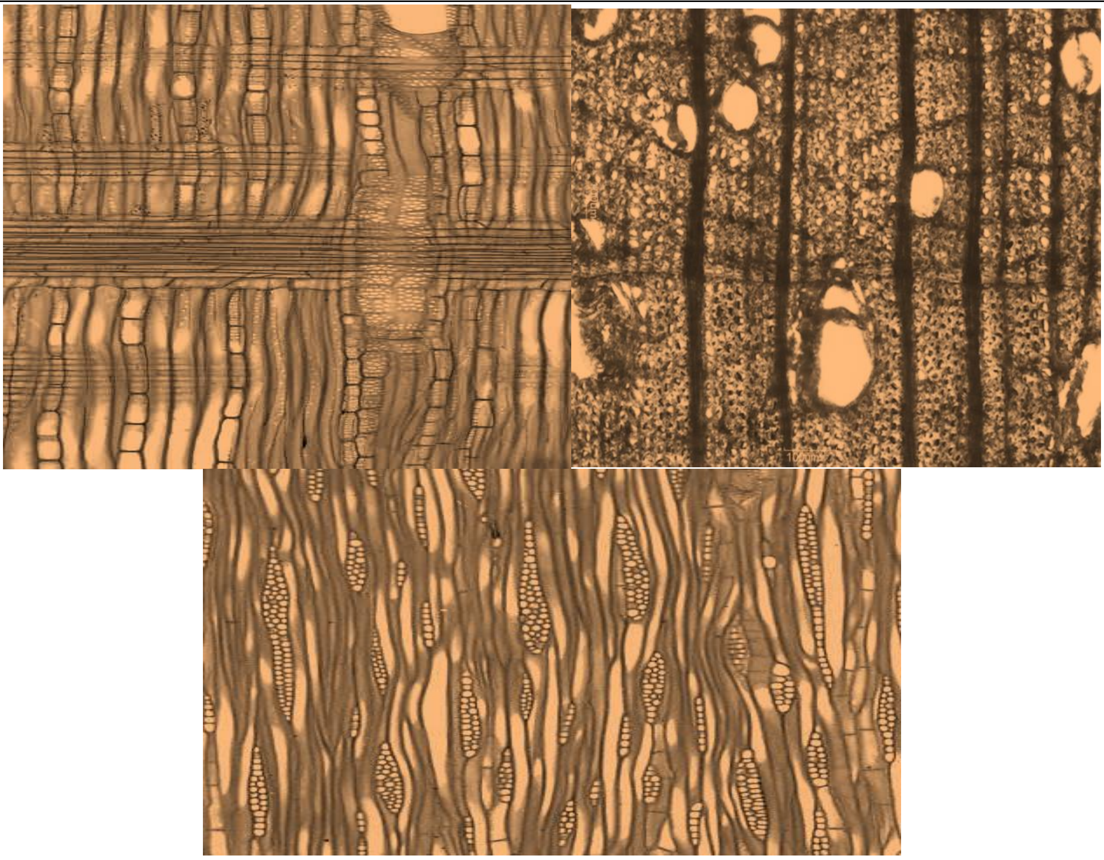

Figure (8) The three wooden sections (transverse, radial and tangential) of the Denmarki cultivar .

