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Original Research Article

Comparing the Anatomical Characteristics of the Stems of Some Species of Papaver Genus Which Belong to the Papaveraceae Family that Grows in the Wild in Middle of Iraq

Khammas Iedan Mohammed[1*], Evan Abdul Rahman Hamza[2], Duaa Ahmed Hassan Al-Kailani[3]

[1]Al-Hadara University college, Tikrit, Iraq
[2]College of Science, Biology Department, Tikrit University, Tikrit, Iraq
[3]Biotechnology Department, College of Applied Science, University of Samarra, Iraq

***Corresponding Author:** Khammas Iedan Mohammed
Al-Hadara University college, Tikrit, Iraq

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Abstract: The research included studying the anatomical characteristics of the stems of four species which belong to Papaver genus, which is one of the genera that belong to the Papaveraceae family grows in the middle of Iraq. The species are P. bornmuelleri, P. curviscapum, P. polychaetum, and P. tauricola. Species samples were collected during 2024, and 7 field turns were carried out, covering the central provinces, in addition to a comprehensive survey of herbarium samples preserved in the Iraqi National Herbarium and other university herbariums for the purpose of diagnosis. The study showed that the vascular bundle consists of bark to outside and wood to inside, as this type of unilateral vascular bundle is called Open collateral vascular bundle, which is a feature that distinguished all the studied species, as the anatomical sections of the stems grand good taxonomic importance in isolating and separating the species from each other through the shape and size of the tissues, the thickness of the bark, the Xylem and Phloem tissues, the number of vascular bundles, and the thickness of the pith.

Keywords: Papaveraceae, *Papaver*, Isodiametric, Open Collateral Vascular Bundle.

1-INTROUCTION

Some researchers have focused on using the anatomical characteristics of some plant parts such as the stem, leaves and fruits in isolating and separating the plant species and genera of some species of the Papaveraceae family, such as the study of Singh and his group (2001) on P.argemone, P.hybridum spices which found in Turkey, Iraq and Iran, and the study of Lujan and his group (2004), Goetz and his group (2009), Rahmatpour and his group (2010), Gupta and Rao (2012).

Archaeological evidence also indicated the cultivation and the use P. somniferum, P. persicum, and P. rhoeas spices in Iraq. These species and their locations were mentioned in the areas adjacent to Turkey, such as Iraq and Iran. The latter species is rarely found in Turkey and is widely spread in Iraq (Gardner and Gardner, 2014).

Elven (2018) indicated that P. macrostomum spice is used as a source of several chemical compounds and is widespread in Iraq, Turkey, Iran, and southern Soviet Union. It has three varieties, but the source did not specify which one exist in Iraq.

While Rahmatpour and his group (2010) mentioned that have an anatomical study to separate the species due to their differences in terms of permanence is a necessary matter, as some of them are perennial and others are annual, as determined by the vascular bundles and their number. Some researchers have described the morphological and anatomical features of genera of Papaveraceae family such as the Glaucium and Fumaria and some species of the genus P. rhoeas

Rajopadhye and Upadhye (2011), Bercu, (2012), Tavakkoli and Assadi (2013), Kilic and his group (2019), and Lack, (2019). One of the important and notable studies that based on studing anatomical features in the classification of plant groups, including Papaveraceae family in Iraq, is the study of Al-Mousawi and his group (2019), he mentioned in his study seven species within 5 genera and the study focused on the anatomical features of leaves and stems by using light and electron microscopes, and indicated both Stomatal complexes and cross-sections.

2-MATERIAL AND METHODS

2.1. Preparing Transverse Sections

Fresh samples collected during field travels were used in this study, as well as some dry samples. The sections were prepared by hand sectioning by adopting the following steps with some modifications in the method of preparing the materials {which is the same method followed by Al-Khafaji (2004)} as follows:

1- The selected plant stems were cut into small pieces with a length ranging between (7-5) cm from an area located approximately in the middle of the plant stem. During cutting, the soft stem was held in a vertical position between the thumb and index finger and cut by a sharp dissection blade into thin pieces in a flat, non-slanted position until the thinnest transverse section of the stem with clear features was obtained. Some plant sections were cut under a dissecting microscope.
2- The small sections were transferred to sodium hypochlorite solution (industrial bleach) with a volume of (1) ml with distilled water with a volume of (0.5) ml to get rid of the chlorophyll dye for 15 minutes.
3- The sections were stained with safranin that (prepared by dissolving 1 gram of the dye in 99 ml of ethyl alcohol with 50% concentration) for 1-2 hours, then sections were washed with ethyl alcohol 70% to get rid of the excess dye.

The sections were transferred to 90% ethyl alcohol for 5 minutes.

4- Then the sections were transferred to alcohol with 95 % concentration and absolute alcohol respectively for 2 minutes for each concentration.
5- The sections were then transferred to a mixture of absolute alcohol and xylene in a volume ratio of 1:1 for 2 minutes.
6- Then the sections were transferred to pure xylene for 2 minutes.
7- The sections were then transferred to a glass slide and loaded with Canada conditioner to cover the section, then the slide cover was gently placed on it, avoiding the formation of bubbles in the section, and left on a hot plate at a temperature of 40-45°C until it dried.
8- The samples were photographed and studied by using a Novel compound light microscope equipped with a digital camera NSZ-606, under magnification powers (10x and 40x). An ocular micrometer was also used to measure some anatomical dimensions.

