J. Fac. Pharm. Ankara / Ankara Ecz. Fak. Derg., 46(2): 342-349, 2022
Doi: 10.33483/jfpau.1068267

ORIGINAL ARTICLE / ÖZGÜN MAKALE

LEAF ANATOMY OF *INULA PEACOCKIANA* (AITCH. & HEMSL.) KOROVIN

INULA PEACOCKIANA (AITCH. & HEMSL.) KOROVIN'NIN YAPRAK ANATOMİSİ

Mert İLHAN[1*], Muhammed Mesud HÜRKUL[2]

[1]Van Yüzüncü Yıl University, Faculty of Pharmacy, Department of Pharmacognosy, 65080, Van, Turkey

[2]Ankara University, Faculty of Pharmacy, Department of Pharmaceutical Botany, 06560, Ankara, Turkey

ABSTRACT

Objective: *Inula peacockiana, which is called "uzunandızotu" in Turkey, is a stout perennial herbaceous plant with yellow flowers, grow up to 2 m. It is a plant belonging to the Asteraceae family, which has medicinal value. The safe use of medicinal plants depends on their correct diagnosis. The anatomical features of the leaves are valuable in diagnosing plants correctly. In this study, the anatomical features of the basal leaf, petiole and cauline leaf of I. peacockiana were investigated.*

Material and Method: *Plant materials were collected from Van (Turkey). A voucher specimen was deposited in the VANF Herbarium. The samples for anatomical studies were preserved in 70% alcohol. The transverse and surface sections were cutted by hand with razor blade in microscopic preparation form. The chloral hydrate solution was used in microscopic examinations.*

Result and Discussion: *The basal and cauline leaves are dorsiventral and contain cover and glandular hairs. The main vein protrudes outward in the midrib of the both leaves. Different the basal leaf, the cauline leaf contains more glandular hairs on the upper surface and cover hairs on the lower surface. In both leaves, ranunculaceae type stomata were observed in the upper and lower epidermis. The simple arc-shaped petiole includes of numerous separate bundles embedded in the parenchymatous cells. The epidermal layer consist of numerous cover and glandular hairs.*

Keywords: *Basal leaf, cauline leaf, Inula peacockiana, petiole, plant anatomy*

ÖZ

Amaç: *Türkiye'de "uzunandızotu" olarak adlandırılan Inula peacockiana, 2 m'ye kadar boylanabilen, sarı çiçekli, güçlü, çok yıllık otsu bir bitkidir. Asteraceae familyasına ait tıbbi değeri olan bir bitkidir. Tıbbi bitkilerin güvenli kullanımı doğru teşhislerine bağlıdır. Yaprakların anatomik özellikleri, bitkilerin doğru teşhis*

* **Corresponding Author / Sorumlu Yazar:** Mert İlhan
e-mail / e-posta: mertilhan@yyu.edu.tr, **Phone / Tel.:** +904324445065

Submitted / Gönderilme: 04.02.2022 **Accepted / Kabul:** 02.03.2022

edilmesinde önemlidir. Bu çalışmada I. peacockiana'nın taban yaprağı, yaprak sapı ve gövde yaprağının anatomik özellikleri incelenmiştir.

Gereç ve Yöntem: *Bitki materyalleri Van'dan (Türkiye) toplanmıştır. VANF Herbaryumuna bir örnek kaydedilmiştir. Anatomik çalışmalar için numuneler %70 alkolde korunmuştur. Enine ve yüzey kesitler bir jilet yardımıyla el ile alınmıştır. Mikroskobik incelemelerde kloralhidrat solüsyonu kullanılmıştır.*

Sonuç ve Tartışma: *Taban ve gövde yaprakları dorsiventraldir, örtü ve salgı tüyleri içerir. Her iki yaprağın orta damarı dışa doğru çıkıntı yapmıştır. Taban yapraktan farklı olarak, gövde yaprağının üst yüzeyinde daha fazla salgı tüyü, alt yüzeyinde ise örtü tüyleri bulunur. Her iki yaprakta da üst ve alt epidermada ranunculaceae tipi stomalar gözlenmiştir. Basit yay şeklindeki taban yaprak sapının enine kesiti, parankimatik hücrelere gömülü çok sayıda ayrı iletim demet içerir. Epiderma çok sayıda örtü ve salgı tüyleri taşır.*

Anahtar Kelimeler: *Bitki anatomisi, gövde yaprağı, Inula peacockiana, petiyol, taban yaprağı*

INTRODUCTION

The Asteraceae family is represented by 1677 genera worldwide and the genus *Inula* L. is naturally distributed in a wide region from temperate Eurasia to Indo-China, including Tropical and South Africa, Madagascar [1].