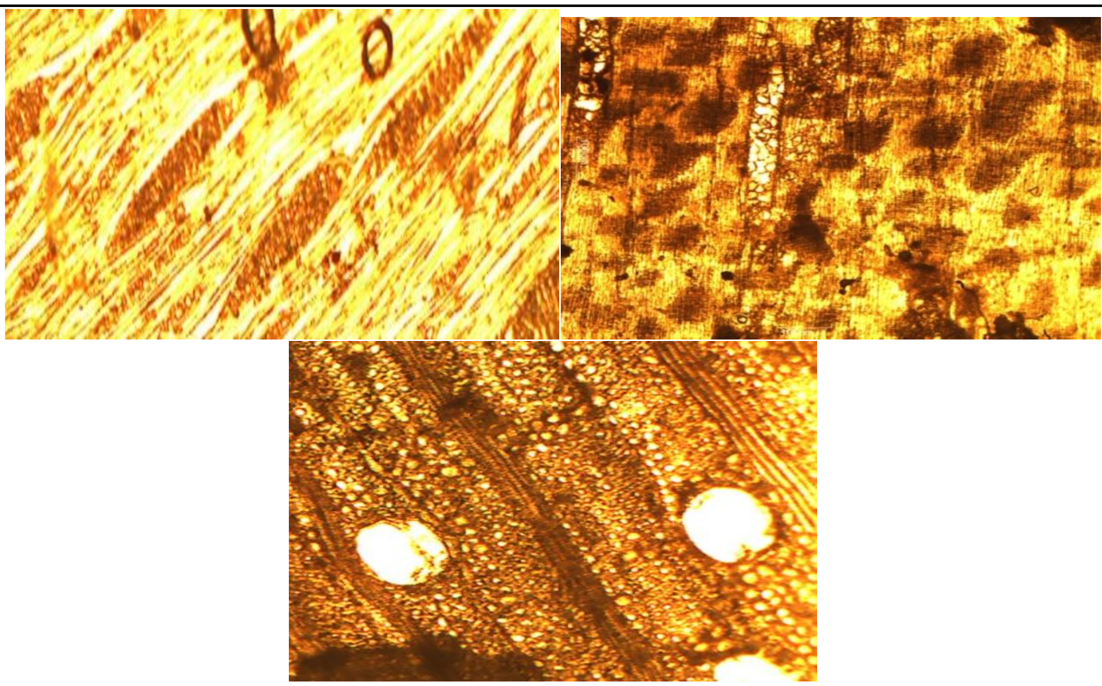

Figure (9) The three wooden sections (transverse, radial and tangential) of the 3-lobed cultivar.

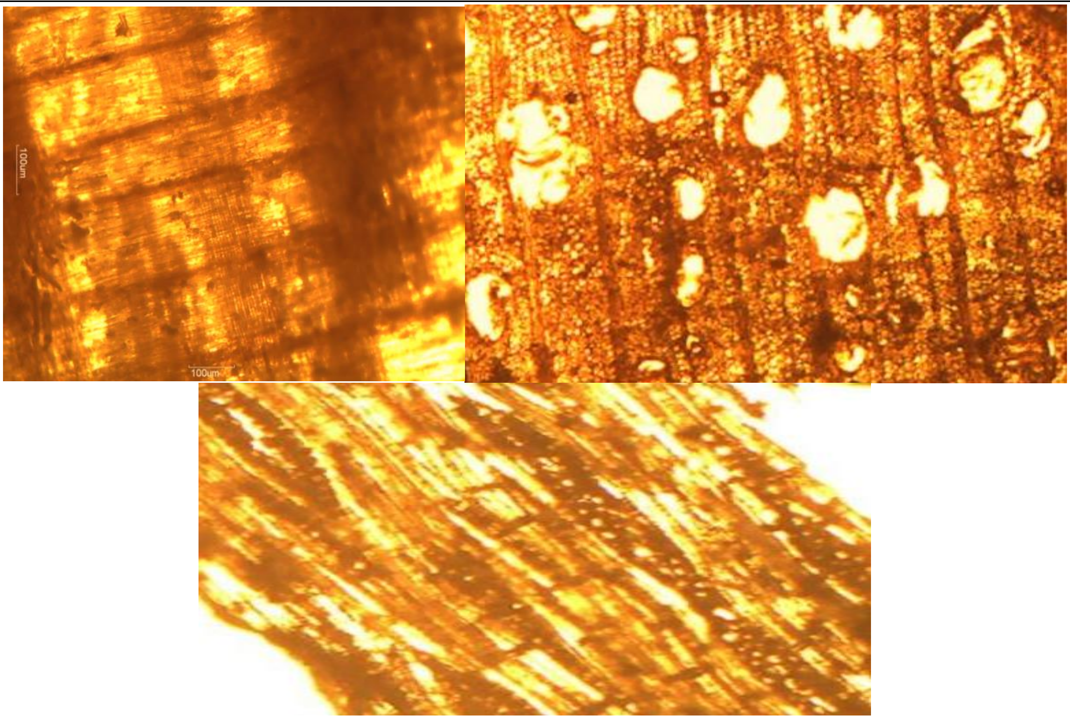

Figure (10) The three wooden sections (transverse, radial and tangential) of the Iranian cultivar(Kirmashan1).

