
Anatomic structure of axial organs of *Echinacea purpurea* (L.) Moench

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This article presents a description of axial organs (anatomical constitution of the stem, stem-root and root) of *Echinacea purpurea* (L.) Moench, which has been grown in the collection of Kaunas Botanical Garden of the University of Vytautas Magnus since 1960.

Literature sources [1, 2, 6] specify only investigations of the anatomical constitution of the underground part of the plants, *i.e.* roots. Most often the underground axial organs of *Echinacea purpurea*, *i.e.* the stem-root and the root, are named “the root” [8] due to their morphological similarity.

This work presents a description of the anatomical constitution of the above-ground stem, stem-root and root of *Echinacea purpurea*, refers to their diagnostic features and quantitative character.

Key words: *Echinacea purpurea* (L.) Moench, anatomical constitution of stem, stem-root and root

INTRODUCTION

The importance of officinal plants and their preparations is evaluated in the documents issued by the world health care organizations, as well as in phytotherapists' works, from the standpoint of their medical effect upon the diseases of the respiratory tract, cardiovascular system, liver, nervous system, stomach and bowels [1]. Plants and their preparations, which strengthen the immune system, gained special attention at the end of the 20th century. Preparations of generic species of *Echinacea purpurea* (L.) Moench, such as *Echinacea purpurea* (L.) Moench, *Echinacea pallida* (Nutt.) Nutt. and *Echinacea angustifolia* DC., are widely used in medicine.

Recently, literary sources have revealed the anatomical constitution of the underground part (the root part) of this sort of plants [4, 7, 8], however, the anatomical analysis of the overground part is missing. Most authors [8] name the underground organs of *Echinacea purpurea* as a “root system” without singling out the underground stems and stem-roots.

The aim of this investigation is to state anatomical diagnostic features of the axial organs of *Echinacea purpurea*, *i.e.* of the stem, stem-root and root, and to present a detailed anatomical description of these organs.

OBJECT AND METHODS

Axial organs of blooming *Echinacea purpurea* were taken for the purpose of investigating its anatomical constitution. *Echinacea purpurea* was chosen from the collections grown in the Kaunas Botanical Garden. Samples were fixed in glycerol–ethanol–water (1:1:1) solution [5].

The anatomical structure of envelope tissues of cortex and central vascular cylinder as well as their quantitative characteristics were defined in the cross and tangent sections of axial organs. Their diameter, width of cells, height and relative volume were measured with the help of an eye-piece micrometer.

RESULTS AND DISCUSSION

Anatomical constitution of the over-ground stem of *Echinacea purpurea* L. The cuticle 15–17 μ thick covers the stem epidermis of *Echinacea purpurea* (Fig. 1). The epidermis consists of one layer, with the cells length 25.2 μ and width 3.3 μ . The exodermis of the primary cortex is 49.9 μ thick and is composed out of 2–3 cellular rows, *i.e.* angular collenchyme. The exodermis cells are of the prosenchymic type. According to Braun et al. [3], exodermis cells are sun-ray permeable and tension-resistant. The mesodermis is composed of assimilated tissue 116.6 μ

thick. There are a lot of intercellulars, which are radially positioned in the mesodermis. The mesodermis cells also belong to the prosenchymic type. There is a central vascular cylinder in the central part of the stem of *Echinacea purpurea*. It is composed of a pericycle and pith-ray eustele. The pericycle is formed of sclerenchymatous tissue 133.2 μ thick. The eustele is composed of one circle of indistinct, collateral, open vascular bundles, the pith and its rays. The quantity of vascular bundles and their size in the circle are unstable. Their thickness is 391.5 μ ; the cambium is of the bundle type. The diameter of the xylem and phloem is 116 μ . There are 15% of water vessels and 85% of xylem fibers in the timber. Water vessels in vascular bundles form groups of 3–7 vessels. The cavity of their inner channel is 29.2 μ (from 16.6 μ in the early timber up to 41.6 μ in the serotinal timber). The wall thickness of xylem fibers is 4.2 μ , the cavity diameter of the inner channel is 8.3 μ .

