

Characterization of Anatomical Characteristics of the Endemic *Digitalis lamarkcii* (Plantaginaceae)

Bayram Atasagun^{*1}, Deniz Ulukuş²

¹Vocational School of Health Services, Selçuk University, Konya, Türkiye

²Sciences Faculty, Biotechnology Department, Selçuk University, Konya, Türkiye

^{*}(byrmatsgn@gmail.com) Email of the corresponding author

Abstract – This research, focusing on the anatomical attributes of the endemic species *Digitalis lamarkcii* within the *Digitalis* genus, strives to make contributions to the taxonomy of the genus. The anatomical examination of *D. lamarkcii* encompassed cross-sections of the stem, leaf, and midrib, utilizing safranin and fast-green staining methods. Subsequently, these samples were meticulously prepared as fixed specimens, followed by comprehensive photographic documentation. The stem exhibits a cortex layer comprising 10-11 rows of robust-walled cells. Vascular bundles, numbering 5-6 layers, are observed after the sclerenchyma layers. The leaf displays a dorsiventral structure, featuring scattered palisade and spongy parenchyma cells, along with abundant intercellular spaces. A parenchymatous cell sheath envelops the vascular bundle.

Keywords – *Digitalis*, Plantaginaceae, Anatomy, Türkiye

I. INTRODUCTION

The Plantaginaceae family, encompassing approximately 90 genera and about 1900 species, displays notable morphological diversity. This family consists of both annual and perennial herbs, sometimes shrubs (for instance, *Veronica* sect. *Hebe*, *Aragoa*), aquatic plants (e.g., *Callitriche*, *Hippuris*, etc.), and even carnivorous plants (e.g., *Callitriche*, *Hippuris*, etc.) [1]. Numerous taxa (e.g., *Plantago*, *Digitalis*, *Antirrhinum*, etc.) have been extensively researched and recognized for their significant medicinal, decorative, and economic importance. *Digitalis* L. species, previously categorized within the Scrophulariaceae family for an extended period, are now classified in the Plantaginaceae family following this molecular-level phylogenetic investigation [2-3].

The taxonomic lineage of the *Digitalis* genus (including *Isoplexis*) traces its origins to Linne [4], although the most thorough and broadly acknowledged taxonomic framework was

documented by Werner [5]. Werner identified 19 *Digitalis* and three *Isoplexis* species [5].

The *Digitalis* comprises nine taxa in Turkey. The genus is an annual or perennial plants. The leaves are simple, arranged oppositely, and positioned at both the base and along the stem. Flowers are located at the terminal ends, bracted, in a racemose arrangement, typically oriented to one side. The calyx is shorter than the deeply divided 5-part corolla. In Turkish species, the corolla is usually yellow or white, with cylindrical, sac-shaped, or hemispherical tubes. The wings exhibit approximately two lips; these lips are slightly parted, with the lower lip slightly longer than the middle lobe and anteriolateral lobes. Stamens 4, didynam. The capsule is shaped like an egg, segmented, and pointed. The seeds are numerous and oblong.

To date, only a single anatomical investigation has been undertaken. This singular anatomical study was conducted by Uysal et al. [6], focusing on the

root, stem, and leaf anatomy of the *Digitalis trojana* Ivanina species.

The primary aim of this research was to elucidate the anatomical characteristics of the stem, and leaves of the endemic *Digitalis lamarckii* Ivanina, a species for which anatomical traits had not been previously delineated. The study aimed to establish a foundational reference for prospective investigations.