Inula species contain eudesmanolides, guaianolides, pseudoguaianolides, germacranolides, xanthanolides, dimeric sesquiterpenes and flavonoids [1-9]. The species of the genus have antibacterial, hypoglycaemic, hypolipidemic, cytotoxic, genotoxic, antioxidant, anti-inflammatory, antidiabetic, antiviral, antifungal, immunomodulatory, cardioprotective and antihypertensive effects [10-25].

Inula peacockiana (Aitch. & Hemsl.) Korovin, which is called "*uzunandızotu*" in Turkey [26], is a stout perennial herbaceous plant with yellow flowers, grow up to 2 m. Basal leaves of the plant are oblong or ovate, acute or subacute at apex, villous-pubescent and minutely glandular. The cauline leaves are smaller and sessile [27].

In this study, leaf anatomy of *I. peacockiana*, which belongs to the medically important genus *Inula*, was investigated.

MATERIAL AND METHOD

Plant materials

Plant materials were collected from Van (Turkey) (*38°51'37.5"N 43°26'46.8"E*) in June of 1st, 2021 (Figure 1). The identification of samples were carried out by Assoc. Prof. Mesut Pınar from Department of Botany, Faculty of Science, Van Yüzüncü Yıl University. A voucher specimen was deposited in the VANF Herbarium in Turkey (VANF 165228).

Light microscopy analysis

The samples for anatomical studies were preserved in 70% alcohol. The transverse and surface sections were cutted by hand with razor blade in microscopic preparation form. The chloral hydrate

solution was used in microscopic examinations. The anatomical analysis and the microphotographs were taken using the Leica DM 4000B [28].

Figure 1. General view of *I. peacockiana*

RESULT AND DISCUSSION

Basal leaf

Transverse and surface sections of basal leaf were observed as in Figure 2. The leaf is dorsiventral. Upper and lower epidermis cells were observed as square-rectangular. The epidermal cells of both layers do not differ in size, the upper and lower epidermal layers contain stomata, glandular and covering hairs. The leaf is protruding in the adaxial and abaxial sides in the midrib. In the adaxial part of the midrib, the sub-epidermis is covered with 1-3 rows of collenchyma tissue. In the main vein, the xylem is surrounded by a crescent-shaped phloem. The main vein is protected in both sides by the sclerenchymatous cap. A ring of parenchymatous cells is surrounded the main vein and the sclerenchymatous tissue. The mesophyll layer consists of palisade parenchyma cells and oval-shaped sponge parenchyma cells. In the surface sections of the leaf, the number of cells adjacent to the stoma was observed as 4-5 in the upper epidermis and 4-7 in the lower epidermis. The glandular hairs of leaf are composed a multiseriate stalk and a multicellular head. In addition, multicellular cover hairs are located both the epidermal layers.

Petiole of basal leaf

In the cross section of the simple arc-shaped petiole, numerous separate bundles embedded in the parenchymatous cells are observed. The epidermal layer consist of numerous cover hairs and glandular

hairs. The stoma was not observed. The cover hairs are simple, multicellular, the cell of distal end of hairs are more elongated. The glandular hairs of petiole are composed a multiseriate stalk and a multicellular head. The sub-epidermal layer is covered by a tissue consisting of suberized cells on the adaxial side. Seperated vascular bundles are embedded in the parenchymatous tissue and support each bundle from the abaxial side to the crescent-shaped sclerenchyma (Figure 3).

