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تقييم الأهمية التصنيفية للسمات التشريحية في تمييز أنواع العائلة المظلية في العراق

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المستخلص:

كشفت الدراسات التشريحية لمراتب العائلة المظلية Apiaceae عن مجموعة من السمات المشتركة ذات الأهمية التصنيفية. شملت هذه السمات اختلافات الشعيرات والثغور بين الاجناس، كما أظهرت المقاطع العرضية للساق اختلافات في شكل الحافة الخارجية، تتراوح بين المتموجة والمضلعة والنجمية، مع وجود أضلاع وأخاديد واضحة في معظم الاجناس.

من السمات التشريحية الرئيسية لهذه العائلة وجود قنوات إفرازية تحتوي غالباً على زيوت عطرية متطايرة، وهي سمة مميزة للعائلة المظلية، موزعة في القشرة أو بالقرب من الحزم الوعائية، وتُعد هذه السمات من الخصائص التشخيصية المهمة، بالإضافة إلى اختلافات في اللب، سواء كان كاملاً أو مجوفاً.

تؤكد هذه النتائج أن السمات التشريحية للسيقان وبشرة الأوراق، ونوع الثغور، ونوع النسيج الداعم، ووجود القنوات الإفرازية، تُعد أدوات تصنيفية فعالة يمكن الاعتماد عليها للتمييز بين اجناس العائلة المظلية وتوضيح علاقاتها التصنيفية.

الكلمات المفتاحية: العائلة المظلية، مراتب، نوع الثغور، الخلايا الإفرازية.

Evaluating the taxonomic significance of anatomical features in distinguishing species of the Apiaceae family in Iraq

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Abstract



Anatomical studies of the taxa within the Apiaceae family revealed a set of common features of taxonomic importance. These included variations in hairs and stomata within the genus, and stem cross-sections showed variations in the shape of the outer margin, ranging from wavy to ribbed to star-shaped, with distinct ribs and grooves present in most genera.

A key anatomical feature of the family is the presence of secretory ducts that often contain volatile essential oils, distributed in the cortex or near the vascular bundles, which are important diagnostic characteristics, as well as variations in the pith, complete or hollow.

These results confirm that the anatomical features of stems and leaf epidermis, stomatal type, supporting tissue type, and the presence of secretory ducts are effective taxonomic tools that can be relied upon to distinguish among genera in the Apiaceae family and to clarify their taxonomic relationships.

Keywords: Umbelliferae family, Genus, stomata type, Secretory cells.

Introduction

The Apiaceae family, or the old name Umbelliferae family, is one of the most important and widespread flowering plant families in the world, comprising approximately 434 genera and more than 3,700 species (Heywood *et al.*, 2007). Members of this family are characterized by their umbel-like inflorescences, which are their primary morphological feature (Stace, 2010). They also contain volatile oils and active compounds that have given many species significant nutritional, medicinal, and economic importance. Some of the most well-known plants in this family include carrots, celery, parsley, dill, coriander, cumin, and fennel.

The Apiaceae family is found in most parts of the world, but its greatest diversity is found in the temperate and sub-temperate regions of the Northern Hemisphere. Numerous species are also found in Europe, Asia, Western Asia, the Mediterranean basin, and North America. These species are adapted to diverse environments, including grasslands, plains, mountains, and semi-arid regions (Taylor, 1994).

In Iraq, the Apiaceae family is a significant plant family within the country's natural vegetation, comprising approximately 155 species recorded in the



Iraqi flora, making it one of the largest plant families in the country (Guest, 1966). Its species are distributed across various ecological zones, particularly in the mountainous and semi-mountainous regions of northern Iraq, as well as in plains, valleys, and desert and semi-desert areas. This diversity is attributed to Iraq's geographical location and the variation in its climatic and topographical conditions, which provide suitable environments for the growth of numerous genera and species within this family (Davis, 1975).

Given its economic, medicinal, and environmental importance, the Apiaceae family has garnered considerable attention from researchers in the fields of plant taxonomy, anatomy, and phytochemistry, as it is a vital source of active ingredients and essential oils used in the food and pharmaceutical industries (Clarkson *et al.*, 2021).

The research aims to reveal the taxonomic importance of anatomical and morphological characteristics in members of the Apiaceae family, and to determine their efficiency in separating different species and genera, as well as to build a diagnostic database that contributes to supporting taxonomic and floristic studies of Iraqi plants, and to highlight the role of plant anatomy as a tool to support traditional classification in clarifying taxonomic relationships within the family.