The pith diameter is 3781.8 μ . It consists of parenchyma type cells together with intercellulars. There are 83 cells in 1 mm². The pith makes 64.0% of the stem cavity. Pith rays are narrow, double-quarter-lined.

Anatomical constitution of the stem-root of *Echinacea purpurea*. Rather frequently literary sources [8] refer to the stem as to the “root”. The stem-root is covered with two layers of periderm cells, the total height of which is 49.9 μ (Fig. 2). The cells are thick-walled (their thickness makes 4 μ) and are inlaid with cutin. The height of one periderm cell is 22.4–25.0 μ , the width is 33.3–33.8 μ .

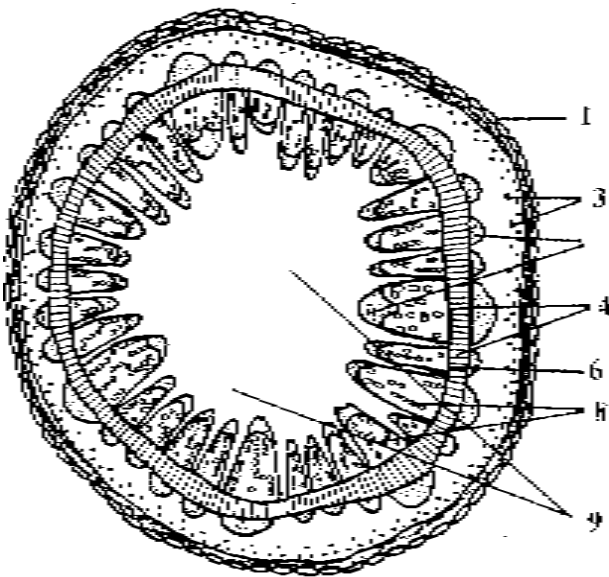


Fig. 1. Anatomical constitution of the stem of *Echinacea purpurea* (L.) Moench: 1 – epidermis, 2 – periderm, 3 – schizogenic glands, 4 – sclerenchyma, 5 – phloem, 6 – cambium, 7 – primary xylem, 8 – secondary xylem, 9 – pith

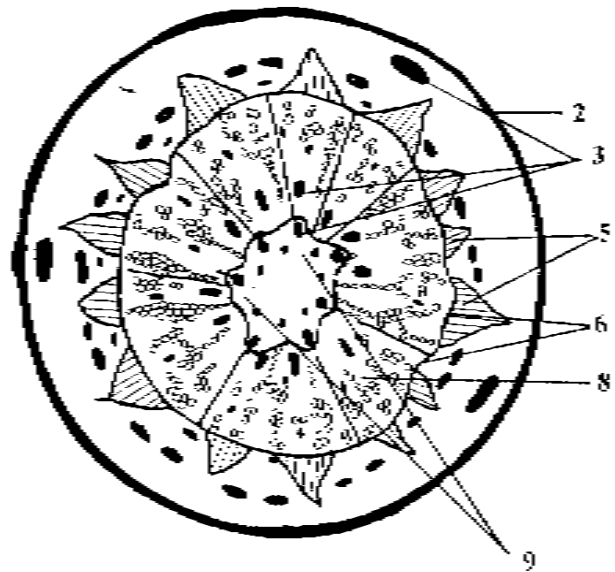


Fig. 2. Anatomical constitution of the stem-root of *Echinacea purpurea* (L.) Moench: 1 – epidermis, 2 – periderm, 3 – schizogenic glands, 4 – sclerenchyma, 5 – phloem, 6 – cambium, 7 – primary xylem, 8 – secondary xylem, 9 – pith

The width of the primary cortex of the stem-root of *Echinacea purpurea* is 1249.5 μ . It is homogeneous, composed of 26 parenchyma cells possessing schizogenic intercellulars. The external part of the primary cortex is composed of six small layers 16.6 μ high and 33.3 μ wide. There are no intercellular parenchyma cells. The inner layers of the primary cortex consist of parenchyma cells 44.9 μ and high 91.6 μ wide. With schizogenic intercellulars among them. There are 94.0 cells in 1 mm².

