MORPHOBOTANICAL EVALUATION OF *ECHINACEA PURPUREA* (L.) MOENCH

Cristina BURLOU-NAGY(FATI),[1, 2], Monica Tabita MORAR(ROMOCEA) [1], Larisa Ioana BENE[3], Maria Flavia GÎTEA[4], Iulia-Ana PAȘCA[5], Annamaria PALLAG [1,2]

[1] *Doctoral School of Biological and Biomedical Sciences, University of Oradea, 410087 Oradea, Romania;*
[2] *Department of Pharmacy, Faculty of Medicine and Pharmacy, University of Oradea, 410028 Oradea, Romania,*
[3] *Department of Agriculture, Horticulture, Faculty of Environmental Protection, University of Oradea, 410048 Oradea, Romania*
[4] *Faculty of Medicine and Pharmacy, University of Oradea, 410068 Oradea, Romania*
[5] *Iuliu Haţieganu University of Medicine and Pharmacy, Faculty of Medicine, Cluj-Napoca, Romania*

RESEARCH ARTICLE

Abstract
Echinacea purpurea (L.) Moench, a member of the Asteraceae family, is a medicinal plant widely recognized for its immunostimulatory and anti-inflammatory properties. This study presents a morphobotanical evaluation aimed at identifying key diagnostic features useful for pharmacognostic authentication.
Macroscopic examination showed that E. purpurea has an erect, cylindrical stem covered with fine hairs, alternate leaves with serrated margins and prominent venation, and a characteristic solitary capitulum with purple ligulate ray florets and brown tubular disk florets. Microscopically, the stem exhibits a uniseriate epidermis with glandular and non-glandular trichomes, a collenchymatous cortex, and a continuous ring of vascular bundles. The leaf is dorsiventral with anomocytic stomata, capitate trichomes, and a clearly differentiated mesophyll.
These morphological and anatomical traits provide reliable criteria for the identification and standardization of Echinacea purpurea, supporting its quality control and safe use in pharmaceutical and herbal preparations.

Keywords: Echinacea purpurea (L.) Moench, Morphobotanical evaluation, Diagnostic features, Pharmacognostic authentication
#Corresponding author: burlounagy.cristina@student.uoradea.ro

INTRODUCTION

The purple coneflower, *Echinacea purpurea* (L.) Moench, is a perennial herbaceous species from the Asteraceae family, widely recognized for its horticultural and medicinal significance. Although native to the prairies of North America, *E. purpurea* is now cultivated globally due to its attractive inflorescences and its extensive use in traditional and modern phytotherapy (Burlou-Nagy, 2022). Among its various medicinal applications, the species is prized for its immunostimulant, anti-inflammatory, and antioxidant properties, making it a cornerstone in the formulation of herbal remedies aimed at preventing and alleviating upper respiratory tract infections and other immune-related conditions (Choirunnisa, 2021; Burlou-Nagy, 2023).

With the increasing demand for herbal products containing *E. purpurea*, the need for precise identification and quality control has become paramount (Kornievskiy, 2021; Pidoux, 2021). Many commercial preparations may be subject to adulteration or substitution with related species or morphologically similar taxa, which can compromise therapeutic efficacy and consumer safety. In this context, morphobotanical evaluation serves as a fundamental tool for ensuring the authenticity and purity of raw materials (Lin-na, 2013).

Leaves and stems, as primary vegetative organs, offer a wealth of diagnostic morphological and anatomical features. The leaves of *E. purpurea* typically exhibit a distinctive lanceolate to ovate shape, with serrated margins and a pronounced venation pattern. The stem is generally erect, robust, and covered by characteristic trichomes. Detailed analysis of these organs—encompassing attributes such as surface texture, trichome type and distribution, venation, tissue organization, and vascular arrangement—provides essential criteria for distinguishing *E. purpurea* from other Echinacea species or potential adulterants (Belaeva, 2013).