Materials and methods

• Plant collected

The current study depended on soft samples, which were gathered on 26/4/2026-8/5/2026, from Sulaymaniyah district (MSU) and Arbil district (FAR) in the north of Iraq Table 1.

The mentioned type was diagnosed using classification keys of Apiaceae in Flora of Iraq (Guest, 1966), as well as internet sources. Samples of the leaves and stems were taken from specific areas of the plant (Al-Shami *et al.*, 2024). Then, fixation was performed with F.F.A. solution for 24-48 hours according to Johansen (1940); it was also washed with 70% alcohol and kept in the same solution at the same concentration until use.

• Epidermis preparation

To prepare the epidermis of the leaves, the epidermis of the leaf was rubbed off to reveal the stomata, and then the sample was immersed in distilled



water and treated with a 5% sodium hypochlorite solution for 10 minutes. It was later washed with distilled water and transferred to another Petri dish containing 10% KOH for 5 minutes. Then, the solution was replaced with ethyl alcohol 70% for 10 minutes. At the end, the sections were washed with distilled water and placed under a slide microscope examination.

Examination was done with a KRÜSS compound microscope, and a photograph was taken with an AmScope (Model MU 1000) microscope-mounted camera. The method followed Al-Khazraji & Aziz (1989), with some modifications according to Al-Taie *et al.* (2025).

The stomata index, a measure of stomatal density and its relationship to normal epidermal cells, was calculated based on Stace (1965).

Stomata Index = Amount of Stomata / Number of Normal Epidermal Cells × 100

• Cross-section preparation

Samples were intended manually by following Hutchinson (1954) with some modification according to Al-Rawi *et al.*, (2025)

The leaves were cut into very small pieces and immersed in a 5% AL-Sodium hypochlorite solution for 10 minutes to remove chlorophyll. Later, the parts were stained with 5% safranin for 2 hours and then washed with 70% ethyl alcohol to remove excess dye. Then, the parts were put into 90% ethyl alcohol for 6 min., and 95% alcohol and absolute alcohol, respectively, for 2 min for each solution. At the end, the samples were examined with a KRÜSS compound microscope and photographed with an AmScope Model MU 1000 camera.

Results and Discussion

The leaves of members of the Apiaceae family are characterized by the presence of stomata scattered across their epidermis. These leaves are often amphistomatic, meaning that stomata are present on both the Adixial and Abxial surfaces of the leaf.

The characteristics of the stomatal complex in leaves of Apiaceae taxa are shown in Table 2.



In all taxa, the stomata appeared on both the adaxial and abaxial surfaces, except for the taxon *Zosima absinthifolia*, where the stomata appeared only on the abaxial surface.

While stomata vary in type within the Apiaceae family, anomocytic type stomata (the guard cells are surrounded by several ordinary epidermal cells) appear in the taxa: *Artemisia squamata*, *Prangos ferulacea*, *Tordylium aegyptiacum* (Abxial service only), *Trigonostadium viscidulum*, *Zosima absinthifolia* and *Cuminum cyminum*. So, the taxa: *Daucus Carota* and *Tordylium aegyptiacum* (Adixial service only) were diacytic type (the guard cells are surrounded by two subsidiary cells that are perpendicular to the longitudinal axis of the stomata). The guard cells are usually kidney-shaped and surrounded by epidermal cells with varying degrees of straight or wavy walls. Anatomical studies have shown that the number of stomata, their dimensions, stomatal density, and stomatal index are useful diagnostic characteristics that can be used to differentiate between different species and genera within the Apiaceae family (Christodoulakis *et al.*, 2002 and Al-Taie *et al.*, 2022).

Characteristics of the stem cross-section in Apiaceae taxa appear in Table 3. The stems of taxa in the Apiaceae family are characterized by distinctive anatomical and morphological features that make them of great taxonomic importance (Clarkson *et al.*, 2021). In cross-section, the shape of stems varied in the taxa under study, where it appeared circular in *Artemisia squamata*, Rhombic in *Daucus Carota* and *Trigonostadium viscidulum*,

Polygonal with prominent ribs in *Prangos ferulacea* and *Tordylium aegyptiacum*, Oval in *Zosima absinthifolia*, and Stellate in *Cuminum cyminum* (Table 3 and Figure 2).

