A Comparative Study of Anatomical and Taxonomical of Juniperus Species Grown in Northern Iraq

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Abstract. This comparative anatomical taxonomic study was conducted for 3 species belonging to the genus Juniper of the Cupressaceae family that grow wild in northern Iraq, in 7 sites distributed over the governorates of Nineveh, Dohuk and Sulaymaniyah, and these species are (Juniperus oxycedrus L., Juniperus polycarpos K. Koch and a new species that was recorded for the first time in the Flora of Iraq by the same researchers, which is Juniperus macrocarpa Sibth and Sm.). The study included the chemical separation of wood Maceration, the results showed the variation of the studied species in the dimensions of the tracheids (like length, diameter of the tracheids and wall thickness) and in the Runkel ratio as well as the variation in the dimensions of the Bordered pits. It was possible to diagnose and isolate the two species of J. oxycedrus and J. Macrocarpa that have similar phenotypes, as the species J. macrocarpa had longer, wider and thicker tracheids than those of J. oxycedrus, while the species J. Polycarpos had the lowest average tracheids length, diameter and thickness; Thus, it was isolated from the previous two species. Regarding the Runkel ratio, the results showed that all types of juniper studied are suitable for the manufacture of pulp and paper. And that is because they have Runkel ratios that have fallen within the approved range for the best production and quality of the paper pulp, as the values for the studied species were limited to between (0.425 - 0.922). The lined click diameters were also varied according to species. It was also found that the qualitative characteristics of the tracheids have a prominent role in the diagnosis of the studied species, as they are constant genetic characteristics of the species, as it was found that there are variations in the qualitative characteristics between the studied species, such as the presence of Thickening Helical in the tracheids of J. oxycedrus, in addition to the presence of Dentate in the walls His tracheids and their absence in the other two species, as well as the presence of two rows of bordered pits in the tracheids of juniper, which is called the Biseriate, and their absence in the other two species. It was evident from these results that the anatomical characters of the wood have a great taxonomic importance that contributed to the diagnosis of Juniper species. This is the first time in the Iraqi country that an anatomical diagnostic key has been placed for the wood of Juniperus L. species growing in northern Iraq. The woods of this studied species.

1-Introduction:
A new species of juniper was recorded in the flora of Iraq by the same researchers[1]. The family Cupressaceae belongs to the plant kingdom (Plantae), sub-kingdom (Embryophyta), division of vascular plants (Tracheophyta), sub-division of (Pteropsida), class (Gymnospermeae), sub-class of (Coniferophytae), Order of (Coniferales)[2]. Cupressaceae is the largest family in the geographical range. With regard to the number of genera belonging to this family, it varies according to different sources, as [3] mentioned that it contains 15 genera and about 140 species, and the largest of these genera is Juniperus L., which includes 70 species. But[4] mentioned that the Cupressaceae contains 18 genera and 130 species, most of which live in the northern hemisphere, [4] mentioned that this family includes...
16 genera and 120-150 species. The Cupressaceae is the largest family in conifers in terms of genera, the third largest family in terms of species, as it includes 30 genera and 142 species according to the classification[5] of the Department of Conifers Pinophyta. Juniper is the second most diverse genus in Coniferales, as its number ranges from about 67 species spread in the world at sea level to the top of the tree-line (above the tree-line), and Juniperus trees are long-lived trees that sometimes live up to 2000 years [6]. Other common names for the genera Juniper include: Juniper, cedar, red cedar; cedro, sabino [Spanish] [7]. The genus Juniper includes evergreen species of high value that withstand harsh climatic and environmental conditions in forests, arid. and semi-arid [8]. The genus has a worldwide geographical distribution among forest tree species , and can be found throughout the northern hemisphere, with the exception of the J. procera , which are native to Africa and the gin hemisphere[9]. The Juniper genus is also widespread in the western United States of America, northern Mexico, and central and southwestern Asia. Juniper is also found mainly in Eurasian, with one species being J. drupacea [10; 11; 12].

