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## RESEARCH ARTICLE

**Anatomical investigations on *Haplophyllum cappadocicum* Spach**Hüsniye Kayalar\*<sup>ID</sup>, Gökay Arar<sup>ID</sup>

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**ABSTRACT****Aim and objective:** The aim of this work is to put forward the anatomical features of *Haplophyllum cappadocicum*, an endemic plant for Turkey.**Methods:** Plant materials were fixed in 70 % ethyl alcohol. The anatomical studies include transverse sections of roots, stems, leaves, fruits and seeds with illustrations. The investigations were made under microscope and photographs were taken by microphotography apparatus.**Conclusion:** *Haplophyllum* genus with potential pharmaceutical interest are worthy of investigation not only for chemical content but also anatomically. This is the first report on anatomical features of *Haplophyllum cappadocicum* collected from Malatya, Türkiye.**Keywords:** Anatomy, *Haplophyllum cappadocicum*, Rutaceae.**Article Info:** Received 1 March 2022; Revised 19 April; Accepted 1 May, Available online 15 May 2022**Cite this article-**Kayalar H, Arar G. Anatomical investigations on *Haplophyllum cappadocicum* Spach. Universal Journal of Pharmaceutical Research 2022; 7(2):16-20.**DOI:** <https://doi.org/10.22270/ujpr.v7i2.753>**Address for Correspondence:****Dr. Hüsniye Kayalar**, Ege University, Faculty of Pharmacy, Department of Pharmacognosy, Bornova, İzmir-Türkiye. Tel- +902323112549; E-mail: [husniye.kayalar@ege.edu.tr](mailto:husniye.kayalar@ege.edu.tr)**INTRODUCTION**

The Rutaceae family is represented by 153 genera and 1800 species<sup>1</sup>. This family is represented in Turkey by the genera *Ruta* L., *Haplophyllum* A. Juss., *Dictamnus* L., *Citrus* L. and *Poncirus* Rafin. *Haplophyllum*, richest in species, is one of the least known genus of Rutaceae. Turkey is an important gene center for the *Haplophyllum* genus with an endemism rate of 58% (19 taxa, 11 of which are endemic)<sup>2,3</sup>. The genus *Haplophyllum* is represented by about seventy species distributed in an area stretching from the Mediterranean to Eastern Siberia<sup>4</sup>. Members of the genus *Haplophyllum* are known for their use in traditional medicine<sup>5-7</sup>, as well as for containing a variety of chemical constituents of diverse structures such as lignans, quinoline alkaloids, coumarins, flavonoids and volatile compounds<sup>8-18</sup>. The leaves of plants belonging to *Haplophyllum* genus are used in traditional medicine for malaria, rheumatoid arthritis and gynecological disorders. *Haplophyllum* species are reported to be used in the treatment of diarrhea, constipation, and skin diseases<sup>19,20,21</sup>. In addition to cardiovascular effects, *Haplophyllum* species are previously shown to exhibit antimalarial, antileishmanial, antioxidant anti-insecticidal, anti-

microbial, anti-inflammatory activities whereas *H. sahinii* and *H. vulcanicum* were reported to possess anti-cholinesterase and anti-tyrosinase activities<sup>22,23</sup>. The phytochemical analyses, morphological and palynological studies have been previously conducted on plants from *Haplophyllum* genus. In respect of anatomical characteristics, *Haplophyllum* species were also investigated but the most important anatomical studies were restricted for species such as *H. megalanthum*, *H. myrtifolium*, *H. telephioides* and *H. vulcanicum*<sup>24-36</sup>. In previous studies, phytochemical investigations have been carried out on *H. cappadocicum*. Lignans and quinoline alkaloids isolated from this plant exhibit its potential activity<sup>18,37,41</sup>. Although secondary metabolites of *H. cappadocicum* were extensively examined, comprehensive anatomical features of this species is scarce in the literature.

The aim of this work was to put forward the comprehensive anatomical features of *H. cappadocicum* which is endemic to Turkey.