A lot of schizogenic glands of different size are seen in the primary cortex of the stem-root. Glands present in the external cortex are surrounded with 1–2 layers of epithelium cells. There are 2–4 layers of epithelium cells in the inner cortex. The schizogenic glands are oval. Their height is 114.5 μ , their width is 122.1 μ . The width of the inner cavity of channel glands is 62.5 μ ; the height of epithelium cells is 8.3 μ , the width is 41.7 μ .

The width of the stem-root phloem of *Echinacea purpurea* is 166.6 μ . Its height is 33.32 μ ; the width of sieve vessels and comcomitant cells is 49.98 μ . There are no glands in the stem-root phloem.

The width of the stem-root xylem of *Echinacea purpurea* is 5997.6 μ . Spiral and net water vessels perform the vascular function in the xylem. They form bent radial rows of 2–8 vessels. Water vessels are composed of vessel compartments with small spouts 149.9 μ long. They are solitary. Their inner channel cavity is oval and makes 29.2 μ . Their wall thickness is 8.3 μ , and an ordinary perforation is typical of them. They make 8.3% of xylem volume. The store parenchyma makes the biggest part

(80.6%) of xylem volume. Parenchyma cells of the xylem are oval. Their width is 33.3 μ . Fibers of the inner xylem make 10.0% of xylem volume. They make islands of 208.3 μ in size. Schizogenic intercellulars make the rest part, which is equal to 2.0%, of xylem volume.

Intercellulars exist in the inner xylem, close to the pith. They are oval-shaped. Their width is 166.6 μ . The cavity of the inner channel, which is surrounded by 2 layers of epithelium cells, reaches 74.9 μ .

There is a pith 5997.6 μ wide in the central part of the stem-root. It is composed of parenchyma cells 54.2 μ high and 70.8 μ wide, with large (78.5 μ) schizogenic intercellulars among them. Numerous schizogenic glands 608.1 μ in size are found in the pith.

The height of the inner channel cavity is 122.9 μ and; the width 99.9 μ . Thirteen layers of epithelium cells surround the channel. The epithelium cells that are close to the channel are larger and filled with a content.

The interbundle parenchyma, which exists inbetween two large schizogenic intercellulars serves as the grounds for the formation of stem-root additional roots.

Anatomical constitution of the root of *Echinacea purpurea* (L.) Moench. The root of *Echinacea purpurea* is polyarchic, of non-bundle type (Fig. 3). Vascular tissues stretch in the root siphonostele. The periderm 24.9 μ thick, composed of 1–5 cell rows, covers the root. It makes 0.8% of the root volume. The primary cortex phloem has turned into scler-

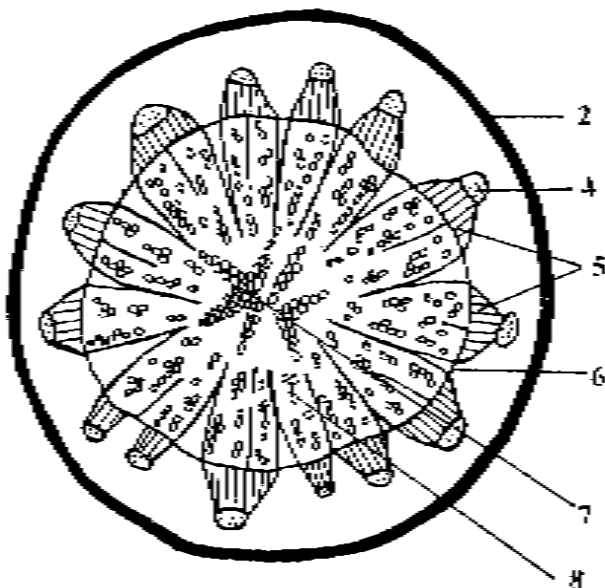


Fig. 3. Anatomical constitution of the root of *Echinacea purpurea* (L.) Moench: 1 – epidermis, 2 – periderm, 3 – schizogenic glands, 4 – sclerenchyma, 5 – phloem, 6 – cambium, 7 – primary xylem, 8 – secondary xylem, 9 – pith

enchymatous islands 124.9 μ and 149.9 μ wide. The secondary phloem is weakly developed. Wide pith rays split it into triangle islands. There are sclereids 41.7 μ and druses 33.3 μ in diameter in the cortex parenchyma. There are organic inclusions in its outer part as well. The cortex makes 22.0% of the root volume. A cylinder of the bundle and interbundle cambium separates the cortex from the xylem.