Cauline leaf

The leaf is dorsiventral. Upper and lower epidermis cells were observed as square-rectangular. The epidermal cells of both layers do not differ in size, the upper and lower epidermal layers contain stomata, glandular and covering hairs. Leaf protrudes in both sides on midrib, the abaxial side more then adaxial. The sub-epidermis of the midrib is covered with collenchyma tissue both sides. In the main vein, the xylem is surrounded by a crescent-shaped phloem and the sclerenchymatous arc is located abaxial side of the phloem. A ring of parenchymatous cells is surrounded the main vein. The mesophyll layer consists of palisade parenchyma cells and oval-slightly elongated sponge parenchyma cells. In the surface sections of the leaf, the number of cells adjacent to the stoma was observed as 4-5 in the upper epidermis and the lower epidermis. Both epidermis layers contain cover hairs and glandular hairs. The glandular hairs are denser in the upper epidermis and the covering hairs in the lower epidermis. The glandular hairs are composed a multiseriate stalk and a multicellular head. The cover hairs are simple, multicellular, the cells of distal end of hairs elongated (Figure 4).

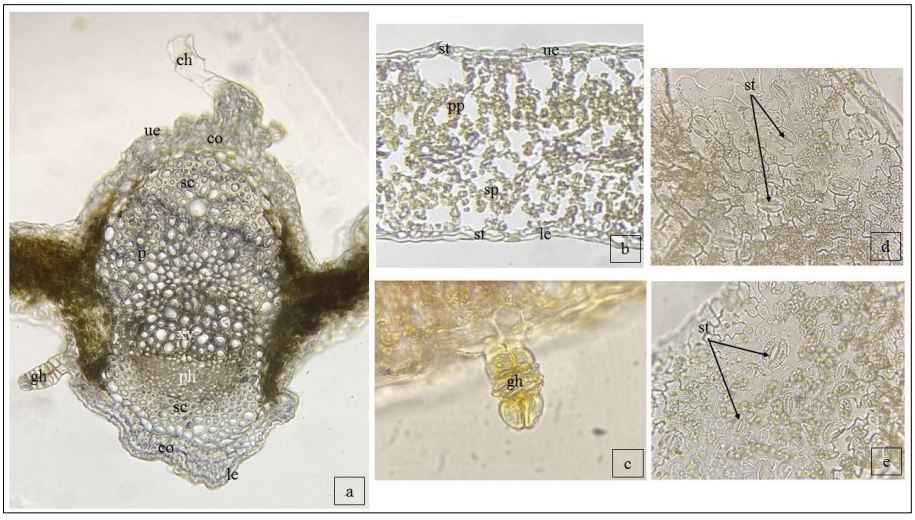

Figure 2. Anatomical features of basal leaf

a: Transverse section of midrib (x4), b:Transverse section of lamina (x10), c: Glandular hair in leaf transverse section (x40), d: Surface section of upper epidermis (x40), e: Surface section of lower epidermis (x40), ch: covering hair, co: collenchyma, gh: glandular hair, le: lower epidermis, ph: phloem, pp: palisade parenchyma, sc: sclerenchyma, sp: spongy parenchyma, st: stomata, ue: upper epidermis, xy: xsilem