II. MATERIALS AND METHOD

During the course of this research, samples of the species were gathered, and comprehensive records of their distribution areas and habitats were meticulously documented. Additionally, visual documentation in the form of photographs was acquired (Fig. 1). Standard herbarium techniques were employed to dry the collected plant specimens, and subsequent identification was performed utilizing a binocular microscope with the Flora of Turkey serving as the primary reference. For the anatomical investigations, stem and leaf segments preserved in 70% alcohol during fieldwork were utilized. The paraffin embedding method was employed to obtain sections of 8 and 10 μm thickness using a microtome. The resulting sections were stained using the safranin fast-green staining technique and fixed using entellan [7]. These prepared specimens were then photographed using a binocular light microscope and camera. In the anatomical examinations, the sample locality denoted as – A7 Giresun; From Şebinkarahisar to Giresun, Asarcık Village, 1518 m, 12.07.2023, D.Ulukuş-2580 & F.Celep (KNYA) was utilized.



Fig.1. General view of *Digitalis lamarckii*

III. RESULTS

Stem

The stem exhibits a prominent external cuticle, followed by an epidermal layer composed of single-row cells. Beneath lies a cortex layer comprising 10-11 rows of robust-walled cells. Succeeding the sclerenchyma layers, one can observe 5-6 layers of vascular bundles, wherein phloem occupies a compact space while xylem constitutes a larger area. Occasionally, cambium is discernible between the phloem and xylem. These bundles encircle the stem. Towards the innermost layer, a central pith predominates, primarily composed of parenchyma cells, occupying a considerable area (Fig. 2).

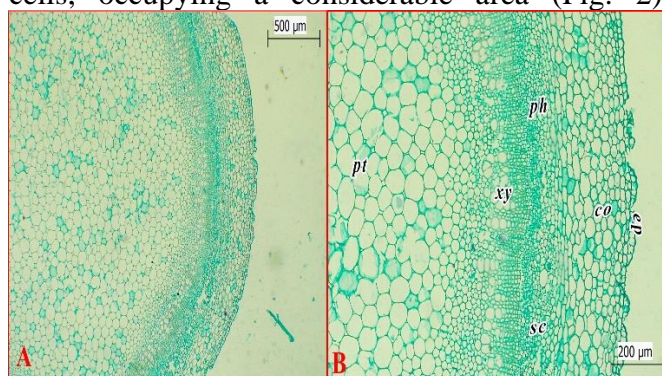


Fig. 2. Cross-section of *Digitalis lamarckii* stem (ep: epidermis, co: cortex, sc: sclerenchyma, ph: phloem, xy: xylem, pt: pith)

Leaf

The leaf features an outermost cuticle, followed by the upper epidermis and subsequently 2-3 layers of palisade parenchyma. Beneath lies a sponge parenchyma characterized by a scattered arrangement and expansive intercellular spaces extending to the lower epidermis. Both palisade and sponge parenchyma cells display a rich presence of chloroplasts. The leaf is dorsiventral in nature. The primary conduction bundle passing through the midrib is notably large. Within the transport bundle, phloem is positioned externally while xylem occupies the interior. Sclerenchyma cells are sporadically present in the xylem. Phloem occupies a minimal space. The bundle is enveloped by a sheath comprising 1-2 rows of parenchyma cells with slightly thickened walls (Fig. 3).



Fig. 3. Cross-section of *Digitalis lamarckii* leaf (ue: upper epidermis, le: lower epidermis, col: collenchyma, pp: palisade parenchyma, sp: spongy parenchyma, vb: vascular bundle)

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IV. DISCUSSION

Uysal et al. reported that the cross-section of the *Digitalis trojana* stem had approximately 3-4 cortex layers and lacked a sclerenchyma layer [6]. In contrast, our study identified 10-11 stem cortex layers and 5-6 sclerenchyma layers. Additionally, [6] Uysal et al. mentioned that the number of palisade parenchyma in the cross-section of *Digitalis trojana* leaves was about 3-4. However, our research determined the number of palisade parenchyma to be 2-3.

V. CONCLUSION

This study marks the inaugural comprehensive documentation of *Digitalis lamarckii* species anatomy. We trust that our findings will enrich systematic investigations of *Digitalis* and provide valuable support for forthcoming anatomical research on this species.

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