The person engaged in taxonomic science no longer relies solely on the phenotypic characteristics in his taxonomic studies, although they were and are still very important and essential in these studies. In recent years, the classifiers have tended to benefit from some of the results reached by researchers in other sciences. In view of the similarity and similarity that may occur in the phenotypic characteristics of plants, such as the nature of growth, leaf shapes, and other characteristics, these evidences have been supported by studying the anatomical features and their relationship to classification. Modern botanical taxonomy has proven that anatomical traits are equal in importance to other traits such as appearance and should not be overlooked [13]. The scientist [14] emphasized the importance of anatomical characters in taxonomic studies due to their lack of influence with the surrounding conditions. The tracheids are the main building block in conifer wood and constitute a high percentage of the xylem in the seedlings, as they constitute more than 90% of the volume Softwoods [15], as the tracheids make up the very high percentage of xylem; It had a significant effect on the properties of wood compared to other cells. The length of the tracheids in conifers is one of the most important anatomical properties that affect the characteristics and quality of the cellulosic paste and the paper, as it is useful in producing pastes with specific characteristics of the paper, noting that there is strong evidence that some characteristics of wood are genetically controlled to a large extent. This means that it is governed by the heritability of the tree[16]. Recent studies have shown that anatomical features have great importance in taxonomic studies, and give support to the phenotypic characteristics.

Wood varies in its suitability for the manufacture of pulp and paper based on the genetic characteristics of each species and the developmental conditions under which the trees grow. There are large anatomical variations in the properties of wood in the radial and axial directions. Pulp and paper, increasing the length of the fiber and lowering the ratio of the Runkel have a positive effect on the quality of the pulp and paper and the mechanical properties of the wood [17]. [18]. Emphasized that the anatomical properties of the fibers and their dimensions have the greatest influence on the properties and strength of the produced paper, including the strength of tearing, tensile and stretching, and in general long-fiber wood species are preferred in the paper industries; Because it produces paper with good strength and high tear resistance, short-fiber woods lower the fiber's elasticity [19]. Also indicated [20] that a difference in fiber length is desirable to produce papers with specific properties according to the purpose of its manufacture. The Runkel ratio (twice the thickness of the tracheids wall to the diameter of the lumen) is a good and important indicator for the classification of tracheids according to [21]. As for [1; 22; and 23] they all indicated that the mathematical ratios computed from Measuring the dimensions of the wood fibers helps in identifying and guessing the various properties of the paper, and that the Runkel ratio is the most important in indicating the suitability of any type of wood for the manufacture of cellulosic pulp and paper. And that the approved standard value for the Runkel Ratio is equal to (1), and the acceptable range for the Runkel Ratio in paper industries ranges between (0.25-1.5) [24], and that this ratio is affected by the thickness of the fiber wall and the diameter of the fiber cavity and changes with the change of their path[25]. The lower the value than the one, the better the strength properties will be obtained according to[26] who considered that the value of the Runkel ratio for the most suitable fibers for paper making is less than one, while increasing the value over one indicates that the reed is rigid, i.e.
low elasticity, which leads to Create thick, stiff paper with little bonding strength. Among the recent anatomical studies on Pinales in Iraq is the study of [27] of the pine species growing in northern Iraq, and the study showed that the six studied species of pine (Pinus brutia, Pinus halepensis, Pinus pinea, Pinus eldarica, Pinus canariensis, and Pinus radiata) have low values for the Rank pine According to this percentage, all of the mentioned types of pine are suitable for making pulp and paper. This is because the values of the Runkel Ratio were less than one, as the values ranged between (0.255 - 0.656), and that P. radiata is the best of the six studied species for the manufacture of paste and paper. Runkel of the six species all fall within the group of tracheids, according to the classification [28]. The species of the genus Juniperus L. did not receive taxonomic or anatomical studies in Iraq, as there is a legislative study of the types of juniper specifying the status of the species of this genus in Iraq, and perhaps studies can be pointed out outside Iraq are what [29] species of this genus in Iraq did The average diameter of tracheids for J. oxycedrus was (21.6) microns in early wood, at (12.7) microns in late wood, and that the rays were of the Uniseriate type. In [30] he conducted a study of anatomical characteristics of wood in Cedrus lebani Rich. (Pinaceae) family in Turkey, the dimensions of the tracheids (length and diameter and the thickness of the wall), their shape, the stacks, the Trabeceulæ found in the tracheids, and the parenchymal rays that identified three types (Uniseriate, Biseriate, and Multiseriate) and the dimensions of rays (length, diameter and height), and it was found to him that the average length of tracheids for this type of needles (Coniferales) is (2.75) mm and the average diameter is (18.40) microns and the average thickness of the wall is (13.15) microns, the height of the high material is (624.40) microns. [31] studied the anatomical structure of Juniperus excelsa, and the results showed that the average thickness of the tracheids wall of early wood was (7) microns in thickness in late wood was (10) microns, the average diameter of early wood tracheids is (14) microns, and the average The length of the tracheids of early wood (1.4) mm, the average length of the bronchi in the wood of the wood (1.8) mm, the height of the rays (number of cells) is 4 cells. J. communis ranged between (15-25) microns in early wood and (10) microns in late wood, while walls thickness ranged between (0.7 - 1.5) microns per early wood, and the length of the tracheids in early wood ranged between (0.7 - 1.5) mm, and in late wood it ranged between (0.5 - 1.2) mm.

