MORPHOLOGY AND ANATOMY OF THE STEM AND LEAF FROM THE *LOPHANTHUS ANISATUS* SPECIES (NUTT.) BENTH.

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Abstract

The objective of this work was the study of vegetative organs in the species Lophanthus anisatus (Nutt.) Benth., synonymous with Agastache foeniculum (Pursh) Kuntze. The species L. anisatus Nutt, includes herbaceous, perennial plants belonging to the Lamiaceae family, the subfamily Nepetoideae, is native to America, North and East Asia. It was introduced relatively recently in Romania, being used as a medicinal plant, spice, ornamental and melliferous. For medicinal purposes, it is used the aerial part (herba) with multiple uses, for affections of the digestive system, prevents vascular accidents, increases the immunity system. Analysis of the leaves showed that the stem is 4-muchied, according to the Lamiaceae Family, the epidermis shows tectoral and glandular hairs, well-developed colenchymis, with 5-7 rows of cells, the ross with leading beams and pitch. The kambium connects the 4 leading beams of the trunk. The pitch is centrally situated. The epidermis is composed of a single row of cells where peri tectors and glandulars are observed.
The knowledge of these elements of anatomy is very important in the field of taxonomy and in the characterization of species, varieties.

Key words: vegetative organs, analysis, anatomy, taxonomy

INTRODUCTION

The humans have developed a broad knowledge of useful plants over time through continuous contact with their environment (Tabaraki,2012). At present, there is an increasing interest in industry and scientific research of vegetables, fruits, medicinal plants and spices because of their antioxidative phytochemicals and antimicrobial properties (Nitu S. et al 2016). Lophantus anisathus (Nett) Benth. synonym (Agastache foeniculum (Pursh) Kuntze) belongs to the Lamiaceae family.

The Agastache genus includes 22 species of perennial aromatic medicinal plants. However, according to the current list of taxonomic working groups in World Flora Online (WFO) (http://www.worldfloraonline.org), Agastache genre contains about 37 recognized taxa and 28 synonymous taxa.

The genus Agastache belongs to Nepetoideae - a subfamily of Lamiaceae (Cantino et al. 1992). Agastache species are separated into two sections: Brittonastrum and Agastache (Lint and Epling 1945 ; Sanders 1987).

The name of the genus comes from the Greek word „agatos", which means admirable, popular it is known as: Big blue Isop, huge isop, huge scented isop, anise isop, wild anise, wild anise, wild anise, and a, and popular Lofant (Luchian et al., 2020). It is a herbaceous plant, perennial (Vantoru et al., 2019; Ivanov et al., 2019; Kormosh et al., 2020; Badea et al., 2022).

L. aninatus is an aromatic plant considered among the first melliferous in the world. For

medicinal purposes, the aerial part (herba) with multiple uses. It is used in natural medicine with because it prevents and treats gastritis, gallbladder diseases, hepatitis, strokes, increases the immunity system, balances metabolic processes (Mirzan, O. ei al. 2021), abdominal pain, burns, fever and cold symptoms (Duda et al., 2013).

L. anisathus extract has the action: antimicrobial, antiviral, antimutagenic, antiproliferative, antiatherogenic, cytotoxic (for cancer cells), anti-inflammatory, antioxidant and relaxing effect, etc. (Yashika et al., 2013; Sanchez-Recillas et al., 2014; Mazza and Kiehn, 1992; Mostafa et al., 2018; Omidbaigi and Sefidkon, 2003; 2004; Zielinska and Matkowski, 2014; Mihailova et al., 2013; Duda et al., 2015; Hashemi et al., 2017; Ivanov et al., 2019; Luchian et al. 2020)

L. anisathus is recently cultivated strip in Romania. The specie has the advantage of being able to endure low winter temperatures, up to -25°C in snow-covered soil (Duda et al.2013) The plant does not have special demands of the soil, showing increased resistance to diseases and pests (Mirzan, O. ei al. 2021). The acclimatization of the specie, Lophanthus anisatus Nutt, in our country has been done at the Research Institute in Buzau since 2010.

Currently, breeding studies are conducted at USAMV Cluj-Napoca and at SCDA Secuieni are conducted studies on the technology of cultivation in ecological system.

MATERIALS AND METHODS

The objective of this paper was the morphological and anatomical study of some vegetative organs of the specie L. anisatus (Nutt.) Benth.

The research material used was represented by plants in the stage of 4-8 leaves, obtained from seed. Microscopic analyses were performed on fresh material, between 11-13 October 2024. The initial material (seed) was procured from SCDA Secuieni.