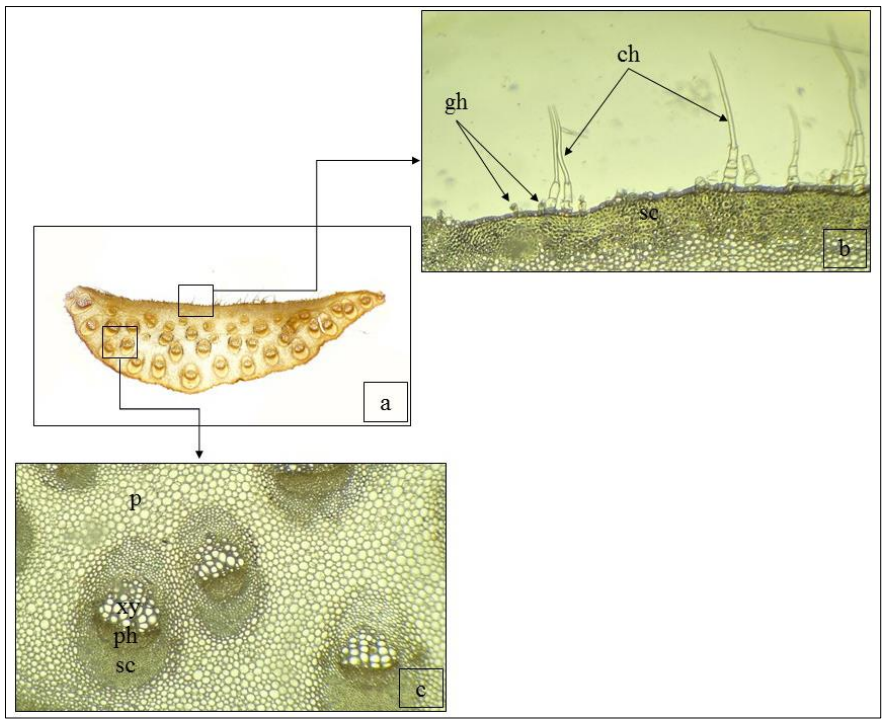

Figure 3. Anatomical features of petiole

a: Transverse section of petiole (x4), b:Transverse section of petiole (x40), c: Transverse section of petiole (x40), ch: covering hair, gh: glandular hair, ph: phloem, p: parenchyma, sc: sclerenchyma, xy: xsilem

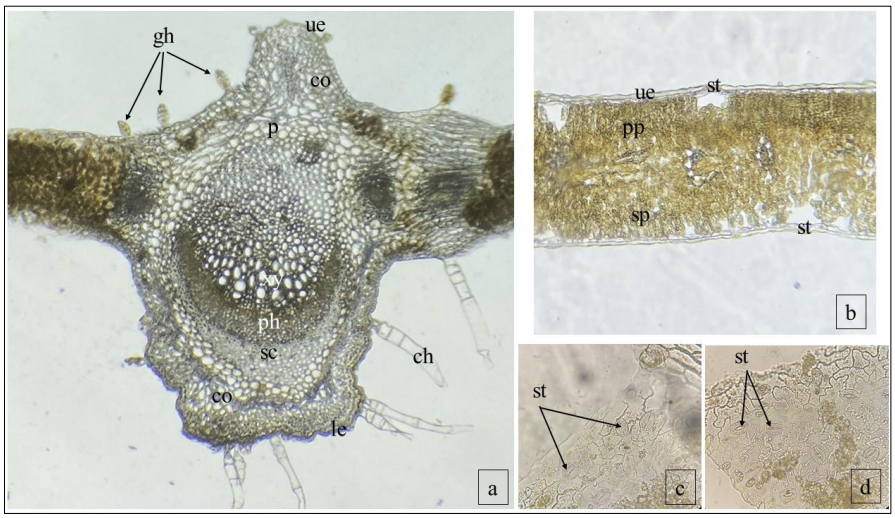

Figure 4. Anatomical features of cauline leaf

a: Transverse section of midrib (x4), b:Transverse section of lamina (x10), c: Surface section of upper epidermis (x40), d: Surface section of lower epidermis (x40), ch: covering hair, co: collenchyma, gh: glandular hair, le: lower epidermis, ph: phloem, pp: palisade parenchyma, sc: sclerenchyma, sp: spongy parenchyma, st: stomata, ue: upper epidermis, xy: xsilem

The results showed that both the basal and cauline leaves are dorsiventral. Basal leaf and cauline leaf differ in terms of midrib. The midrib protrudes ad- and abaxial sites in both leaf types. However, in the cauline leaf, the midrib clearly shows more doming in the abaxial site. In addition, the upper and lower epidermis of both leaves contain cover and glandular hairs. However, the upper epidermis of cauline leaf rich in glandular hairs and the lower epidermis rich in cover hairs. The leaves and petiole differ in cover hairs. The cover hairs on leaves and petiole are multicellular, simple, but the cells of the distal end of the cover hairs on the petiole epidermis are relatively longer. Previous studies on the Asteraceae family have shown that the family contains cover hairs of different structures [29]. In the report of Metcalfe and Chalk [29] about the Compositae family, the dorsiventral leaves, the presence of cover and glandular hairs and the presence of ranunculaceae type stomata are compatible with this study.