**MATERIALS AND METHODS**

Material for *H. cappadocicum* was collected from Boranköy, Malatya. Voucher specimens are deposited

in the Herbarium of the Ege University, Faculty of Pharmacy, Department of Pharmacognosy (1178). Plant material was identified by the authors HK and GA. A part of the plant material was fixed in 70% alcohol for anatomical studies of root, stem, leaf, fruit and seed. The investigations were made under Carl Zeiss Jena microscope and photographs were taken by Carl Zeiss Jena microphotography apparatus with 3.2x, 10x, 40x, 100x magnifications.

### *H. cappadocicum* Spach

Stems moderately to densely crisped-pubescent, 25-50 cm. Leaves usually entire, oblanceolate to linear, rarely lanceolate-obovate, occasionally trisect or incised, long-attenuate and pseudopetiolate below. Inflorescence broad and lax, the lower branches much exceeding the terminal cyme, at least the upper branches crisped-pubescent. Sepals broadly to narrowly deltoid, persistent. Petals bright yellow, oblong-elliptic, 5-6 mm. Filaments abruptly expanded and  $\pm$  parallel-sided in the lower half. Young ovary segments biovulate, each with a pronounced terminal apical corniculus, densely pilose on the upper inner surface, more sparingly so below. Capsule with divergent unbonate appendages on the upper dorsal surface, remaining glands convex, the raised margins not confluent into transverse ridges. Fl. 6-7. Grassy and stony steppe, 700-1500 m<sup>4</sup>.

## RESULTS AND DISCUSSION

### Anatomy of Root

On the outermost side there is a single layer of exodermis made up of suberised cells. The vascular bundles constitute a collateral arrangement. The endodermis is not detected in the transverse sections (Figure 1).

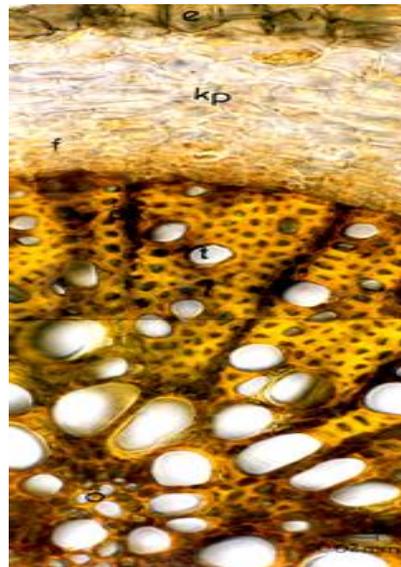
### Anatomy of Stem

Stem cortex, with a thin cuticle on the outer side, has xerophytic stomata. On the epidermis, thick cell walled unicellular hairs with dots on cuticle (Figure 2), assume straight or hook-like shapes. In the cortex parenchyma, schizolysigenous oil cavities are just in touch with the epidermal cells (Figure 3). The cortex parenchyma consists of starch sheath cells, schlerenchyma fibers, xylem, phloem and the pith. The pith is composed of parenchymatous cells (Figure 4).

### Anatomy of leaf

The leaf is monofacial. As seen in the cross sections of leaf laminae, the outer layers of lower and upper epidermis with thickened walls, have xerophytic stomata (Figure 5). Within the mesophyll tissue,

palisade parenchyma is composed of two or three rows whereas the spongy parenchyma takes a little place on the center of the mesophyll tissue. Oil cavities are just in touch with upper epidermis (Figure 6).



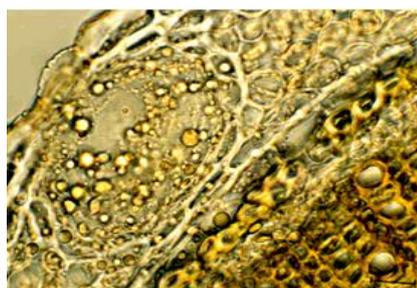
**Figure 1: Cross section of the root of *H. cappadocicum*.**

e: exodermis, f: phloem, kp: cortex parenchyma, t: trachea, ök: medullary rays, ö: pit