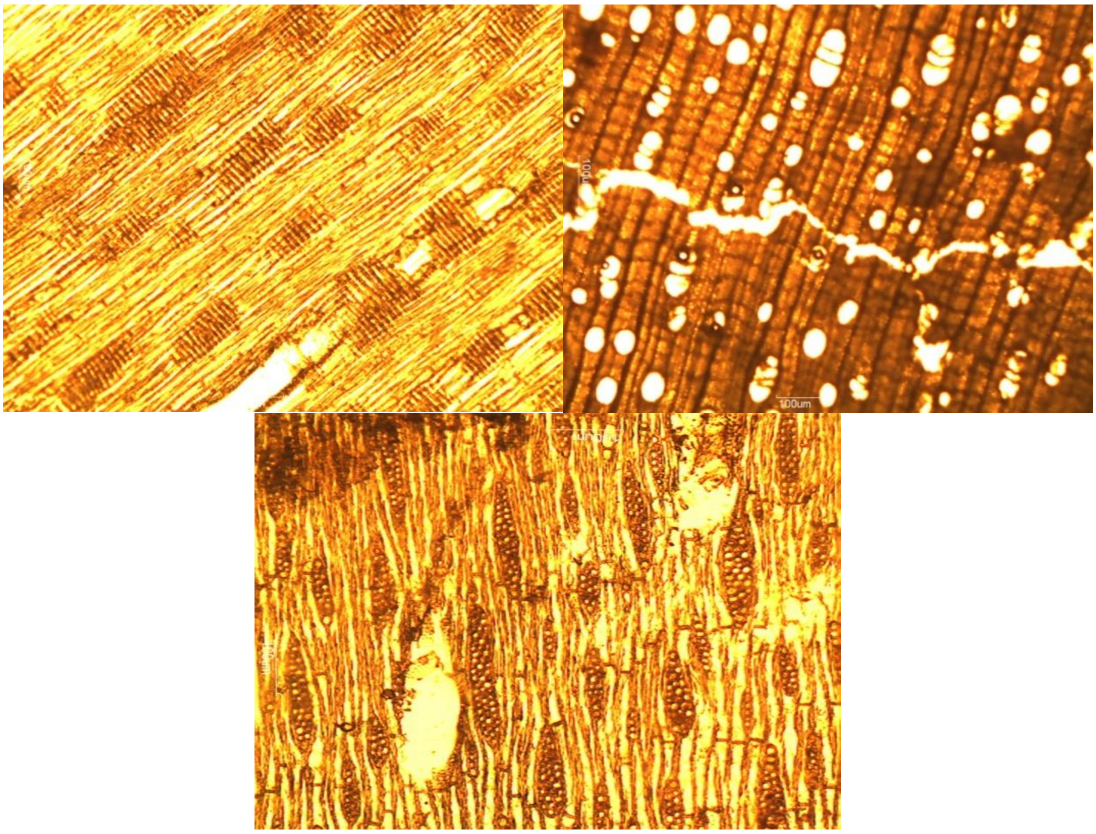

Figure (11) The three wooden sections (transverse, radial and tangential) of the Afghani cultivar.