AUTHOR CONTRIBUTIONS

Conception: *M.İ.*; Design: *M.İ., M.M.H.*; Supervision: *M.İ.*; Resources: *M.İ., M.M.H.*; Materials: *M.İ.*; Data collection and/or processing: *M.İ., M.M.H.*; Analysis and/or interpretation: *M.İ., M.M.H.*; Literature search: *M.İ., M.M.H.*; Writing manuscript: *M.İ.*; Critical review: *M.İ., M.M.H.*; Other: -

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS COMMITTEE APPROVAL

The authors declare that the ethics committee approval is not required for this study.

REFERENCES

1. Plants of the World Online Web site. (2022). Retrieved January 23, 2022, from http://www.plantsoftheworldonline.org

2. Qi, J.L., Fu, Y., Shi, X.W., Wu, Y.B., Wang, Y.Z., Zhang, D.Q., Shi, Q.W. (2008). Sesquiterpene lactones and their anti-tumor activity from the flowers of *Inula britannica*. *Letters in Drug Design & Discovery, 5*(7), 433-436. [CrossRef]

3. Chin, Y.W., Yoon, K.D., Kim, J. (2009). Cytotoxic anticancer candidates from terrestrial plants. *Anti-Cancer Agents in Medicinal Chemistry, 9*(8), 913-942. [CrossRef]

4. Zhang, T., Xiao, W., Gong, T., Yang, Y., Chen, R.Y., Yu, D.Q. (2010). Two new eudesmanolides from *Inula racemosa*. *Journal of Asian natural products research, 12*(9), 788-792. [CrossRef]

5. Cheng, X.R., Li, W.W., Ren, J., Zeng, Q., Zhang, S.D., Shen, Y.H., Yan, S.-K., Ye, J., Jin, H.-Z., Zhang, W.D. (2012). Sesquiterpene lactones from *Inula hookeri*. *Planta Medica, 78*(05), 465-471. [CrossRef]

6. Gökbulut, A., Kaiser, M., Brun, R., Sarer, E., Schmidt, T.J. (2012). 9β-hydroxyparthenolide esters from *Inula montbretiana* and their antiprotozoal activity. *Planta Medica, 78*(03), 225-229. [CrossRef]

7. Stojanović-Radić, Z., Čomić, L., Radulović, N., Blagojević, P., Denić, M., Miltojević, A., Rajković, J., Mihajilov-Krstev, T. (2012). Antistaphylococcal activity of *Inula helenium* L. root essential oil: eudesmane sesquiterpene lactones induce cell membrane damage. *European journal of clinical microbiology & infectious diseases, 31*(6), 1015-1025. [CrossRef]

8. Talib, W.H., Zarga, M.H.A., Mahasneh, A.M. (2012). Antiproliferative, antimicrobial and apoptosis inducing effects of compounds isolated from *Inula viscosa*. *Molecules, 17*(3), 3291-3303. [CrossRef]

9. Seca, A.M., Grigore, A., Pinto, D.C., Silva, A.M. (2014). The genus *Inula* and their metabolites: from ethnopharmacological to medicinal uses. *Journal of Ethnopharmacology, 154*(2), 286-310. [CrossRef]

10. Zeggwagh, N.A., Ouahidi, M.L., Lemhadri, A., Eddouks, M. (2006). Study of hypoglycaemic and hypolipidemic effects of *Inula viscosa* L. aqueous extract in normal and diabetic rats. *Journal of Ethnopharmacology, 108*(2), 223-227. [CrossRef]

11. Kaileh, M., Berghe, W.V., Boone, E., Essawi, T., Haegeman, G. (2007). Screening of indigenous Palestinian medicinal plants for potential anti-inflammatory and cytotoxic activity. *Journal of Ethnopharmacology, 113*(3), 510-516. [CrossRef]

12. Oskay, M., Oskay, D., Kalyoncu, F. (2009). Activity of some plant extracts against multi-drug resistant human pathogens. *Iranian Journal of Pharmaceutical Research, 8*, 293-300.