This study seeks to conduct an in-depth morphobotanical assessment of the leaves and

stems of *Echinacea purpurea* (L.) Moench. Through comprehensive macroscopic and microscopic examination, the research aims to document and analyze the specific structural features of these organs. Macromorphological observations will be complemented by anatomical investigations, including the study of epidermal patterns, mesophyll structure, and vascular tissue distribution. By establishing a robust set of diagnostic markers, this work will support the development of reliable identification protocols for *E. purpurea*, thereby enhancing quality assurance in both pharmacognostic research and the herbal product industry (Ragažinskienė 2001).

Ultimately, the findings from this study will contribute to a deeper understanding of the morphobotanical distinctiveness of *E. purpurea* leaves and stems, facilitating their recognition in both raw and processed forms. This is particularly relevant for the standardization and authentication of herbal medicines, supporting the safe and effective use of *Echinacea purpurea* in contemporary healthcare.

The leaves exhibit a dorsiventral structure, with a thin but continuous cuticle and a single-layered epidermis on both surfaces. The stomata are predominantly anomocytic and occur more frequently on the abaxial surface. Non-glandular trichomes are uniseriate and multicellular, while glandular trichomes are capitate, each composed of a short stalk and a rounded head of secretory cells responsible for the production of essential oils and phenolic compounds. The mesophyll is differentiated into an upper palisade parenchyma and a lower spongy parenchyma, the latter with abundant intercellular spaces to facilitate gas exchange. The vascular bundles are collateral and embedded within a parenchymatous sheath, forming a distinct reticulate venation pattern throughout the lamina (Manayi, 2015).

The diagnostic combination of features—such as the presence of capitate glandular trichomes, anomocytic stomata, well-developed collenchyma, and a continuous ring of vascular bundles—confirms the structural identity of *Echinacea purpurea* and ensures its reliable recognition in pharmacognostic evaluation. These morphological and anatomical traits not only serve as taxonomic markers but also underline the plant's physiological adaptations and its role in the biosynthesis of secondary metabolites of therapeutic significance.

Overall, the findings of this study highlight the relevance of detailed morphobotanical characterization of stem and leaf structures in establishing the authenticity, quality, and standardization of *Echinacea purpurea* raw material used in medicinal and pharmaceutical applications.

MATERIAL AND METHOD

Fresh leaves were used for morphological examinations. For the microscopic study, tiny transverse sections were manually excised from fresh leaves and stems with a razor blade. The preparations were looked at under a light microscope with 40X and 20X magnifications to see diagnostic anatomical features such as the structure of the epidermis, the arrangement of the mesophyll, and the placement of the vascular tissues in stem. A digital camera attached to the microscope took microphotographs. Images obtained from the morphobotanical observations were compared with literature descriptions to confirm the identification of *Echinacea purpurea* (L.) Moench and to highlight its characteristic features relevant for pharmacognostic authentication and quality control. Observations and image acquisition were performed using an optical microscope (Optika, model C-B10+ 24010, Ponteranica, Italy) equipped with 10×, 20×, and 40× objectives and an Optika B10 digital camera.

RESULTS AND DISCUSSIONS

The morphobotanical assessment of Echinacea purpurea (L.) Moench concentrated on the comprehensive examination of its vegetative structures—the leaf **Figure 1** and stem **Figure 2** —displaying a synthesis of diagnostic characteristics significant for taxonomy and pharmacognosy within the Echinacea genus.

The stem of E. purpurea is upright, cylindrical, and fairly branched at the apex, with an average height between 70 and 120 cm. It is dense and has a green- to reddish-green hue.

The surface has a slightly rough texture owing to the visibility of small, short hairs, resulting in a scabrous quality. The epidermis exhibits longitudinal striations, indicative of the configuration of the underlying vascular bundles and the overall sturdiness of the plant.

The transverse section of the stem has a characteristic dicotyledonous structure. The outermost layer consists of a unilaminar epidermis, enveloped by a delicate cuticle and featuring both non-glandular and glandular trichomes. The non-glandular trichomes are uniseriate, multicellular, and somewhat curved, whereas the glandular trichomes are capitate, featuring a short stalk and a rounded head of secretory cells. Below the epidermis, many layers (3–5) of collenchymatous cells offer mechanical support, particularly in ridged areas. The cortex consists of 6–10 layers of parenchymatous cells interspersed with intercellular gaps, some of which contain microscopic oil droplets or calcium oxalate crystals. The circulatory system has a continuous loop of collateral bundles interspersed with slender medullary rays. The phloem is positioned externally, whereas the xylem is the predominant majority of the vascular tissue, facilitating effective water and nutrient transport. The middle pith consists of big, thin-walled parenchyma cells containing extensive intercellular gaps. This interior structure offers both stability and adaptability, aiding the plant's vertical growth and enabling the movement of metabolites.