The importance of this research can be summarized in the following points:

1- Diagnosis of juniper species developing at each site of the study using anatomical features.
2- Establishing an anatomical key to diagnose the species of juniper species under study.
3- Determine the suitability of the wood of the studied juniper species in the manufacture of pulp and paper.

And in the absence of any local taxonomic study of these species in Iraq, it was necessary to conduct this study on the species of the genus naturally spread in the north of our country by highlight on the anatomical properties of these species.

2-Materials and Methods:
2.1 Chemically separated cells: Maceration: (6) trees were selected from different study sites with roughly equal ages in order to reduce the effect to the minimum tree diameter and age, in order to reduce its effect on the anatomical properties of the wood [32]. All anatomical samples were taken from the same direction from the west side of the trees at DiAmeter at breast height(d.b.h.) of the leg, based on the method reported by[16;33; and 34] Small wooden pieces of (1-2) cm long were placed in the form of matches representing the diameter level at d.b.h. of the species under study in glass bottles with a lid. To dissolve the nuclei of the middle plate, equal volumes of snow acetic acid and hydrogen peroxide (H₂O₂) were added to (9%) (according to the sample size) in a ratio of 1: 1, then put in an electric oven at a temperature of (65° C) for a period of (48) hours, after which the wooden parts were washed with water and distilled water was added to each vial and then exposed to shake to ensure that the largest number was obtained. From single cells[35].

A- The cell fixation method: the separated cells were fixed on temporary slices using a clean steel bar without a cover to prevent any distortion of the dimensions of the separated cells [36].
B- The method of measuring the dimensions of cells: the dimensions of the tracheids were measured with a Motic Image plus2 microscope, and to measure the length of the tracheids, an objective lens with a magnification power (10x) was used, and for measuring the diameter of the tracheids and their wall thickness, an objective lens with a magnification power (10x) was used.

C- The ratio of the Runkel to each rod was calculated using the following equation: Runkel ratio = twice the thickness of the tracheids wall / the diameter of the tracheids lumen. The thickness of the tracheids wall = diameter of the tracheids - diameter of the tracheids lumen / 2. The Runkel ratio (the length of the stem to its diameter) was calculated, and the length of the tracheids element was measured from end to end, and (20) readings were taken for each of the studied characteristics, and the measurements included trees for each species of Juniperus studied. It was taken into account that these trees were straight, free of diseases, had no curvatures, were not crooked, and that they were not branched, and that the distances between the trees were not less than 50 meters and were more than 15 years old, while avoiding border trees. Table (1) shows the studied Juniper species and the locations and prevalence of each species.