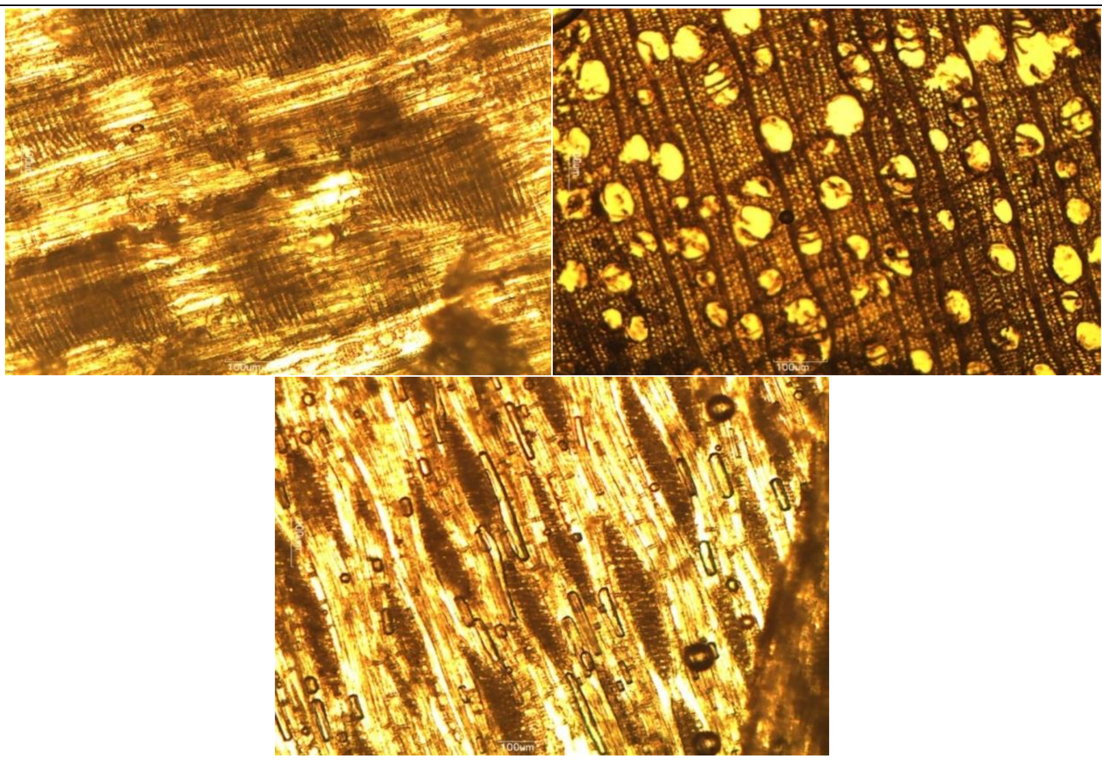

Figure (12) The three wooden sections (transverse, radial and tangential) of the cultivar Horaman1 .