The leaves of E. purpurea are simple, alternating, and polymorphic on the stem. Basal leaves are more substantial and attached to elongated petioles, whereas cauline leaves diminish in size and are either sessile or subsessile. The leaf morphology ranges from ovate to lanceolate, including a coarsely serrated border. The adaxial surface is dark green and shiny, while the abaxial surface is lighter and has stiff, non-glandular trichomes, especially along the veins, which gives it a rough texture. The venation is reticulate, including a pronounced midrib and subsidiary veins that create a net-like configuration.

The leaf has a dorsiventral architecture characteristic of dicotyledonous plants at the microscopic level. The adaxial and abaxial epidermises are composed of a single layer of polygonal cells featuring straight to slightly undulating anticlinal walls and are enveloped by a thin, continuous cuticle. Stomata are anomocytic and mostly located on the abaxial surface, representing a xeromorphic adaptation that facilitates efficient gas exchange while reducing water loss. Non-glandular trichomes are uniseriate and multicellular, characterized by thicker walls and pointed tips, whereas glandular trichomes are capitate, consisting of a short stalk and a spherical head composed of 4–8 secretory cells that synthesize volatile oils and other secondary metabolites.

The mesophyll is distinctly organized into a single layer of elongated palisade parenchyma situated under the adaxial epidermis and 4–6 layers of spongy parenchyma below, abundant in intercellular gaps that promote gas passage. The vascular system of the midrib comprises a substantial collateral bundle encased in a parenchymatous bundle sheath, with sclerenchymatous cells offering structural support and protection. Minor vascular bundles diverge into the lamina, leading to the distinctive reticulate venation.

The integrated macroscopic and microscopic features of the stem and leaf validate the identification of Echinacea purpurea (L.) Moench. Diagnostic features encompass the presence of capitate glandular trichomes, anomocytic stomata, calcium oxalate crystals, and well-developed collenchyma. These anatomical characteristics facilitate the plant's adaptation to its environment and align with its established capacity to synthesize physiologically active chemicals, notably phenolic derivatives like caffeic acid and its conjugates.

This morphobotanical characterization offers critical diagnostic information for the accurate identification and verification of Echinacea purpurea vegetative material utilized in herbal preparations, hence ensuring its appropriate standardization in phytotherapeutic applications (Kim, 2019).