Table (1) The study sites and the spread ratio of each Juniper species

| seq. | Species            | Nineveh Governorate | Dohuk Governorate | Sulaymniyah Governorate | Spread ratio |
|------|--------------------|---------------------|-------------------|--------------------------|--------------|
|      |                    | Akre (1)            | Akre, (2) Sril-Sadah Mount | Akre, (3) Bakrman Mount | Zawita Kurt Kafanah | Swaratuka, Sarsing district | Atrush, Berkah | Qara-dagh Sakirmah Mount | %  |
| 1    | *Juniperus oxycedrus* L. | +                  | +                  | +                        | +             | +                          | 85.7 |                  | %  |
| 2    | *Juniperus macrocarpa* Sibth and Sm. |                  | +                  | +                        | +             | +                          | 28.57 |                   | %  |
| 3    | *Juniperus polycarpos* K. Koch. | +                  |                   |                          | +             |                            | 14.2  |                   | %  |

The sign (+) indicates the presence of the species at the indicated site.

As for the locations of the study, their height above sea level, longitude and latitude, they are shown in Table (2).

Table (2) Study locations, their altitude above sea level, latitude and longitude, using GPS device.

| Sites               | Elevation above sea level (m) | longitude | latitude         |
|---------------------|-------------------------------|-----------|------------------|
| Akre (1) Nineveh    | 1031                          | 44.025296 | 36.0743626       |
| Akre (2) Nineveh    | 1142-1200                     | 44.01778  | 36.752823        |
| Akre (3) Nineveh    | 777                           | 43.692974 | 36.832107        |
| Zawita (Dohuk)      | 900                           | 43.148377 | 36.924003        |
| Swaratuka (Dohuk)   | 1196.50                       | 43.218864 | 37.005280        |
| Atrush (Dohuk)      | 926.4                         | 43.148376 | 36.923992        |
| Qara-dagh (Sulaymniyah) | 1413 | 45.403877 | 35.223294        |

3- Results and Discussion:
Anatomical characters are important characteristics in taxonomic studies, as they enhance the results of morphological studies, especially if the species are similar in appearance, which causes controversy
between researchers and classifiers as well as causes classification problems, and to solve these problems anatomical studies are resorted to support the morphological studies [27].

3-1 length of the tracheids of Juniper species wood:
The length of the tracheid affects the characteristics and quality of the cellulosic pulp and the properties of the paper, so studying the differences in the length of the rod is useful in producing slurries with specific characteristics of the paper, there is strong evidence that some of the characteristics of the wood are genetically controlled, as they are governed by the inheritance of the tree [16;37]. Table (3) shows a remarkable difference between the studied Juniper species in the rates of tracheids , and through our study of these anatomical features, it was found that the tracheids of the J. macrocarpa species are longer than those of J. oxycedrus, as the average length of the tracheids was (1.608 and 1.233) mm on J. macrocarpa thus had the highest rate of tracheid length and the lowest rate of J. polycarpos; It reached (0.993) mm, thus isolating the species from each other through the length of their tracheids . The results of the study also showed that trees have an effect within the same species due to the effect of genetic factors on the length of the tracheid. The results of [29] study agreed on the length of the Juniperus communis ssp. nana, which ranged in length between (0.680 - 1.750) mm, with the results of [31] who found that the length of Juniperus excels ranged between (1.4-1.8) mm. This result is also consistent with what [38] stated that trees differ within one species. In terms of sites, it had no effect on the length of the tracheids . This is consistent with what [39] who studied the qualities of Pinus brutia wood in Zawita and Atrush and [40] who studied Pinus brutia in Zawita and Atrush and Shakfti sites in northern Iraq, as it was evident from the results of all their studies that there is no significant influence of the sites on the characteristic of the length of the tracheids, but there is a difference and a clear effect of the species factor in the length of the tracheids. Due to the fact that J. macrocarpa has the highest rate of tracheids compared to the other studied species, the importance of this type for use in the manufacture of cellulosic pulp and paper is due to the fact that the length of the tracheids positively affects the tear modulus, penetration resistance, tensile strength and the phenotypic characteristics of the produced paper, and this is what As indicated by [18] ,therefore, long-tracheids varieties are preferred in the pulp and paper industry [17;23;41; 42] also indicated that increasing the fiber length and lowering the Runkel ratio had a positive effect on the quality of the paste and the paper and the mechanical properties of the wood.