The plants of L. anisatus were obtained in the Laboratory of medicinal and aromatic plants of the Research and Development Institute for Pajisti Brasov (Figure1).

Morphological and anatomical analyses were performed at the strain, petiol and leaf level. The leaf anatomy was performed according to the classical methods of analysis used in this field.

For morphological analysis, fresh material (strain, leaves) was used.

Microscopic examination was performed on cross-sections, obtained from fresh leaves, treated with hydrochloride, not colored or colored with alumat carmine and methyl green.

The study was made in the Laboratory of Botany-Morphology and Plant Anatomy - USAMV Faculty of Horticulture - Bucharest, Leica binocular, optical microscope, Optika, Leica, Motorola digital camera. The photos were taken with lenses of different sizes.

Knowledge of the elements of plant, the anatomy and the morphology is very important in the field of taxonomy and in the characterization of species, varieties.

Figure 1. *Lophanthus anisatus*

RESULTS AND DISCUSSIONS

The objective of this work was the study of some vegetative organs of the specie Lophanthus anisatus (Nutt.) Benth. Following the microscopic observations, the presence of the common tissue was observed, composed of upper and lower epidermis, stomata, vascular bundles and other similar surface structures such as

glandular trichomes, long and short hair follicles.

The morphology and the distribution of glandular trichomes are often applied as taxonomic characters at the subfamilial level in the family Lamiaceae (Abu-Asab and Cantino 1987; Cantino, 1990; Luchian 2020).

Stem anatomy

In the cross-section, the quadrilateral stem can be seen, according to the organization of the Lamiaceae Family. (Figure 2). From outside to inside of the section, the following areas can be observed: the epidermis with peri tectors and glands (Figure 2,3,4), a well-developed collenchyma in the area of the 4 edges with 5-7 rows of cells (Figure 5), the bark with the conducting fascicles and the medulla. The cambium connects the 4 conducting bundles positioned in the angles of the stem. The marrow is centrally arranged.

Figure 2. *Transverse section in the stem*

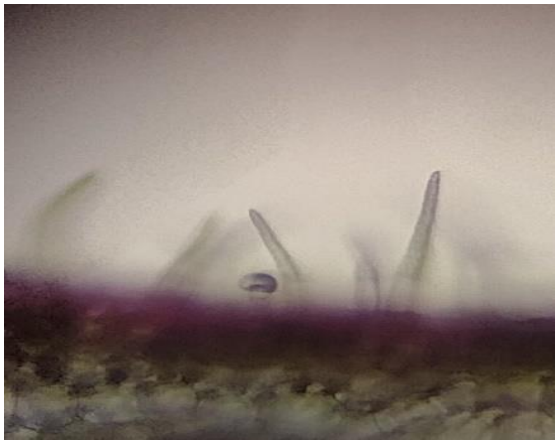

Figure 3. *Peri tectors and glands in the epidermis of the stem*

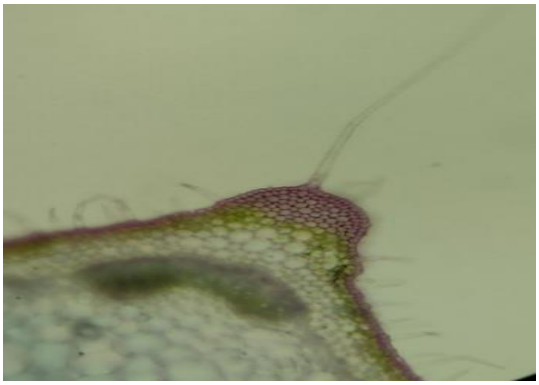

Figure 4. *Long tector hair, in the area of the edge of the stem and short, glandular tector hairs*

Figure 5. *Collenchyma in the edge area in stems*

The epidermis consists of a single row of cells in which peri tectors and glands are observed. The tector hair much longer in border than the rest of the hairs in the epidermis area (Figure 4). Glandular bristles presents a particular importance to the Lamiaceae family, being considered very important characteristics in taxonomy. In the area of the stem edges, the leading vascular tissue, free-woody can be observed (Figure 6), and in the center of the section is the pitch (Figure 7). Glandular trichomes are important taxonomic features in the family Lamiaceae (Xiang et al., 2010).