3-RESULTS AND DISSCUSION

Study of the Cross-Sections of the Stem

The study of the species of the Papaver genus showed variations in terms of the cross-sectional shapes of the stems, as their shapes varied between circular and subcircular in some species, such that they appear clearly during the microscopic cross-sections, and they cannot be easily distinguished phenotypically, and this variation in the anatomical shapes of the stem has been reported and adopted by many researchers (Metcalf, 1957 and Christenhusz and his group, 2017).

All the studied species were characterized by solid aerial stems, noting that the cross-sections of the stem were taken from the area which lies above the base and slightly below the middle for all the studied species.

The cross-section of the stem consists of several parts, the first of which is the cuticle, which is a thin, flat, smooth layer covers skin surface. It varied in thickness and nature in most species, with the highest average thickness of the cuticle reaches to 5.4 micrometers in P. curviscapum and the lowest average thickness reaches 3.37 micrometers in P. polychaetum, and other species ranges between these two averages. It was followed by a ongoing layer of cells that are stacked one by one, uniseriate, with straight walls in some cases. These cells represent the epidermis layer, which considered simple epidermis type. A single layer of epidermal cells was observed in all the studied species. They varied in the cross-section in terms of epidermal thickness, with the highest average reaches 20.2 micrometers in P. curviscapum and the lowest average in epidermal thickness reaches 8.83 micrometers in P. tauricola. The rest of the species ranges between these two averages. The epidermal cells appeared in cross-section of the stem in an oblong to isodiametric shape within a single section of the stem.

The cortex layer, which follows epidermis directly, composed of two or more types of permanent tissues. It also varied in thickness, reaches to the highest average of 178.83 micrometers in P.tauricola and the lowest average of 143.3 micrometers in P.polychaetum. The cortex layer contained the chlorenchyma tissue in all species, and appeared in the form

of a dark layer that contains a good amount of chloroplasts, followed by layers of ordinary parenchyma tissue. This layer has thin walls, gradually increasing in size toward the center, enclosing spaces between them that vary in size according to species. Its shapes ranged between ovate and spherical, while the third tissue was the sclerenchyma tissue, which was more obvious. In terms of the number of its rows inside the cortex layer to perform its support function for the stems, especially in plants whose stems grow prostrate on the ground, such as P.curviscapum and P.tauricola, which had thin aerial stems compared to other species, and this is consistent with what Al-Moussawi and his group (2019) indicated about the nature of the inner part of the cortex layer, which was characterized by being a dense sclerenchyma tissue in weak aerial stems that need support.

While the cross-sectional shape of the conductive elements in the wood was circular in most species, the xylem vessels varied in their thickness between species, as the average thickness ranged between 165.6-216.6 micrometers in P.tauricola and P.bornmuelleri, respectively, and other species ranged between these two limits.

The vascular bundle consists of bark to the outside and wood to the inside, and this type of vascular bundle is called open collateral vascular bundle, which is characterized all the studied species.

The bark thickness varied, it reached 55.23-92.3 micrometers in P.polychaetum and P.curviscapum, respectively, and the rest of the species ranged between these two limits.

While the arrangement of the vascular bundles, it was in the form of a circular cylinder in all species, and the number of vascular bundles ranged from 15-25 vascular bundles in P.bornmuelleri and P.polychaetum, respectively, while the rest of the studied species ranged between these two limits, as in the table.

While the pith in the cross-section of the aerial stems was characterized by its large, circular cells with thin walls, that enclosed by intercellular spaces that differs in size according to the species, it was found that the shape of the pith cells was oval-circular in all the studied species, as the thickness of the pith varied and reached 387.6-792.3 micrometers in P. bornmuelleri and P. curviscapum, respectively, while the rest of the other species ranged between these two levels.

Table of variations in quantitative and qualitative characteristics of cross-sections in the stems of species

(*Measured by micrometer)

	Spices	**Cuticle thickness**	**Epidermis thickness**	**Cortex thickness**	**Wood thickness**	**Bark thickness**	**Number of vascular bundles**	**Pith thickness**
1	*P. bornmuelleri*	(4.6-2.8) 3.53	8.86(11.3-6.8)	152(167-139)	216.6(259-189)	72.6(87-61)	15	387 .6(423-360)
2	*P. curviscapum*	5.4(6.15 4.35)	20.2(22.5-18)	171.5(191.5-158)	166.3(179-151)	92.3(102-82)	21	792.3(891-709)
3	*P. polychaetum*	(3.63-3) 3.37	10.58 (12.25-9)	143.3(154-135)	215.6(247-190)	55.23(62.5-50.2)	25	527.6(652-522)
4	*P. tauricola*	3.7(4.15 3.25)	8.83(10.3-7.7)	178.83(192-160)	165.6(176-157)	74.46(86 - 61.1)	22	667(736-610)