3-2 Tracheids diameter of juniper wood:
The results of Table (3) and Figures (1, 2 and 3) shows a variation between the species in the characteristic of the diameter of tracheids, as the species J. macrocarpa had the largest average diameter of tracheids (21,564) microns, followed by J. oxycedrus with average diameter of (19,018) microns. As for the lowest rod diameter, it was distinguished by the species J. polycarpos at average of (14.715) microns. With this result, the species were isolated from each other through the variation of the tracheids diameter. The results of the study of tracheids were consistent with the results of the study of [29] who studied J. excelsa, as the average diameter of the tracheids was (21.6) microns, and with the results of [31], as they found that the average diameter of the Juniper tracheids was (21) micron. It also agreed with the results of [43], as the average diameter of J. communis tracheids ranged between (15-25) microns. It was also found from this study that there was no effect of the sites on the difference in the diameter of the tracheids, and this result was consistent with [1;39 ,and 40] who indicated that the study sites did not contribute any part to the difference in the characteristic of The diameter of the tracheids, as indicated by the results of Table (3) that the individuals of the same species varied slightly among themselves in the diameter of the tracheids, and the reason for this variation may be due to the genetic factors within the same species, or as a result of the surrounding environmental conditions and their effect on the diameter of the tracheids , which are affected In turn, the diameter of the crown, and this was confirmed [17], and [44] stated that the diameter of the stem may develop with the development of the crown of the tree with age due to the increase in the production of the IAA hormone with the increase in the size of the crown, and then lead to Increase the diameter of the tracheids , and because the juniper species with large fruits
has the highest diameter of the stem, it is considered as the best species under study for use in the manufacture of pulp and paper.

3-3 Tracheid Wall Thickness:
Research and studies have proven that the thickness of the tracheids wall has a great influence on the mechanical and physical properties of wood, and on the quantity and quality of cellulosic pulps, paper and other industries that depend on chemically transforming wood for the purpose of benefiting from it [41]. The results of Table (3) show that there is a large variation between juniper species in the thickness of the tracheids wall, as the species J. macrocarpa was distinguished by the highest rate in the thickness of its tracheids wall, reaching (5.595) microns, while the lowest thickness was in the walls of the juniper stems of J. polycarpos, on average, (2.194) microns, while the average thickness of the wall of J. oxycedrus tracheids was (4.373) microns. Thus, the species could be isolated and diagnosed according to the thickness of the tracheids wall. It also agreed with the results of [31], where the average thickness of the tracheids wall for J. excelsa was (3.5) microns. Trees of the same species showed variation among themselves within the different study sites due to genetic reasons [45]. This indicates the significant influence of the sites on the thickness of the tracheids wall. These results are in agreement with the findings of[39], [18 and 46] who emphasized the influence of sites on tracheids wall thickness, and because of the great influence of the species on the thickness of the stalk wall, they differ in their use in the manufacture of paste and paper through the characteristic of the thickness of the stalk wall. Thus, J. macrocarpa has emerged as the preferred species in the manufacture of pulp and paper due to its having the highest rate of tracheids wall thickness.

3-4 Runkel Ratio:
Table (3) shows the Runkel ratios for the juniper species under study, as the Runkel ratios ranged between (0.425-0.922). The species was distinguished by Juniperus polycarpos with the lowest value for the Runkel ratio of (0.425), followed by J. oxycedrus with a value of (0.889), and J. macrocarpa with large fruits with a value of (0.922). Thus, all species of juniper studied according to Runkel's values are considered one of the best types of wood trees for the manufacture of pulp and paper, as they all fall within the group of thin sticks according to the Runkel classification (1952), and thus they give tensile strength and high penetration resistance to the produced paper [42]. The J. Polycarpos is considered as the best studied and fittest type for the manufacture of pulp and paper because it has the lowest values, followed by drinking juniper, then juniper large fruits. Table (3) shows that there is no significant influence of species in the average Runkel Ratio. The results of the current study of the dimensions of the tracheids also showed that the differences between the species are greater than the differences within the same species in the different sites, and this means that the source of the variation may be hereditary Because trees live under the same environmental conditions in one site. This supports the phenotypic study of needle and cone leaves, and emphasizes the necessity of individual selection of trees while trying to improve the trees of these studied species.