Anatomically, the stem consists of a single-layered epidermis covered by a thin cuticle layer, which may bear unglandular hairs in the taxa: *Daucus Carota*, *Trigonostadium viscidulum*, *Zosima absinthifolia*, and *Cuminum cyminum*, the type of which is unicellular, uniseriate.

Beneath the epidermis lies a cortex composed of collenchyma and parenchyma cells and the secretory canals (specialized intercellular spaces) distributed throughout the cortex or near the vascular bundles and containing



volatile oils and resinous substances, and this feature agrees with (Fahn, 1982 and Downie *et al.*, 2010) who state that it is considered among the most prominent anatomical features of the family.

The vascular bundles are arranged in a single ring near the stem's circumference and are of the open collateral vascular type, with the phloem positioned outwards and the xylem inwards, separated by the cambium. The pith occupies the central part of the stem and consists of large, thin-walled parenchyma cells; it is often extensive and well-defined in most species, and in the species *Trigonosciadium viscidulum* and *Zosima absinthifolia*, it was hollow.

The cross-sectional shape, number of ribs, presence of secretory ducts, vascular bundle distribution pattern, and nature of the supporting tissues are among the most important anatomical features used in identifying genera and species within the Apiaceae family and studying their taxonomic relationships (Esau, 1965; Magee *et al.*, 2010).

Table 1. List of collected Apiaceae genus from North of Iraq.

No.	Species	County code*
1	<i>Artemisia squamata</i>	MSU, FAR
2	<i>Daucus Carota</i>	MSU, FAR
3	<i>Prangos ferulacea</i>	MSU, FAR
4	<i>Tordylium aegyptiacum</i>	MSU
5	<i>Trigonosciadium viscidulum</i>	MSU, FAR
6	<i>Zosima absinthifolia</i>	MSU, FAR
7	<i>Cuminum cyminum</i>	MSU



Table 2. Characteristics of stomatal complex in leaves of Apiaceae taxa in Iraq (measurement in μm).

No.	Species	Stomata of Adaxial epidermis			Stomata of Abaxial epidermis		
		length	width	Stomatal index	length	width	Stomatal index
1	<i>Artemisia squamata</i>	32.1.2-28.2 (30.5)	22.5-19.6 (20.9)	16	33.1 36.8 (34.1)	29.5-24.2 (27.9)	18.6
2	<i>Daucus Carota</i>	55.6-47.4 (50.9)	38.1-33.3 (35.5)	16.2	50.5 56.1 (51.3)	45.5-40.1 (44.1)	20
3	<i>Prangos ferulacea</i>	77.4-73.1 (75.4)	49.5-45.1 (48.6)	12	80.4 88.9 (85.1)	57.4-50.6 (53.2)	16
4	<i>Tordylium aegyptiacum</i>	47.6-42.1 (44.9)	33.4-28.6 (31.8)	16.3	52.1 55.6 (53.4)	46.5-41.2 (44.8)	16.5
5	<i>Trigonostadium viscidulum</i>	20.3-16.5 (18.4)	18.5-14.1 (15.5)	12	26.4 35.3 (30.1)	21.5-17.8 (18.2)	16
6	<i>Zosima absinthifolia</i>	-	-	-	50.1 58.6 (57.5)	49.3-45.5 (46.8)	20
7	<i>Cuminum cyminum</i>	67.9-63.1 (65.5)	48.2-45.1 (47.5)	16.5	72.5 76.8 (74.9)	59.3-54.1 (55.9)	22.4

Between brackets = mean of 10 replicates.



Table 3. Characteristics of stem cross section in Apiaceae taxa in Iraq (measurement in μm).