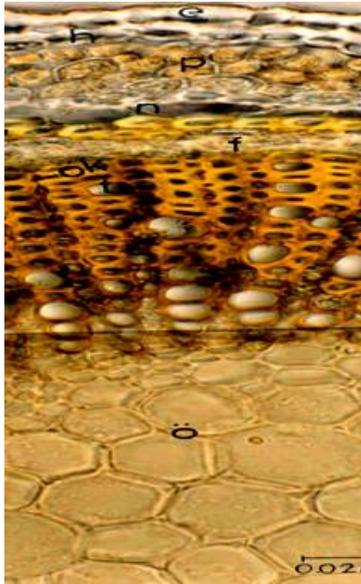
In the cross sections of the mid-rib region, thin-walled parenchymatous cells surround the collateral vascular bundles. Schlerenchyma fibers are detected between starch sheath cells and the phloem (Figure 7). In the surface view of the leaf, on the basis of the arrangement of four to six subsidiary cells relative to stoma, the stomata is found to be as anomocytic type. In the surface view of the epidermis, the epidermal cell walls seem to be thick and unicellular hairs assume straight or hook-like shapes (Figure 8).

### Anatomy of Fruit and Seed

The exocarp with thick outer cell walls, has thin cuticle. In the tissue of the mesocarp, essential oil cavities are orientated where the neighbouring cells to these cavities are thin-walled. The tissue of the endocarp is entirely sclerenchymatous (Figure 9). Testa, the destroyed cells of nucellus, endosperm and embryo constitutes the seed. In the cross section of the seed, the epidermal cells of the testa, assuming papillae with thicker outer cell walls, have hair-like elongations and crystal-like grains which are destroyed by acidic reagents with gas release.



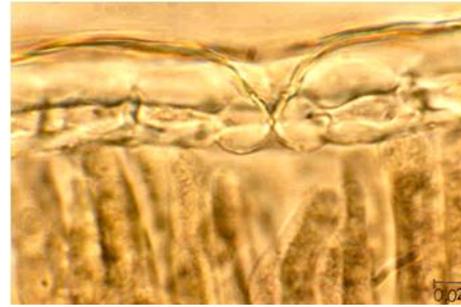
**Figure 2: Unicellular hair on the epidermis of the stem. Figure 3: Oil cavity in the cross section of the stem.**



**Figure 4: Cross section of the stem of *H. cappadocicum*.**

e: epidermis, h: hypodermis, p: parenchymatous cells, n: starch sheath cells, s: sclerenchyma fibers, f: phloem, t: trachea, ök: medullary rays, ö: pith

The lateral and inner cell walls are thinner than the outer walls of the epidermal cells of the testa. The cell walls of the testa parenchyma are thick and seemed to be partially pressed in the mature seeds. The endosperma lying under the destroyed nucellus cells, is composed of thin walled parenchymatous cells and oil droplets as reserve substances are located within the cells (Figure 10 A and Figure 10 B). Rutaceae plants are distinguished from all other families of the order Sapindales by possessing secretory cavities containing aromatic ethereal oils scattered throughout almost all organs, a synapomorphy to the family<sup>42</sup>.



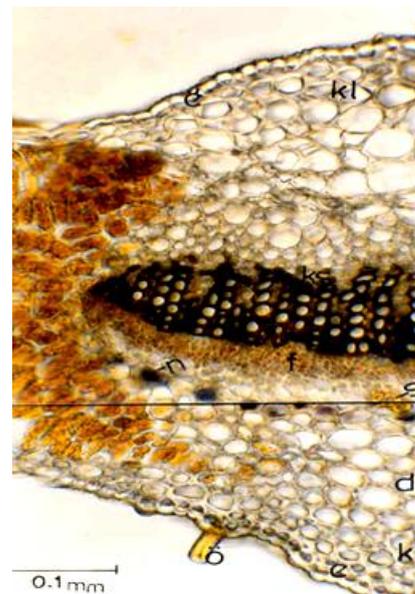
**Figure 5: Xerophytic stomata in the cross section of the leaf.**