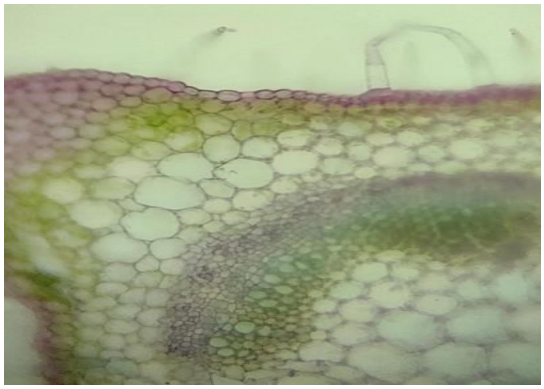

Figure 6. *The leading fascism libero-wooden*

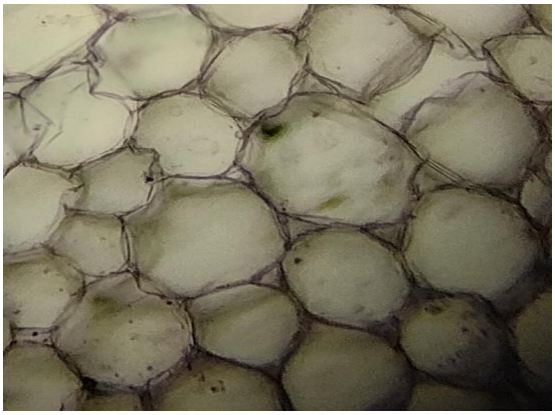

Figure 7. *The central area of the stem-marrow*

Leaf morphology and anatomy

The leaves are arranged opposite to the nodes of the stem, the basal leaves are ovate - cordate to ovate - triangular, with a serrated - crenate margin (Figure 8), with short unicellular and longer pluricellular bristles, with a slightly curved tip, on the edge of the lamina (Figure 9).

Figure 8. *Leaf with serrate - crenate margin*

Figure 9. *Unicellular and multicellular peri tectors on the leaf*

Also, the upper epidermis has tector hairs both on the veins and on the lamina, but also secretory hairs (Figure 10). On the lower epidermis, the presence of tector bristles can be observed, both on the ribbs and on the lamina,but the secretory bristles are more abundant (Figure 11). The upper epidermis consists in a row of cells with wavy walls, being covered by the cuticle (Figure 12).

Figure 10. *Peri tectors - on the upper epidermis*

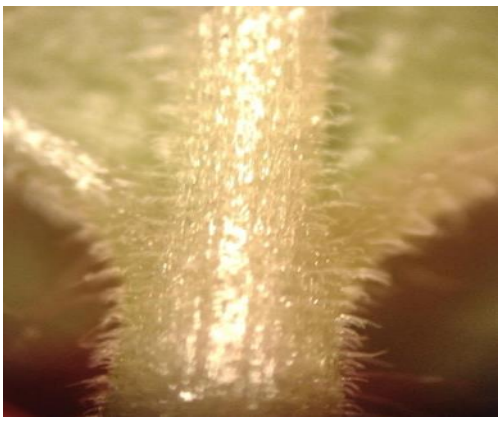

Figure 11. *Leaf densely hairy abaxially*

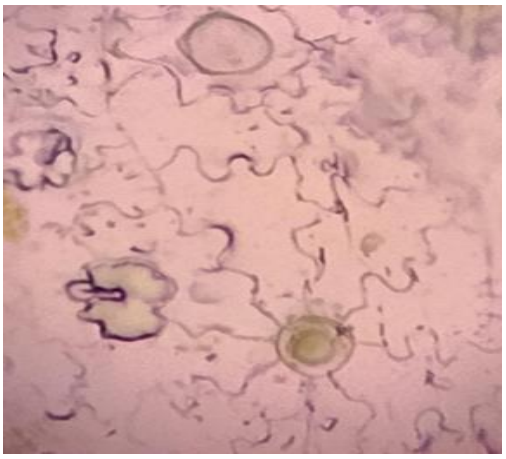

Figure 12. *Upper epidermis*

The lower epidermis has numerous stomatas, the leaf being hypostomatic. Epidermis show tector, simple, unicellular and multicellular trichomes, as well as glandular trichomes with a three-celled pedicel. A spherical secretory cell can be observed in the terminal part and glandular trichomes formed by 8 cells (Figure 13). The lower epidermis is densely hairy, with numerous peri tectors and secretors (Figure 14). Glandular trichomes pelted with essential oil are located on leaf surfaces, both adaxially and abaxially.