3-5 Bordered Pits diameter:
The results of Table (3) show that there are differences between species in the average of the Bordered pits diameters, as the J. oxycedrus species was distinguished by the largest Bordered pits diameter of the matrix of (9.556) microns, followed by the species J. macrocarpa with a rate of (8.645) microns, followed by J. polycarpos at (7.811) microns. Thus, it was possible to diagnose the juniper species and isolate them from each other. Simple pitting is found in parenchyma cells [44], and cross-field click type is a very important diagnostic feature of softwoods [16]. In general, it was found through the anatomical study that the quantitative characteristics of the tracheids of the juniper species under study have taxonomic significance and the heterogeneities that helped and reinforced the variation of the species among them, as it was possible to diagnose and isolate the species of J. oxycedrus and J. Longer, wider and thicker than the tracheids of J. oxycedrus, and with respect to J. polycarpos, it had the lowest mean length, diameter and thickness of the tracheids, and thus it was isolated from the previous two species, due to its smaller
values compared to the previous two types. With regard to the Runkel Ratio, the results showed that all species of studied juniper are suitable for the manufacture of paper pastes and paper, because they have the Runkel ratios that have fallen within the approved range for the best production and quality of the paper pulp. The lack of its values means that it has a positive effect on the quality of the paper pulp and then on the quality of papermaking, as well as its effect on the mechanical properties of wood, and this was confirmed [17; 23; ans 42]. As for the added flicks, it is evident through the results of the anatomical study and shown in Table (3) that all species had their click tracheids, as shown in Figure (1), but their diameters varied according to the species. 

Table (3) Dimensions of Tracheids, Runkel ratio and Bordered Pits diameter of juniper species studied.

| Seq. | Species and sites | Length of tracheid (mm) | Diameter of tracheid (um) | Tracheides Wall thickness (um) | Runkel ratio | Bordered Pits diameter (um) |
|------|-------------------|-------------------------|--------------------------|-------------------------------|--------------|-----------------------------|
| 1    | J. oxycedrus      | 1.473 – 0.919          | 20.000 – 13.836          | 4.604 – 3.405                | 0.915        | 8.856 – 7.208              |
| 2    | J. oxycedrus      | 1.767 – 1.080          | 23.000 – 19.000          | 6.428 – 4.440                | 0.996        | 11.662 – 10.200            |
| 3    | J. oxycedrus      | 1.334 – 0.963          | 24.16 – 14.500          | 5.517 – 3.720                | 0.806        | 11.201 – 7.560             |
| 4    | J. oxycedrus      | 1.421 – 1.016          | 18.544 – 14.001         | 5.730 – 3.125                | 1.175        | 11.827 – 7.696             |
| 5    | J. oxycedrus      | 1.626 – 0.729          | 24.068 – 18.727         | 4.118 – 3.2926               | 0.556        | 12.37 – 9.202              |
| 6    | J. macrocarpa     | 1.813 – 1.223          | 23.440 – 19.796         | 7.147 – 4.000                | 1.035        | 10.881 – 4.838             |
| 7    | J. macrocarpa     | 1.892 – 1.341          | 24.026 – 19.111         | 6.936 – 3.731                | 1.122        | 10.356 – 7.978             |
| 8    | J. polycarpos     | 1.358 – 0.775          | 16.763 – 13.788         | 2.863 – 1.600               | 0.425        | 8.955 – 5.882              |

3-6 Qualitative traits of tracheids:

The qualitative traits of tracheids are the other have had a prominent role in diagnosing the studied juniper species, as they are constant genetic traits of the species, and this is the basis of anatomical classification where certain structures are found in species and are not found in other types, such as the presence of vessels in hard wood and their absence in soft wood, where tracheids are found in soft woods instead of vessels, and vascular plants are distinguished from vascular plants through anatomical features. In this study, the results shown in Table (4) showed that there are variations in the qualitative traits between the studied species. It was possible to diagnose J. oxycedrus, which was characterized by the presence of two rows of Bordered pits in its tracheids, which is called Biseriate. As shown in Figure (1), and it is not present in the other two types. The results also showed the presence of thickening Helical in the tracheids of drinking juniper, as well as the presence of dentate in the tracheids of this species, and their absence in the other two species. As shown in Figure (1). Figures (2 and 3) show the tracheids of the two species J. macrocarpa and Himalayan pens juniper( J. polycarpos). In view of the great economic value of wood and to enhance this value, its different properties must be known and studied in detail due to its great influence on its specifications in the fields of different uses. It affects its uses such as drying, chemical treatments, and the manufacture of cellulosic pulp and paper.
Table (4) Qualitative traits of the tracheids of the studied juniper species.