Schizogenous sac gaps are characteristics for Rutaceae family. In contrast, in this study schizolysigenous secretory cavities were observed in cross sections of *H. cappadocicum*. Taxonomic and systematics studies among *Haplophyllum* A. Juss. and *Ruta* L. Taxa, which are naturally occurring in Turkey, were previously investigated based on morphological, palynological, anatomical and molecular studies. The anatomical characteristics of leaf and stem parts *H. cappadocicum* were also described<sup>43</sup>. Interestingly, thick cell walled unicellular straight or hook like shaped hairs were not mentioned in transverse sections of *H. cappadocicum*. In Rutaceae, in most species stomata are confined to abaxial sides. Conversely the leaves of *H. cappadocicum* are amphistomatic and mesophyll is equifacial as described. Some anatomical features of *Haplophyllum* species were reported before. The most important studies in respect of plant anatomy are restricted for species such as *H. myrtifolium*, *H. telephioides*, *H. megalanthum* etc<sup>34-36</sup>.



**Figure 6: Cross section of the leaf of *H. cappadocicum*.**

e: upper epidermis, sc: oil cavity, y: oil droplets, pp: palisade parenchyma, sp: spongy parenchyma, i: vascular bundles, st: stoma, é: lower epidermis



**Figure 7: The cross section of the mid-rib region.**

e: upper epidermis, é: lower epidermis, kl: collenchyma, ks: xylem, f: phloem, sk: sclerenchyma fibers, n: starch sheath cells, d: parenchyma, ö: unicellular hair



Figure 8: The surface view of the leaf.

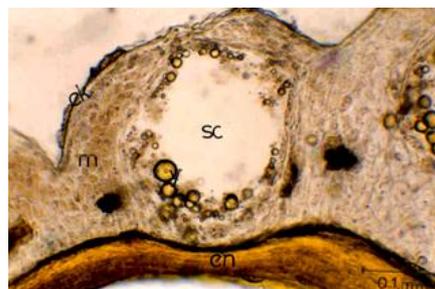


Figure 9: Fruit section of *H. cappadocicum*.

In the present work, anatomical characteristics of *H. cappadocicum* did not show significant differences. The anatomy of roots, fruits and seeds of *H.*

*cappadocicum* is reported for the first time whereas these findings might be useful for distinguishing and for comparison with other *Haplophyllum* species.

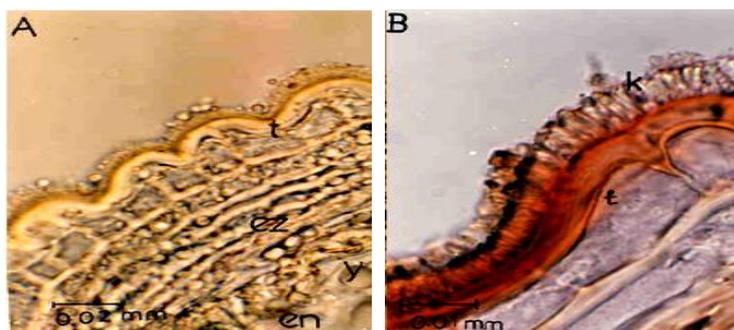


Figure 10: The cross section of the seed of *H. cappadocicum*;

A. In Sartur reagent B: In Chloralhydrat reagent.

t: testa, ez: destroyed cells of nucellus, en: endosperma, y: oil droplets, k: crystal-like grains

## CONCLUSION

*Haplophyllum* genus possessing biologically active natural substances of potential pharmaceutical interest, are worthy of investigation not only for chemical content but also anatomically. To the best of our knowledge, comprehensive anatomical studies have been carried out on *H. cappadocicum*, an endemic plant to Iran-Turan phytogeographical region, from Boranköy-Malatya, Turkey, for the first time in this report. Unfortunately there is a lack of academic education in taxonomy and properly trained pharmaceutical botanists. Endemic medicinal plants that might be of potential economic and pharmacological importance should also be investigated not only for secondary metabolites but also for their morphological and anatomical properties.

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## CONFLICT OF INTEREST

Authors declare that there is no conflict of interest with the present work.

## AUTHOR'S CONTRIBUTION

Hüsniye Kayalar, and Gökay Arar collected the plant material. Hüsniye Kayalar performed the anatomical studies and drafted the manuscript under the supervision of Gökay Arar.

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