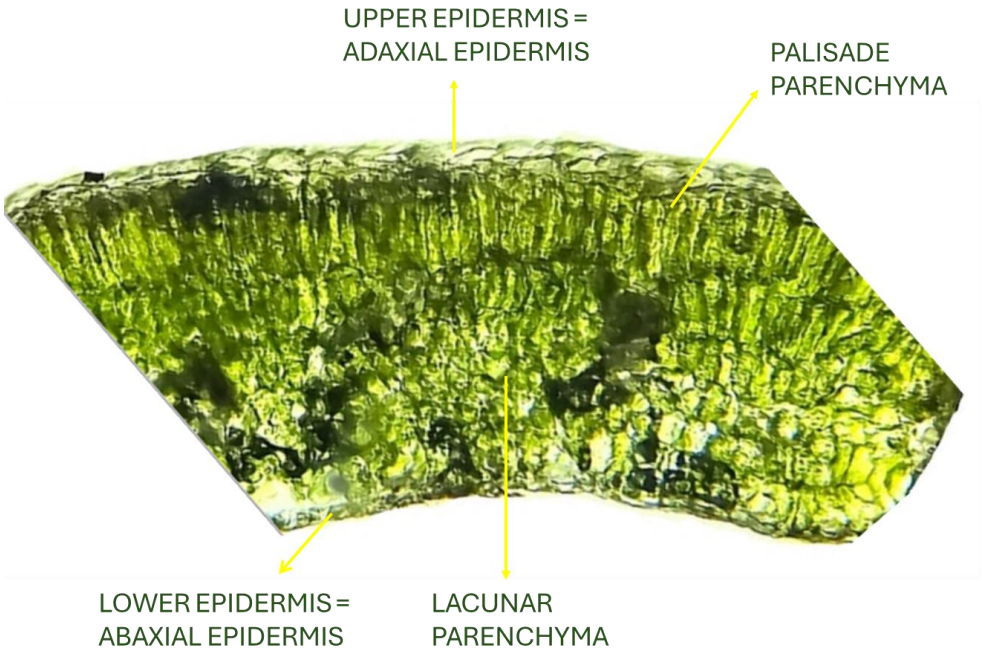

Figure 1. Leaf - transversal section of *Echinacea purpurea (L.) Moench,* observed under microscope with 40X objective

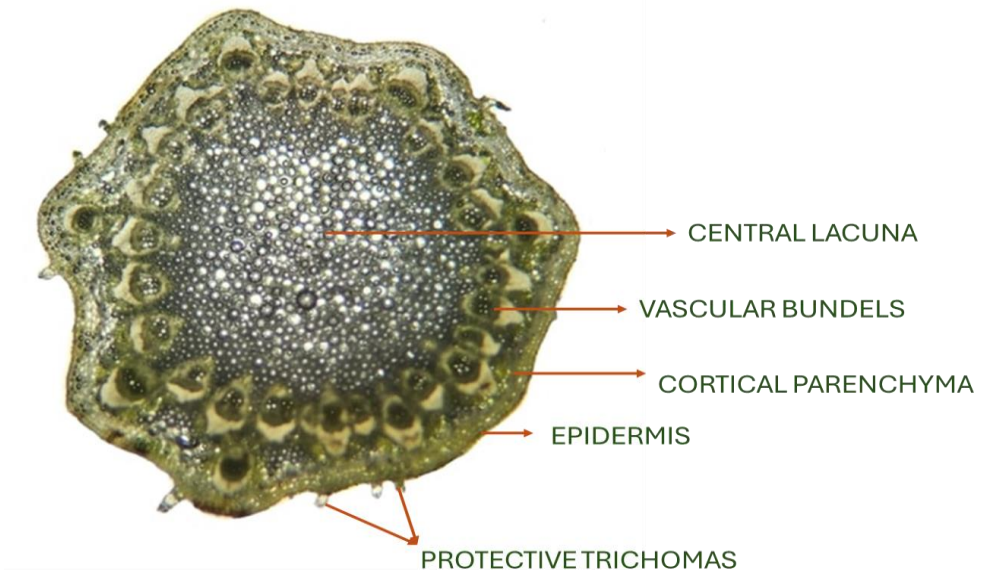

Figure 2. Stem section of Echinacea purpurea (L.) Moench, observed under microscope with 20X objective

CONCLUSIONS

The present morphobotanical study of *Echinacea purpurea* (L.) Moench provides a comprehensive description of the macro- and microscopic characteristics of its vegetative organs—stem and leaf—offering valuable data for accurate identification and authentication in pharmacognostic and botanical research. The species exhibits distinctive diagnostic features in both organs, which are essential for differentiating it from closely related taxa within the genus *Echinacea*.

The stem presents a typical dicotyledonous organization, characterized by a single-layered epidermis covered with a thin cuticle and bearing both glandular and non-glandular trichomes. Beneath the epidermis, a collenchymatous hypodermis provides mechanical strength, while the cortex consists of several layers of parenchymatous cells, some containing calcium oxalate crystals. The vascular system forms a continuous ring of collateral bundles surrounding a well-developed parenchymatous pith. These structural features reflect the plant's adaptation to support large aerial biomass and maintain physiological stability under variable environmental conditions.