No.	Species	Shape of section	Thickness of cuticle	Thickness of epidermis	Thickness of cortex	Pith thickness	Vascular bundle diameter
1	<i>Artedia squamata</i>	Circular	5.5-6 (5.75)	٣٠.٧-٢٥.٥ (٢٦.٣)	٦٣.٢-٥٥.٥ (٦٠.٤)	-٢٨٣.١ ٢٩١.٤ (٢٨٨.١)	-١٥٣.٤ ١٦١.٧ (١٥٥.٣)
2	<i>Daucus Carota</i>	Rhombic	5-5.5 (5.25)	٧٩.٣-٦٥.٢ (٧٨.٤)	٩٧.٥-٨٩.٥ (٩٣.٣)	-٢٠٠.٢ ٢٠٨.٥ (٢٠٤.٥)	-١١٠.٥ ١٢٢.٥ (١٢٠.٨)
3	<i>Prangos ferulacea</i>	Polygonal with prominent ribs	4.25-5.5 (5)	٥٨.١-٤٩.٨ (٥٥.٥)	٨١.٢-٧٥.١ (٨٠.٨)	-٢٩٦.٣ ٢٠٥.٤ (٢٠٣.٨)	-١٨٤.١ ١٩٢.٤ (١٩٠.٥)
4	<i>Tordylium aegyptiacum</i>	Polygonal with prominent ribs	3.25-5.25 (4.5)	٦٨.٧-٥٩.١ (٦٥.١)	٨٨.٣-٧١.٥ (٨٦.٤)	-٢٤٦.٥ ٢٥٥.٣ (٢٥٠.٧)	-١٩٤.١ ٢٠٥.٧ (٢٠١.٦)
5	<i>Trigonosciadium viscidulum</i>	Rhombic	4.5-7 (5.75)	٤٤.٢-٣٤.٨ (٣٥.٥)	٥٥.٩-٤٥.١ (٥٠.٨)	٤٥.٥-٣٥.١ (٣٨.٢)	-١٠٨.٠ ١١٥.٩ (١١١.٣)
6	<i>Zosima absinthifolia</i>	Oval	4.75-5.75 (5.1)	٥٤.٦-٤٤.٥ (٥٠.٣)	-٧٦.١ ٨٠.٢ (٧٧.٢)	-٢١٠.١ ٢١٨.٤ (٢١٥.٤)	-١٨٨.٥ ١٩٦.٤ (١٩٠.٤)
7	<i>Cuminum cyminum</i>	Stellate	3.75-5.5 (4.3)	٧١.٢-٦٠.١ (٦٦.٥)	٦٩.٥-٦٣.٧ (٦٨.٤)	-٢٦٨.٩ ٢٧٧.٤ (٢٧٠.٥)	-١٠٢.١ ١١٥.٥ (١١٠.٦)

Between brackets = mean of 10 replicates.