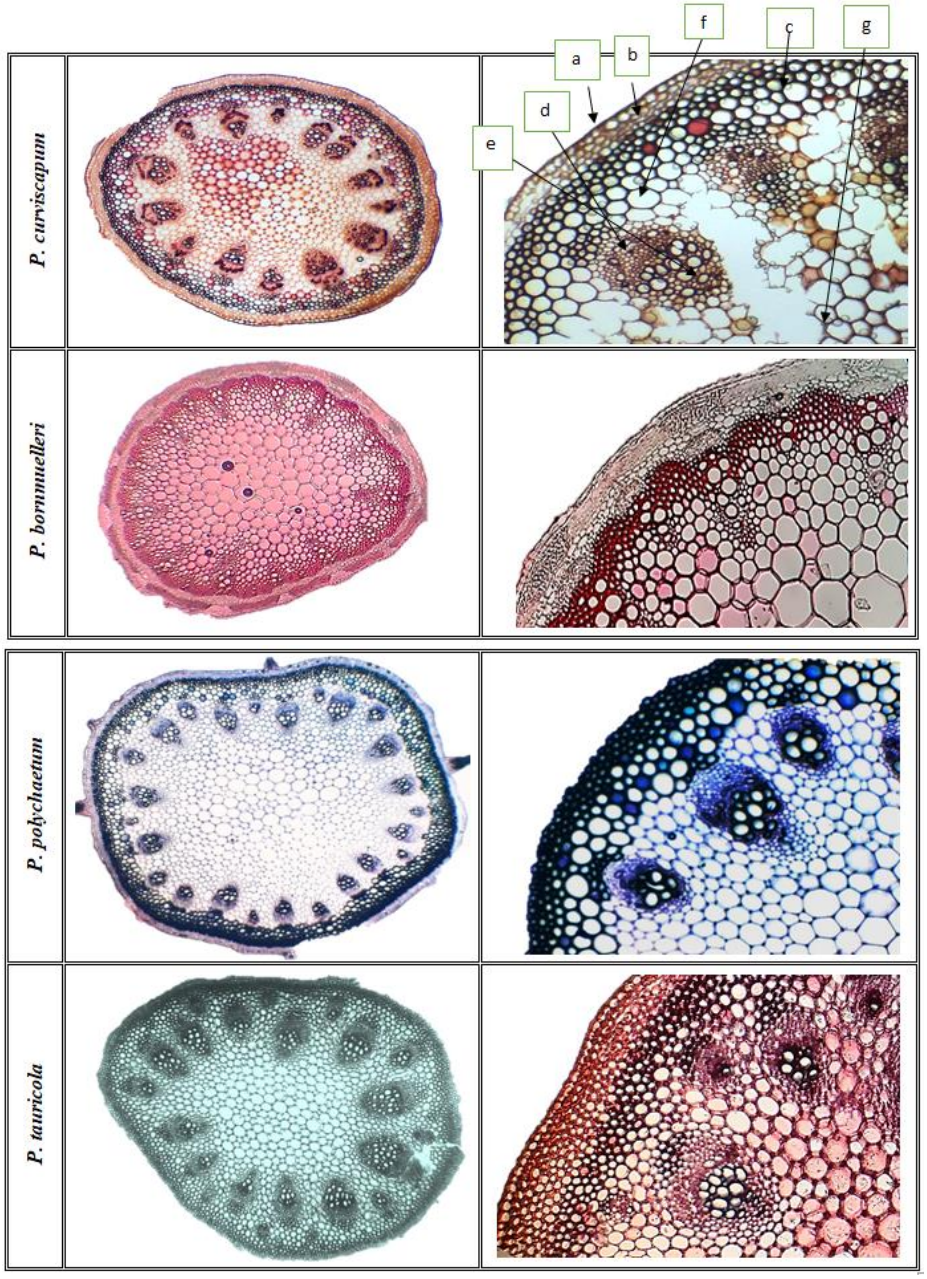

Figure 1: 1-a: Cuticule 2-b: Epidermis 3-c: Cortex 4-d: Xylem 5-e: Phloem 6-f: Collenchyma 7-g: Parenchyma

4-CONCLUSION

This study concluded that the anatomical characteristics of Papaver species provide important criteria for classifying species within the Papaveraceae family. Stem cross-sections showed clear variations in overall shape, the thickness of the different layers, and the number of vascular bundles, helping to distinguish between the studied species.

The results also confirmed that all species possessed rigid aerial stems and varied in the thickness of the epidermis, cortex, and bark, as well as significant differences in the arrangement of vascular tissues and the number of vascular bundles. The study also demonstrated that some species, particularly those with soft stems, contained denser sclerenchyma tissue to provide structural support.

Based on these findings, anatomy can be considered a reliable tool for classifying plant species and provides important insights into understanding the ecological adaptations of these plants. Therefore, the study recommends further research using more advanced microscopic techniques, such as electron microscopy, to study more anatomical details and make comparisons with other species within the plant family.

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