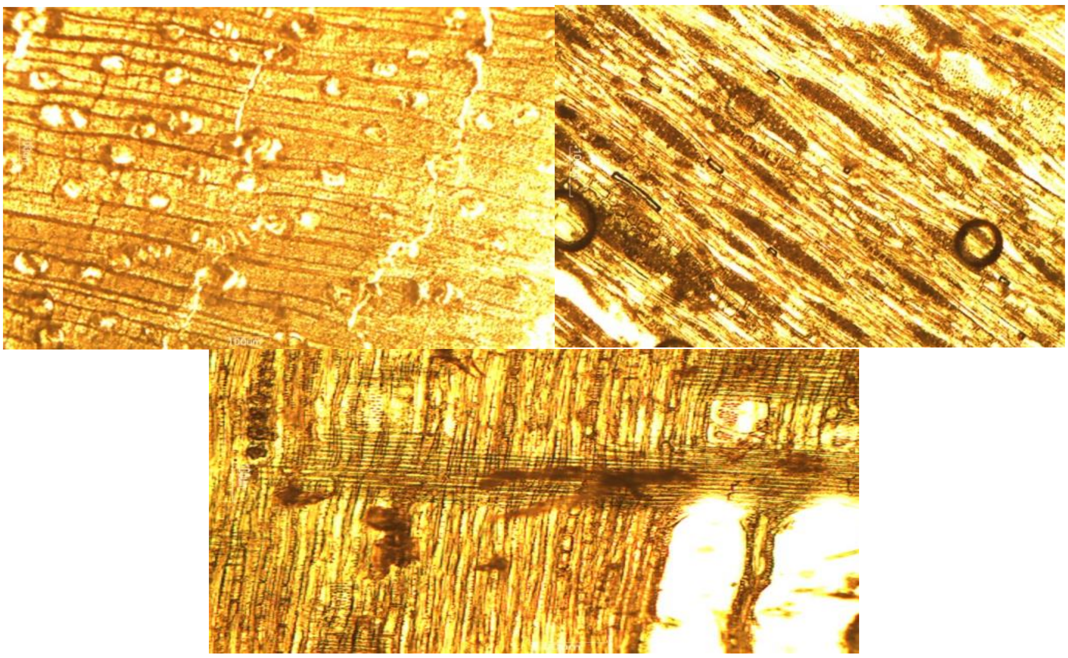

Figure (13) The three wooden sections (transverse, radial and tangential) of the cluster cultivar.

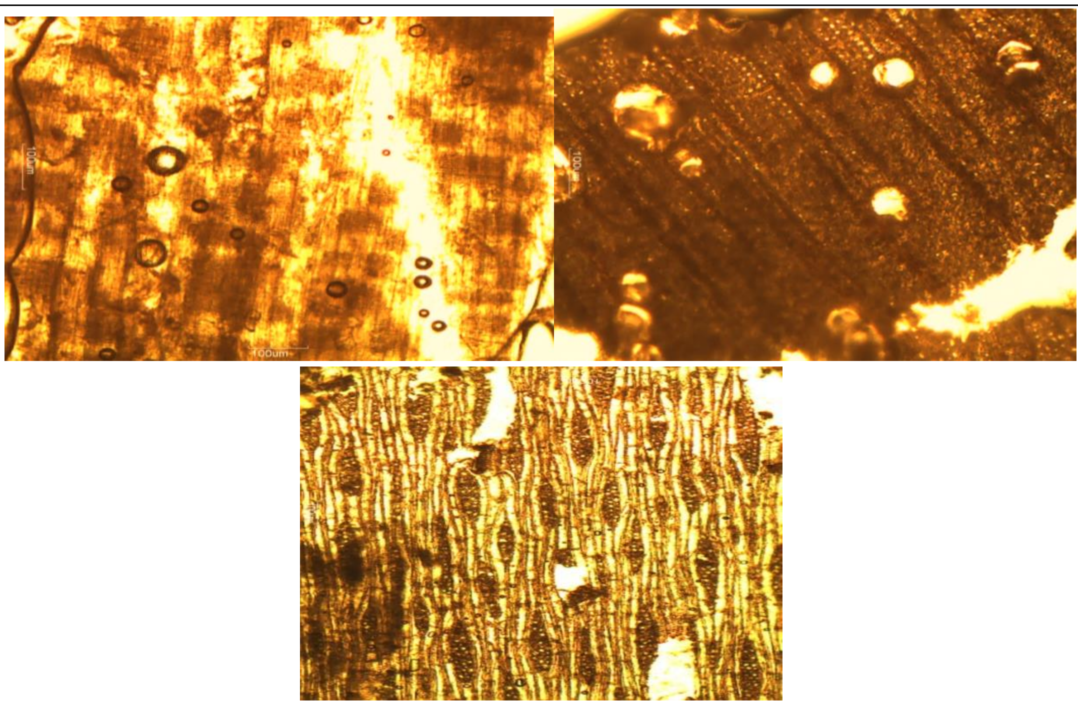

Figure (14) The three wooden sections (transverse, radial and tangential) of the cultivar Horaman2.