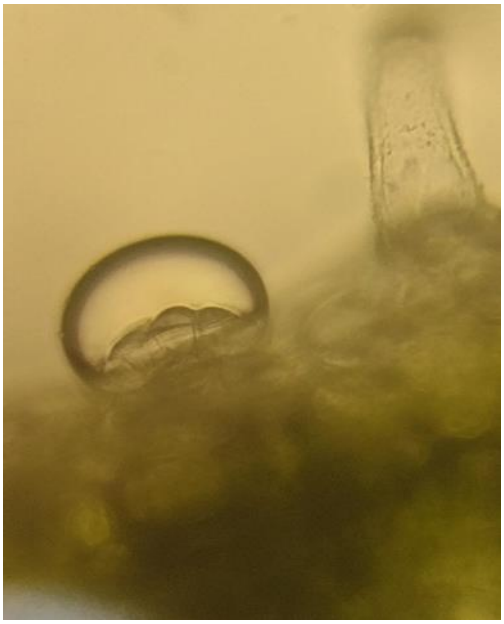

Figure 13. *Lower epidermis with 8-cell glandular hair*

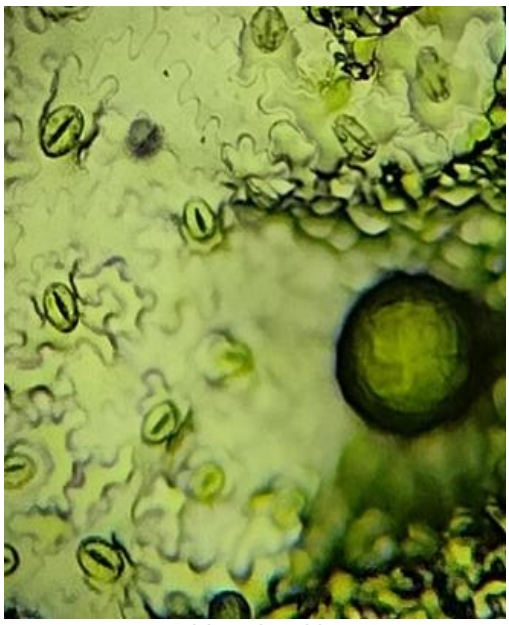

Figure 14. *Lower epidermis with numerous stomata and secretory bristles*

Petiole morphology

The petiole has tector hairs and secretory hairs on the convex side, these being shorter compared to the concave side, where they are longer and oriented in several directions (Figure 15, Figure 16). The petiole also has glandular hairs in the epidermis. The epidermis of the petiole consists of elongated polygonal cells without intercellular spaces (Figure 17).

Figure 15. *Petiole*

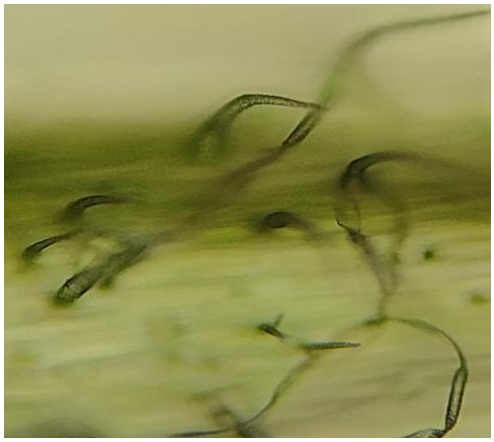

Figure 16. *Petiole epidermis concave side*

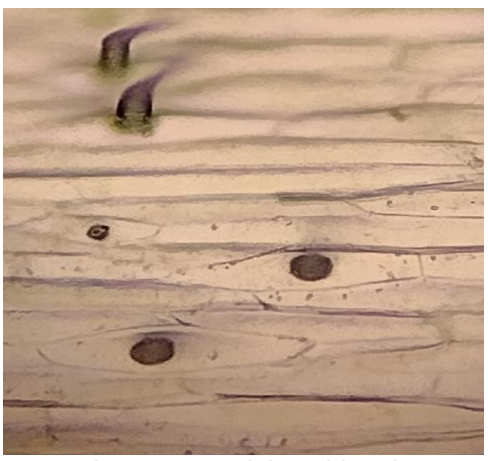

Figure 17. *Petiole epidermis*

Petiole anatomy

The petiole is semicircular in cross-section (Figure 18). On the outside, is observed the epidermis, unistratified, made up of small, uneven cells, with numerous tectors and secretors peri (Figure 19). Under the epidermis, in the rounded parts of the petiole, the collenchyma is observed (Figure 20).

The main part of the petiole consists of parenchyma, with wide cells, of spherical-oval shape with thin walls and the leading bundle of closed collateral type. The main leading bundle, well developed, consists of phloem and xylem, has the shape of a semicircle, occupies the center of the petiole and there are two smaller bundles, barely visible (Figure 21, Figure 22).