| Seq. | Species               | Number of Borderd pits rows | Dentate of Tracheids Wall | Helical thickening |
|------|-----------------------|-----------------------------|---------------------------|-------------------|
|      |                       | Uniseriate                  | Biseriate                 | Presence          | Non Presence      |
| 1    | *J.* *oxycedrus*       | +                           | +                          | +                 | Non Presence      |
| 2    | *J.* *macrocarpa*      | +                           | +                          | +                 | +                 |
| 3    | *J.* *polycarpos*      | +                           | +                          | +                 | +                 |

The sign (+) indicates the adjective for the species.

Through the results of the anatomical study, whether quantitative or qualitative, we can say that the aforementioned wood traits are constant genetic traits for the same species, so the anatomical study of the juniper species wood under study confirms that the three species do not belong to the same taxonomic unit and count them as separate species, as each species is unique. It has special qualities that differ from the characteristics of the other two species, as shown in Tables (3 and 4), and fig. (1, 2, 3). It is evident from the foregoing that the anatomical evidence stands side by side with other taxonomic evidence such as the morphological evidence for the performance of one common purpose is to diagnose, distinguish and isolate each of the species of juniper genus studied. Thus, this anatomical study has confirmed that *J.* *macrocarpa* is a separate species from *J.* *oxycedrus*, due to the qualitative and quantitative difference between the two anatomical characteristics.
Fig. (1) *J. oxycedrus* tracheids: magnification force (x 40)

1- Biseriate of Borderd pits,  2- Dentate  3- Helical thickening
Figure. (2) Tracheids of *J. macrocarpa* with a Monoseriate of Borderd pits.
Figure (3) Tracheids of species *J. polycarpos* with a Monoseriate of Borderd pits.

3-7 *Anatomical Identification key for wood of the studied juniper species:*

Due to the absence of any anatomical taxonomic study of the species of juniper genus in Iraq, for the first time an anatomical key was developed to diagnose *Juniperus* L. wood in the Iraqi country based on the quantitative and qualitative anatomical characteristics of the wood and based on the evidence of [1]. as shown in the table (5).
Table (5) Anatomical key to Identification juniper wood species in Iraq according to [47]

| characters          | Species | J. oxycedrus | J. macrocarpa | J. polycarpos |
|---------------------|---------|--------------|---------------|---------------|
| Length of Tracheids | short (1.233) mm | +            |               |               |
|                     | Medium (1.608) mm | +            |               |               |
|                     | too short (0.993) mm | +            |               |               |
|                     | wide (19.018) μm | +            |               |               |
| Width of Tracheids  | more wide (21.564) μm | +            |               |               |
|                     | less wide (14.715) μm | +            |               |               |
| Thickness of Wall   | Medium thickness (4.373) μm | +            |               |               |
|                      | Thick (5.595) μm | +            |               |               |
|                      | Little thickness (2.194) μm | +            |               |               |
| Number of Borderd pits | Monoseriate | +            | +            | +            |
|                      | Biseriate | +            | +            | +            |
|                      | Dentate | +            | +            | +            |
|                      | Smooth | +            | +            | +            |
|                      | Found | +            | +            | +            |
| Helical thickening  | Not found | +            | +            | +            |
|                      | less value (0.425) | +            | +            | +            |
| Runkel Ratio        | Medium (0.889) | +            | +            | +            |
|                      | The biggest value (0.922) | +            | +            | +            |
| Diameter of Borderd pits | Medium (8.645) μm | +            | +            | +            |
|                      | big Diameter (9.556) μm | +            | +            | +            |
|                      | small diameter (7.811) μm | +            | +            | +            |

The sign (+) indicates the adjective for the species.

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