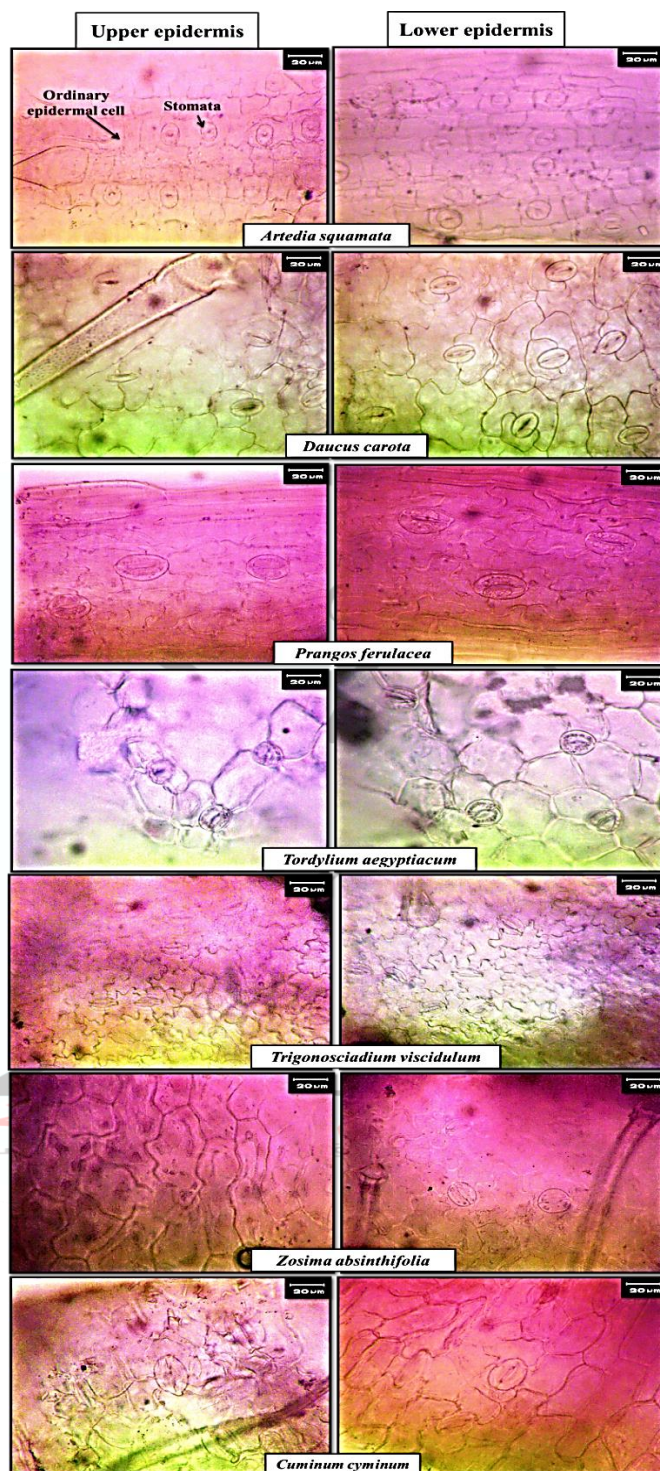


Figure 1: Service view showing the shape and type of stomata in the epidermis of leaves of the genus from the Apiaceae family

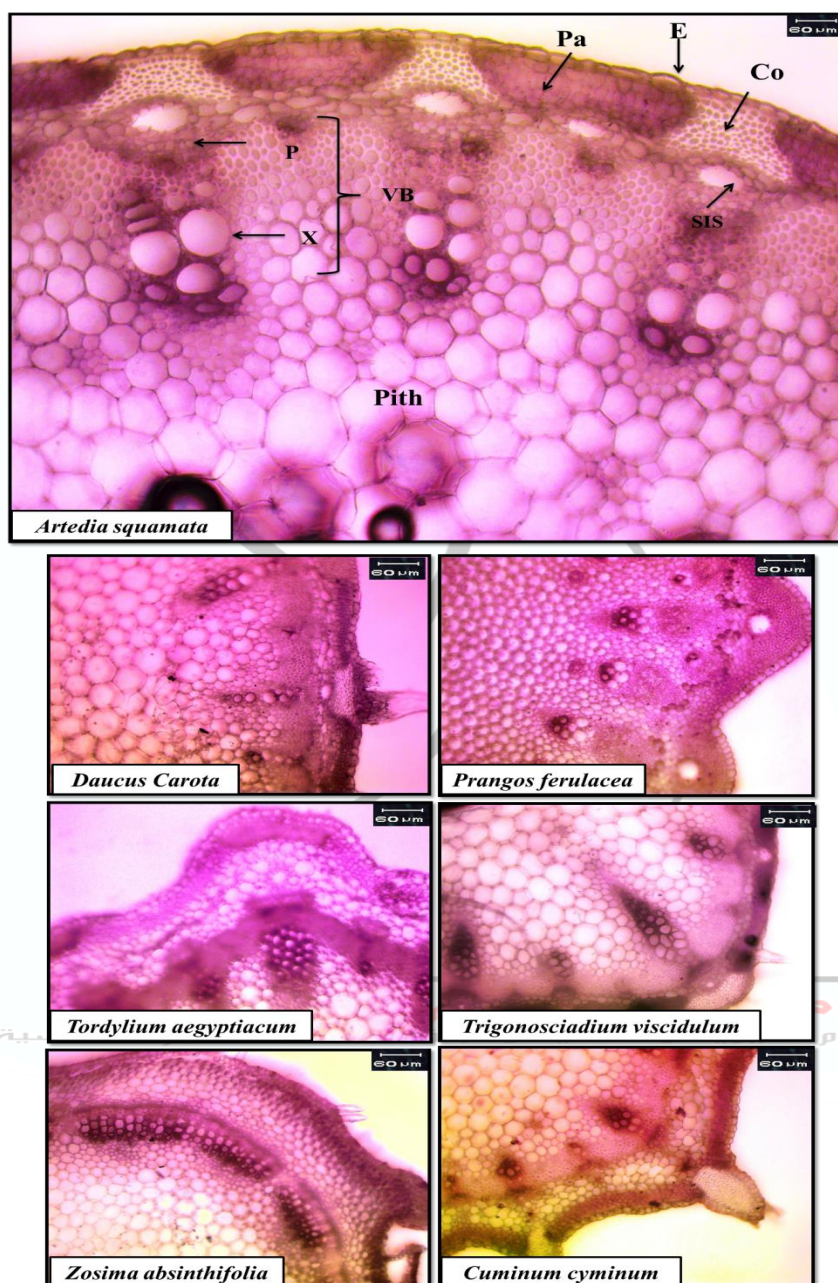


Figure 2: cross-section of the stem of the genus from the Apiaceae family.

