HISTOANATOMY OF VEGETATIVE ORGANS WITH BIOACTIVE PRINCIPLES IN *APIUM GRAVEOLENS* L. VAR. *RAPACEUM* (MILL.) GAUD. (APIACEAE)

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Received 21 April 2014; accepted 30 May 2014

ABSTRACT
The paper presents a detailed anatomical description of the vegetative organs of a well known cultivated plant Apium graveolens var. rapaceum (Mill.) Gaud. For the medicinal purpose, is used the root and leaves, as vegetative organs, of this plant and seeds as well. It was observed that the root has an anomalous secondary structure, due to the cambium activity. The petiole has a one-layered epidermis, covered by cuticle, a differentiated cortex into two zones and a number of collateral vascular bundles. The leaf is bifacial and amphistomatic with a heterogenous mesophyll. The root, petiole and blade possess secretory ducts. The mechanical tissue is represented by sclerenchymatous fibers in the root and collenchyma tissue in the leaf.

KEY WORDS: histoanatomy, root, stem, leaf, Apium graveolens var. rapaceum

INTRODUCTION
Cultivated forms of celery all descend from the wild type, *Apium graveolens* L., growing in saline areas near the coastline in Europe and western Asia. Celery root, or celeriac, *Apium graveolens* var. *rapaceum*, has a swollen, beet-like root with a mild taste. Celery, *Apium graveolens* var. *dulce* has long, thick and crispy stalks. Celery seed oil is produced in France, India and California. It is used chiefly for flavoring foods, vegetable juices, medicamentary purposes, etc., although small quantities are also used in perfumery (Web 1). Celeriac has been cultivated and used in medicine since the ancient Greece and with over 500 BC. The Chinese already used in the traditional cuisine. Celery is an excellent remedy for prophylaxis and treatment of diseases due to the vitamins (A, B, C, K, PP) and in mineral ions (Na, K, Ca, Mg, P, Fe, Mn, Cu).

Few data are known about this species anatomy. Biological properties of different anatomical parts of celery and its extracts were reported in various literature sources (e.g. Bedin et al., 1999; Mencherini et al., 2007). Most of the studies refer to the potent antimicrobial activity against *Bacillus subtilis*, *Escherichia coli* and *Saccharomyces cerevisiae* (Krishna & Banerjee, 1999). Authors, such as Elgayyar et al. (2001), suggested the celery essential oil inhibited various pathogenic and saprophytic microorganisms and Friedman et al. (2002) reported celery seed oil was active against *Campylobacter jejuni*. Some data are known due to the studies of...
(Hajiboland et al., 2012), concerning the morphological and anatomical modifications in leaf, stem and roots of a number of plants species under boron deficiency conditions. In the Romanian literature data on this species structure almost lack and we can cite in this connection Zanovschi & Toma researches (1985) and Bercu et al. (2012).

The purpose of this paper is to highlight the anatomical features of *Apium graveolens* var. *rapaceum* vegetative organs with bioactive principles due to this the plant is used for treatment purpose and to contribute with more information to the knowledge concerning this species.

**MATERIAL AND METHOD**

Small pieces of root and leaf were fixed in FAA (formalin: glacial acetic acid: alcohol 5:5:9). Cross sections of the vegetative organs were performed by the free hand made technique (Bercu & Jianu, 2003). The samples were stained with alum-carmine and iodine green. Anatomical observations and micrographs were performed with a BIOROM–T bright field microscope, equipped with a TOPICA 6001A camera.

**RESULT AND DISCUSSION**

The phellogen (cork cambium) produces 4-5 layers of suberized cells to the exterior - the cork – and 5-6 layers of phelloderm, inside, forming the periderm. The phelloderm consists rare secretory ducts (Fig. 1, A). Cambium produces a thick liner of secondary phloem consisting of phloem vessels, companion cells, phloem parenchyma. The phloem parenchyma is well developed and it cells consists numerous starch grains. The secondary phloem is divided into long strips by secondary radial cellulosic pith rays. Inward, cambium generates a secondary thick xylem mass, composed of xylem vessels and a cellulosic and sclerified parenchyma as well (Fig. 1, B).

Such as Zanovschi and Toma (1985) reported for *Apium graveolens*, our findings disclose the xylem tissue may be differentiate into three areas, an outer zone with rare vessels embedded into a cellulosic parenchyma and few sclerified fibers followed by a median region with a number of xylem vessels, dispersed into a slightly sclerified xylem parenchyma and the third area which, such as the external one, possesses few isolated vessels embedded into a cellulosic parenchyma. Centrally the parenchymatous pith is present (Fig. 1, B, C).

Cross section of the petiole discloses a more or less triangle-coasted shaped-form (Fig.1,A). The epidermis consists of more or less isodiametric slightly tangential elongated cells. The external walls are covered by a thin cuticle (Fig.2,B). Here and there stomata are present. Just below the epidermis is cortex, differentiated into two zones. The external one is composed of collenchyma cells in the coasts. Chafe (1969) studied the morphological forms of collenchyma and lamellae orientation in the cells of stem and petiole for 10 species of plants, and reported for *A. graveolens* petiole an
annular to angular collenchyma. Our findings exhibit an annular collenchyma (Fig. 2, B). The collenchyma alternate with strips of homogenous chlorenchyma tissue. The second zone is represented by 3-4 layers of parenchyma cells with fine cellulosic walls, observed and examined by Thimm et al. (2000) by atomic force microscopy (Fig. 2, B). The vascular bundles, seven in number, are close collateral, arranged in an arc of a circle, the larger in abaxial position. Secretory ducts with volatile oils, are present in the basic parenchyma, the larger placed above each vascular bundles (Fig. 2).


FIG. 2. Cross section of the petiole - ensemble - (x 80, A). Portion with epidermis, cortex and vascular bundles - detail (x 180, B): bp-basic parenchyma, co-collenchyma, chl-chlorenchyma, e-epidermis, pc-parenchyma cortex, ph-phloem, pil-pith lacuna, sd-secretory duct, vb-vascular bundle, x-xylem.

FIG. 3. Cross section of the blade, x 180: le-lower epidermis, pt-palisade tissue, st-stoma, stp-spongy tissue, ue-upper epidermis, vb-vascular bundle.
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Transection of the blade, exhibits the unistartous upper and lower epidermes. However, the lower epidermal cells are smaller than the upper one and slightly elongate tangential. The epidermal cells of both epidermises are covered by a thin cuticle and possess stomata.

The mesophyll is bifacial differentiated into palisade (two layers of cells) and spongy tissue 3-4 layers of parenchyma cells). Small poor developed vascular bundles are embedded in the mesophyll. The secretory ducts are present mostly in the phloem tissue of the vascular bundles (Fig. 3).

**CONCLUSIONS**

The root have an anomalous secondary structure with a well developed phloem and mostly xylem tissues.

The petiole cortex is differentiate into two zones one is a colenchyma and chlorenchyma zone and the other is the parenchymatous region. In the basic tissue are embedded a number of vascular collateral bundles. The blade is bifacial, heterogenous and have stomata on both sides (on both epidermises).

The mechanical tissue in the petiole is represented an annular colenchyma.

The secretory elements are represented by secretory ducts present in root, petiole and blade.

**REFERENCES**

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