Figure 20. *Collenchyma*

Figure 18. *Petiole - assembly*

Figure 21. *Main closed collateral conducting fascicle*

Figure 19. *Epidermis with bristles*

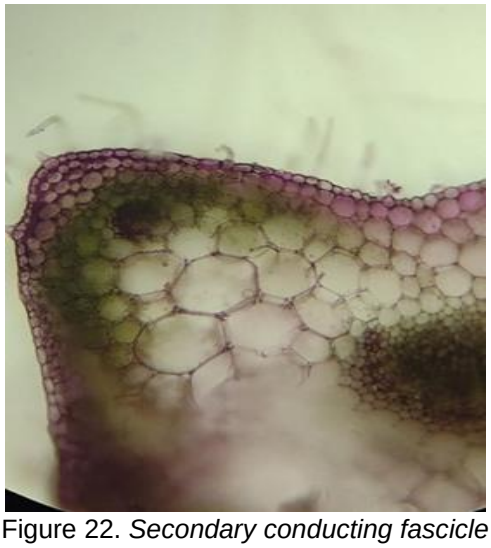

Figure 22. *Secondary conducting fascicle*

Leaf anatomy

In the cross section, the upper epidermis, the lower epidermis, the mesophyll with the conducting bundles and the main nerve can be seen (Figure 23, Figure 24). Epidermis have tectors and secretors peri (Figure 25). Fungi show bifacial type mesophyll, with palisade tissue (1 row of cells) under the upper epidermis and lacunar tissue (4-5 rows of cells) under the lower epidermis. Spherical-oval chloroplasts are observed in the cells of the palisade layer, the lacunar tissue has parenchymal, spherical cells with intercellular spaces. In the mesophyll, a closed collateral-type leading beam is observed. Simple, unicellular and multicellular tector trichomes, tricellular and bicellular globular glandular trichomes, as well as eight-celled glandular trichomes are observed in both epidermises. The main nerve is prominent towards the lower face, the epidermis bordering it has tector and secretory trichomes.

Figure 23. *Transverse section in the leaf*

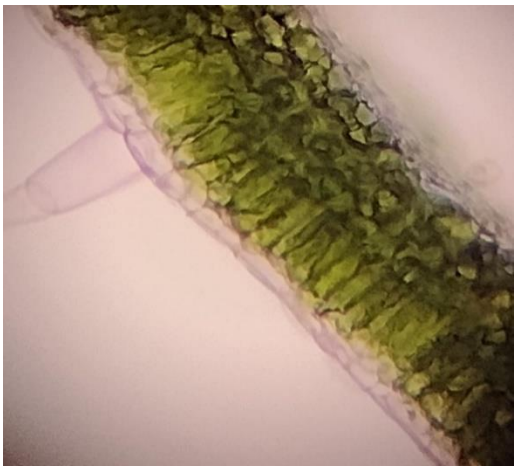

Figure 24. *Lamina with mesophyll*

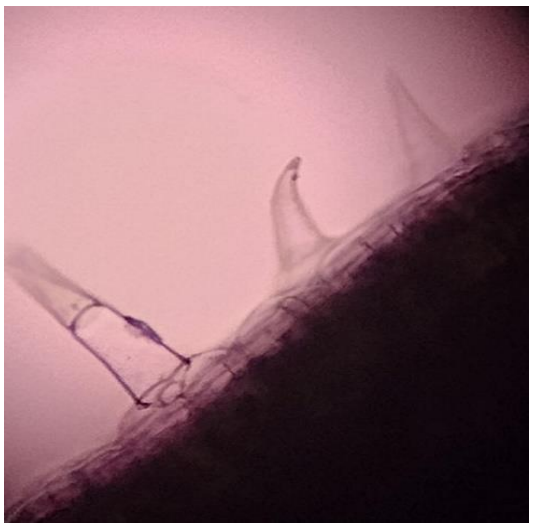

Figure 25. *Hairs in the epidermis*

CONCLUSIONS

Microscopic observations of the fresh samples indicated healthy plant tissues with normal morphological and structural characteristics, specific to the genus of which it belongs.

The morphological and anatomical elements of the organs described in this work constitutes important data for the diagnosis of the species, very useful in taxonomy.

The obtained results can be used for the correct identification of the products on the market in natural pharmacies.

Knowing the types of trichomes (secretory or glandular hairs) is very important for the Lamiaceae Family.

The morphological and anatomical studies we carried out bring new elements for this species adapted to our country.

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