The secondary xylem is composed of spiral water vessels, xylem parenchyma and xylem fibers. It makes 61.1% of root volume. Water vessels make 21.6%. And the pith ray parenchyma 26.7% of xylem volume. Xylem fibers make the remaining 51.7%. There is the primary xylem 208.3 μ wide in the central part of the root. It makes 16.1% of root volume. The secondary xylem is 1499.4 μ wide. There are 21 solitary and 2 grouped water vessels in the field of vision. The cavity of the inner channel of solitary water vessels is oval. Its diameter is 59.7 μ . The diameter of grouped vessels is 54.2 μ .

The root is of polyarchic type. There are heterogeneous single-row and multi-row pith rays in the secondary xylem. Multi-row pith rays are composed of 2–11 cell rows, their width fluctuating from 74.9 μ up to 166.6 μ .

The side roots are formed of pericycle cells located close to the primary xylem rays.

CONCLUSIONS

1. Heterobathmia was revealed in all axial organs of *Echinacea purpurea* (L.) Moench studied.
2. Schizogenic glands are present in stems and stem-roots in roots.
3. Vessel tissues in stems of *Echinacea purpurea* (L.) Moench stretch in the bundle eustele, in the stem-root (of non-bundle type) in the siphonostele, in the root (of non-bundle type) in the root siphonostele.
4. Water transporting function in the axial organs of *Echinacea purpurea* (L.) Moench is performed by solitary circle and spiral, oval-shaped water vessels. They are composed of water compartments with small spouts and an ordinary perforation.
5. Pith rays are heterogeneous, single-row and multi-row, composed of 2–11 rows of cells.
6. Water vessels in the stem make 15%, in the stem-root 8.3%, in the root 15% of xylem volume.

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**ECHINACEA PURPUREA (L.) MOENCH AŠINIŲ
ORGANŲ ANATOMINĖ SANDARA**

S a n t r a u k a

Straipsnyje pateikiami *Echinacea purpurea* (L.) Moench. ašinių organų – stiebų, šakniastiebių ir šaknų anatomicinės

sandaros aprašymai. Visuose tirtuose organuose nustatyta heteroblastija. Šizogeninės kilmės liaukos yra stiebuose ir šakniastiebiuose, o šaknyse, kaip nurodo V. N. Samorodov [8], jų nėra. Medienoje ir šerdyje liaukų vidinio kanalo ertmė apvali, žievėje – ovali. Liaukos kanalo ertmę supa 2–13 epitelinių ląstelių eilių.

Apytakos audiniai *Echinacea purpurea* (L.) Moench. stiebuose išsidėsto kūlelinio tipo stelėje-eustelėje, šakniastiebyje – nekūlelinio tipo sifonostelėje, šaknyje – nakūlelinio tipo šaknų sifonostelėje. Vandens pernešimo funkciją atlieka pavieniai žiediniai ir spiraliniai ovalia vidine ertme vandens indai. Juos sudaro 149,9 μ ilgio indų nareliai su snapeliu. Vandens indų vidinio kanalo ertmė 29,2 μ, paprasta perforacija išsidėsto įstrižoje sienelėje. Vandens indai stiebe sudaro 15%, šakniastiebyje – 8,3%, šaknyje – 15% medienos tūrio.

Šerdies spinduliai, horizontaliai pernešantys įvairios paskirties medžiagas, – heterogeniniai, vienaeiliai ar daugiaeiliniai, sudaryti iš 2–11 ląstelių eilių.