13. Kattouf, J., Belmoukhtar, M., Harnafi, H., Mekhfi, H., Ziyyat, A., Aziz, M., Bnouham, M., Legssyer, A. (2009). Antihypertensive effect of an aqueous extract of *Inula viscosa* leaves. *Phytothérapie, 7*(6), 309-312. [CrossRef]

14. Celik, T.A., Aslanturk, O.S. (2010). Evaluation of cytotoxicity and genotoxicity of *Inula viscosa* leaf extracts with *Allium*. *Journal of Biomedicine and Biotechnology*, 189252. [CrossRef]

15. Lee, N.H., Hong, J.I., Kim, J.Y., Chiang, M.H. (2009). Antioxidant properties and protective effects of *Inula britannica* var. *chinensis* regel on oxidative stress-induced neuronal cell damage. *Korean Journal of Food Science and Technology, 41*(1), 87-92.

16. Wang, J., Wang, N., Yao, X., Ishii, R., Kitanaka, S. (2006). Inhibitory activity of Chinese herbal medicines toward histamine release from mast cells and nitric oxide production by macrophage-like cell line, RAW 264.7. *Journal of natural medicines, 60*(1), 73-77. [CrossRef]

17. Shan, J.J., Yang, M., Ren, J.W. (2006). Anti-diabetic and hypolipidemic effects of aqueous-extract from the flower of *Inula japonica* in alloxan-induced diabetic mice. *Biological and Pharmaceutical Bulletin, 29*(3), 455-459. [CrossRef]

18. Somesh, T., Goel, K.K., Nidhi, G. (2011). Antiinflammatory activity of *Inula cuspidata* leaf extract. *Asian Journal of Chemistry, 23*(2), 943-944.

19. Gebre-Mariam, T., Neubert, R., Schmidt, P.C., Wutzler, P., Schmidtke, M. (2006). Antiviral activities of some Ethiopian medicinal plants used for the treatment of dermatological disorders. *Journal of Ethnopharmacology, 104*(1-2), 182-187. [CrossRef]

20. Pal, H.C., Sehar, I., Bhushan, S., Gupta, B.D., Saxena, A.K. (2010). Activation of caspases and poly (ADP-ribose) polymerase cleavage to induce apoptosis in leukemia HL-60 cells by *Inula racemosa*. *Toxicology In Vitro, 24*(6), 1599-1609. [CrossRef]

21. Ajani, H.B., Patel, H.P., Shah, G.B., Acharya, S.R., Shah, S.K. (2009). Evaluation of antidiabetic effect of methanolic extract of *Inula racemosa* root in rats. *Pharmacologyonline, 3*, 118-129.

22. Ojha, S., Nandave, M., Kumari, S., Arya, D.S. (2010). Cardioprotection by *Inula racemosa* Hook in experimental model of myocardial ischemic reperfusion injury. *Indian Journal of Experimental Biology, 48*, 918-924.

23. Guinoiseau, E., Luciani, A., Rossi, P.G., Quilichini, Y., Ternengo, S., Bradesi, P., Berti, L. (2010). Cellular effects induced by *Inula graveolens* and *Santolina corsica* essential oils on *Staphylococcus aureus*. *European Journal of Clinical Microbiology & Infectious Diseases, 29*(7), 873-879. [CrossRef]

24. Attard, E., Cuschieri, A. (2009). *In vitro* immunomodulatory activity of various extracts of Maltese plants from the Asteraceae family. *Journal of Medicinal Plants Research, 3*(6), 457-461.

25. Khan, A.L., Hussain, J., Hamayun, M., Gilani, S.A., Kim, Y.H., Rehman, S.U., Watanabe, K.N., Lee, I.J. (2010). Elemental allelopathy and antifungal activities of *Inula falconeri* from Himalaya Pakistan. *Acta Agriculturae Scandinavica, Section B-Soil & Plant Science, 60*(6), 552-559. [CrossRef]

26. Güner, A., Aslan, S., Ekim, T., Vural, M., Babaç, M.T. (2012). Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyigit Botanik Bahçesi Yayınları, Flora Dizisi I.

27. Davis, P.H. (1975). Flora of Turkey and the East Aegean Islands, Edinburgh University Press, Edinburgh.

28. Hürkul, M.M., Yayla, Ş. (2021). Leaf anatomy of *Quercus macranthera* subsp. *syspirensis* (K. Koch) Menitsky. *Biological Diversity and Conservation, 14*(3), 405-410. [CrossRef]

29. Metcalfe, C.R., Chalk, L. (1965). Anatomy of Dicotyledones, Clarendon Press, Oxford.