Where E: epidermis, Co: collenchyma tissue, Pa: parenchyma cell, VB: vascular bundles, P: phloem, X: xylem, and SIS: specialized intercellular space

**References:**

1. Heywood, V.H., Brummitt, R.K., Culham, A., and Seberg, O. (2007). Flowering plant families of the world. New York, U.S: Firefly Books.
2. Stace, C. A. (2010). New Flora of the British Isles (Third ed.). Cambridge, U.K.: Cambridge University Press. p. 88.
3. Taylor, R. J. (1994). Sagebrush Country: A Wildflower Sanctuary (rev. ed.). Missoula, MT: Mountain Press Pub. Co. p. 94.
4. Guest, E. (1966). Flora of Iraq. Ministry of Agriculture, Iraq, Vol.1, 213 PP.
5. Davis, P. H. (1975). Flora of Turkey & the East Aegean Islands. Edinburgh, Univ. Press, Vol. 5:788-812.
6. Clarkson, J. J., Zuntini, A. R., Maurin, O., Downie, S. R., Plunkett, G. M., Nicolas, A. N., Smith, J. F., Feist, M. A. E., Gutierrez, K., Malakasi, P., Bailey, P., Brewer, G. E., Epiawalage, N., Zmarzty, S., Forest, F. and Baker, W. J. (2021). A higher-level nuclear phylogenomic study of the carrot family (Apiaceae). American Journal of Botany. 108 (7): 1252–1269.
7. Al-Shami, S. S. D., Al-Taie, A. T., Al-Hadeethi, M. A. H., Hasan, S. A. R. (2004). Morphological and Anatomical study of the floral parts of lily (*Lilium candidum* L.) cultivated in Iraq. Sabrao Journal of Breeding and Genetics. 56(6): pp. 2351–2357.
8. Johansen DA (1940). Plant microtechnique. Mc. Grow-Hill Book Company, New York and London. 523pp.
9. Al-Khazraji T. O. and Aziz F. M. (1989). Practical in plant anatomy and microscopic preparations. Press of the Ministry of Higher Education and Scientific Research. University of Salahuddin, 321pp. (In Arabic).
10. Al-Taie, A. T., Mahboba, B. A. and Al-Hadeethi, M. A. (2025). STOMATA STRUCTURE ON THE FRUIT EPIDERMIS IN WILD FRUIT SPECIES. Sabrao Journal of Breeding and Genetics Open-source preview. 57(4), pp. 1652–1659.
11. Stace, C. A. (1980). Plant taxonomy and biosystematics. Edward Arnold. London: 279p.



- 12.Hutchinson, E.P. (1954). Sectioning methods for moss leaves. *Bryologist*, 57: 175-176.
- 13.Al-Rawi, A. A. F., Al-Taie, A. T., Al-Hadeethi, M. A. and Khal, L. H. (2025). ANATOMICAL STUDY OF THE GENERA DACTYLORHIZA ELATA AND OPHRYS BOMBYLIFLORA (ORCHIDACEAE) GROWING WILD IN IRAQ. *Sabrao Journal of Breeding and Genetics* Open-source preview. 57(1), pp. 303–310
- 14.Christodoulakis, N. S., Menti, J., Galatis, B. (2002). Structure and development of stomata on the primary root of *Ceratonia siliqua* L. *Ann Bot*, 89:23–9.
- 15.Al-Taie, G. R., Malik, W. M. D. and Al-jibouri, K. D. W. (2022). A comparative taxonomical, anatomical and molecular study of the Genera *Grammosciadium* DC and *Torilis Adans* (Apiaceae) in mountain and upper plains and foothills regions in Iraq. A Thesis, College of Education for Pure Sciences / Diyala University, Iraq.
- 16.Clarkson, J. J., Zuntini, A. R., Maurin, O. (2021). A higher-level nuclear phylogenomic study of the carrot family (Apiaceae). *Am J Bot*, 108:1252–69.
- 17.Fahn A. *Plant Anatomy*, 3rd edn. Oxford: Pergamon Press, 1982.
- 18.Downie, S.R., Spalik, K., Katz-Downie, D.S. (2010). Major clades within Apiaceae subfamily Apioideae as inferred by phylogenetic analysis of nrDNA ITS sequences. *Plant Diversity and Evolution*, 128:111–36.
- 19.Esau, K. (1965). *Plant Anatomy*, 2nd edn. New York: Wiley.
- 20.Magee, A. R., Calviño, C. I., Liu, M. (2010). New tribal delimitations for the early-divergent lineages of Apiaceae subfamily Apioideae. *Taxon*, 59:567–80.