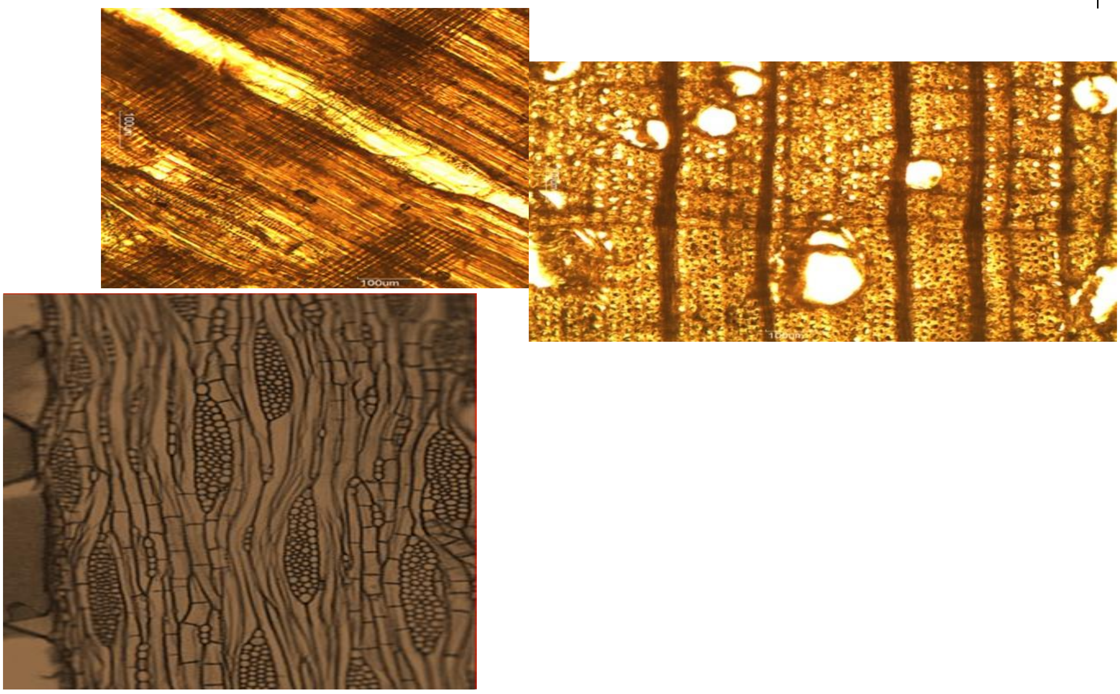

Figure (15) The three wooden sections (transverse, radial and tangential) of the Yahoodi cultivar.

CONCLUSION

The results of the anatomical study showed extremely important diagnostic importance in distinguishing and diagnosing the species and varieties of Juglans growing in northern Iraq. The anatomical study of wood contributed greatly to supporting the phenotypic study and highlighted its major role in diagnosing and isolating the species and varieties studied. The distribution of bordered pits, the type of pitting, and the presence of crystals showed great diagnostic importance, contributing to the isolation of the species and cultivars studied.

REFERENCE

Abd al-Qadir, Aree A. , Sulayman, Hishyar H., Dawud, Nasir A.and Husayn, Bilnd J.(2016). Characteristics and some technological properties of *Juglans regia* L. trees grown in Duhok province. The Scientific Agricultural Conference (2nd : 2016 : University of Duhok, Kurdistan region of Iraq). . Vol. 19, no. 1 (Special Issue) Agricultural and Veterinary Sciences (J. 2016), pp.280-287.Duhok Iraq. University of Duhok.

Adamopoulos, S. and Voulgaridis, E. (2002). Within-tree variation in growth rate and cell dimensions in the wood of black locast(*Robinia pseudoacacia*). *IAWA Gournal*,23(2) : 191-199.

Akkemik. Ünal. And Barbaros, Y.(2012). Wood anatomy of Eastern Mediterranean Species . Turkey. Kessel Publishing House. 308 pp.

AL- Katib, Youssef Mansour (2000). Classification of Seed Plants, Dar Al-Kutub for Printing and Publishing, University of Mosul, Iraq.

AL-Jowary, Haees Sayel Jarjes (2017). Identification of some species of the genus *Pinus* L. growing in northern Iraq by using Morphological, anatomical and chemical characteristics. PhD thesis, College of Agriculture and Forestry, University of Mosul, Iraq.

Al-Mashhadani, Marwa Mahmoud Badr (2020). Dimensions of the fibers and their effect on the paper industry and an estimate of a number of natural products of birds' tongue trees growing in the city of Mosul. Master's Thesis, College of Agriculture and Forestry. University of Al Mosul.