The leaves exhibit a dorsiventral structure, with a thin but continuous cuticle and a single-layered epidermis on both surfaces. The stomata are predominantly anomocytic and occur more frequently on the abaxial surface. Non-glandular trichomes are uniseriate and multicellular, while glandular trichomes are capitate, each composed of a short stalk and a rounded head of secretory cells responsible for the production of essential oils and phenolic compounds. The mesophyll is clearly differentiated into an upper palisade parenchyma and a lower spongy parenchyma, the latter with abundant intercellular spaces to facilitate gas exchange. The vascular bundles are collateral and embedded within a parenchymatous sheath, forming a distinct reticulate venation pattern throughout the lamina.

The diagnostic combination of features—such as the presence of capitate glandular trichomes, anomocytic stomata, well-developed collenchyma, and a continuous ring of vascular bundles—confirms the structural identity of *Echinacea purpurea* and ensures its reliable recognition in pharmacognostic evaluation. These morphological and anatomical traits not only serve as taxonomic markers but also underline the plant's physiological adaptations and its role in the biosynthesis of secondary metabolites of therapeutic significance.

Overall, the findings of this study highlight the relevance of detailed morphobotanical characterization of stem and leaf structures in establishing the authenticity, quality, and standardization of *Echinacea purpurea* raw material used in medicinal and pharmaceutical applications.

REFERENCES

Belaeva, T. N., & Butenkova, A. N. (2013). *Comparative analysis of the leaf anatomy of Echinacea purpurea and E. pallida*. Biosystems Diversity. DOI:10.15421/011812. ecology.dp.ua+1

Burlou-Nagy, C., Bănică, F., Jurca, T., Vicaș, L.G., Marian, E., Muresan, M.E., Bácskay, I., Kiss, R., Fehér, P., Pallag, A. (2022). *Echinacea purpurea (L.) Moench: Biological and Pharmacological Properties. A Review*. Plants, 11(9), 1244. DOI:10.3390/plants11091244. MDPI+1

Burlou-Nagy, C., Bănică, F., Negrean, R. A., Jurca, T., Vicaș, L. G., Marian, E., Bácskay, I., Kiss, R., Fehér, P., Vicaș, S. I., Miere, F., Memete, A. R., & Pallag, A. Determination of the Bioactive Compounds from Echinacea purpurea (L.) Moench Leaves Extracts in Correlation with the Antimicrobial Activity and the In Vitro Wound Healing Potential. Molecules 2023, 28, 5711. https://doi.org/10.3390/molecules28155711

Choirunnisa, J. P., Widiyastuti, Y., Sakya, A. T., & Yunus, A. (2021). Morphological characteristics and flavonoid accumulation of *Echinacea purpurea* under salinity stress. *Biodiversitas*, 22(9), 3716–3721.

Kim, D. H., & Kim, S. H. (2019). Microscopic evaluation and histological localization of secondary metabolites in *Echinacea purpurea* leaf tissues. *Journal of Plant Research*, 132(6), 833–842.

Kornievskiy, Y. I., Skoryna, D. Yu., Korniievska, V. H., & Kandybei, N. V. (2021). Comparative chromato-mass spectrometric study of tinctures based on *Echinacea purpurea* (L.) Moench. *Current Issues in Pharmacy and Medicine: Science and Practice*, 3, 45–52.

Lin-na, H. (2013). *The morphological markers of Different phenotypes Echinacea purpurea*. Journal of Applied Pharmaceutical Science, 3(9), 78-80. DOI:10.7324/JAPS.2013.3914. IMSEAR

Manayi, A., Vazirian, M., & Saeidnia, S. (2015). *Echinacea purpurea: Pharmacology, Phytochemistry and Analysis Methods*. Pharmacognosy Reviews, 9(17), 63-72. DOI:10.4103/0973-7847.156353. phcogrev.com

Pidoux, O., Etienne-Mesmin, L., & Chassaing, B. (2021). The cypsela of *Echinacea purpurea* as a diffusion unit of microorganisms. *Applied Microbiology and Biotechnology*, 105(18), 6937–6951.

Ragažinskienė, O., Kmitienė, G., & Janulis, V. (2001). *Anatomical structure of stem, leaf, and inflorescence of Echinacea purpurea*. Botanica Lithuanica, 7(3), 227-233. VDU