AL-Takay, Talal Qassem (2012) Secondary chemical components and some anatomical characteristics of the trunks of *Melia azedarach* L. growing trees in Mosul, PhD thesis, College of Agriculture and Forestry, University of Mosul.

Anthono, F. and Antwi -Boasiako, C.(2017). The characteristics of fibers within coppiced and rosewood (*pterocarpus erinaceuspoir*) and their aptness for wood-and paper-based products. 13(2): 27-39.

Atchison J.E. (1987): Data on non-wood plant fibers. In:Hamilton F., Leopold B. (eds.): The Secondary Fibers and Non-Wood Pulping. 3rd Ed. Atlanta, TAPPI Press.

Dalal Bashe, Nabaa Zaher Mahmoud (2022). Anatomical Characteristics and Dry Density of Common Hawthorn Wood, *Crataegus azarolus* L. Grown in Akrae District. Higher Diploma Thesis, College of Agriculture and Forestry, University of Mosul, Iraq.

Domec, J.C. and Gartner, B. L. (2002). Age –and position related changes in hydraulic versus mechanical dysfunction of xylem :inferring the design criteria for Douglas-fir wood structure. Tree Phy. 22:91-104.

EL-Juhany, L.I.(2011).Evaluation of some wood quality measures of eight year-old *Melia azedarach* L. trees. Turk. J. Agric. For.35:165-171.

Franklin, G. L. (1945). Preparation of thin section of synthetic resins and wood composites and anew macerating method for macerating wood Nature155(3-24).

Kassir, Walid Aboudi, Salim Ismail Shahbaz and Bassem Abbas Abd Ali (1985). Wood as a raw material. Translator book. Ministry of Higher Education and Scientific Research, House of Books for Printing and Publishing, University of Mosul, Iraq.

Kiaei, M., Sadegh, A. and Moya ,R.(2013). Site Variation of Tracheid Features and Static Bending Properties In Pinus eldarica Wood. Cellulose Chem. Technol., 47 (1-2), 49-59 .

Larson, P. R. (1973) . The Physiological Basis for Specific Gravity in Conifers, Proceedings, IUFRO- 5 , Meet , 672 – 678 .

Merev, N., (1998). Doğu Karadeniz Bölgesindeki Doğal Angiospermae Taksonlarının Odun Anatomisi, Trabzon, Türkiye, KTÜ Basımevi.

Mono, S.M.C. ;Avana, M.L.; Ngueguim, J. R. and Kemeuze ,V.A. (2017). Wood characterization of Gnidia glauca (Fresen). Gilg (Themelaeaceae) .

Panshin, A.J. and DeZeeuw, C. (1980) .Textbook of Wood Technology, 4th ed. McGraw- Hill, New York.

Richter, H.G., and Dallwitz, M.J.(2000)onwards. Commercial timbers: descriptions, illustrations, identification, and information retrieval. In English, French, German, Portuguese, and Spanish. Version: 9th April 2019. delta-intkey.com’.

Simon, Ellis (2019). Wood 280 Wood Anatomy and Identification2018-19 pp.19.

Wani, B.A., وAmina K. (2013). Wood fiber variability in stems of Juglans regia L. from temperate climate of Kashmir Himalaya. J Indian Acad Wood Sci 10, 95–102 .

Wiedenhoeft, A. (2010). Structure and Function of Wood, Wood handbook--- Wood as an engineering material .Chapter3.

Woodcock, D. W. ,G. Dos Santos and C. Reynel (2000). Wood Characters of Amazon Forest types. IAWA J. vol.21(3),277-292.

Yaman, B. (2007 b). Anatomy of Lebanon Cedar (Cedrus lebani Rich.) Pinaceae Wood with indented Growth rings. ACTA BIOLOGICA Series Botanical 49\1:19-23. 2007.

Yaman, B. (2008). Variation in Quantitative vessel element features of *Juglans regia* wood in the Western Black sea region of Turkey. Agrociencia 42,357-365.