The study of perspective medicinal plants using the example of *Helianthus tuberosus* L.

Tamila Utegalieva[1], *Assiya* Dukenbayeva[1], *Aida* Ergazy[1], *Gulden* Yessenova[1], and *Altynay* Nurgabyl[1]

[1]L.N. Gumilyov Eurasian National University, 010000, Astana, Kazakhstan

Abstract. This paper presents the results of microscopic analysis of a perspective medicinal plant *Helianthus tuberosus* used for the treatment of diabetes mellitus. The study was conducted to identify specific morphological and structural characteristics of this plant, which may have a positive impact on the efficacy and safety of its use for medical purposes. Different types of plant material were used in the research: fresh plants, dried plant material and preserved plant material. For preservation of the latter, a special mixture consisting of ethyl alcohol, glycerol and distilled water in equal volumes was used. Anatomical study of the structure and structure of plants was carried out using several methods: to study the structure of the epidermis, surface samples were prepared, which allowed us to get a detailed idea of the cellular composition and location of the epidermis on the surface of leaves, stems and roots of plants; for a deeper study of the internal structure of plants, transverse sections were made, which were further investigated. The results of the study suggest the high potential of this plant as a basis for the development of safe and effective phytopreparations.

1 Introduction

The emergence and development of scientific thought about phytopreparations based on medicinal plants has a long history. In modern society, there is a growing interest in maintaining health by natural methods, and in this context, preparations based on medicinal plants are of particular relevance [1]. Currently, the most important thing in healthcare is to provide the population with new, harmless, and inexpensive drugs [2]. It is known that chemically derived drugs have good action and have a wide spectrum of action. However, chemical drugs cause various allergic and other adverse reactions in the human body [3]. Whereas phytopreparations based on medicinal plants are attracting attention as natural and effective means to maintain health. One perspective medicinal plant is *Helianthus tuberosus* L., which has the unique property of accumulating inulin in underground organs. It is the tubers of *Helianthus tuberosus* that are rich in inulin, protein and other bioactive ingredients and are used for the production of functional food ingredients. *Helianth tuberosus* L. has many applications due to its rich chemical composition, resistance to biotic and abiotic factors, as a functional food product. It can be used in medicine and pharmaceutical industry as it contains antifungal, anticarcinogenic and antioxidant components [4-6]. The aim of our study was microscopic examination of above-ground and underground organs of topinambur,

in order to identify diagnostic characters. In this regard, a comprehensive study of morphological description and detailed microscopic analysis of the plant as a whole was carried out. The novelty of the research lies in the identification of diagnostic features of medicinal raw materials, which can then be used in the pharmacognostic analysis of raw materials.

2 Materials and Methods

The object of the study are aboveground (leaves and stems) and underground parts (roots) of *Helianthus tuberosus* L. Raw materials were collected in dry weather during the flowering phase of plants in the vicinity of Akmola region in wild conditions. Anatomical studies were carried out according to the methodological guidelines [7-9]. Dry raw materials (stems, leaves, tubers) were fixed in the ratio 1:1:1 glycerol - distilled water - 96% alcohol. Preparations for microscopic analysis were made by hand with a dangerous blade. The preparations were examined using Altami BIO - 1 microscope. Digital photographs were taken using eyepieces and lenses with magnifications of 10x4, 10x10, 10x40, 10x100. To describe the anatomical structure, the terminology proposed by Ezau [10].

3 Results and Discussion

3.1 Morphological and anatomical features of vegetative organs of the species Helianthus tuberosus L. belonging to the family Asteraceae L.

3.1.1 Botanical Description

The family *Asteraceae* L. (Compositae) belongs to the genus *Helianthus tuberosus* L. (earth pear or topinambur). *Helianthus tuberosus* is a root perennial plant. The underground part of the topinambour is represented by tubers of different colours depending on the variety. In shape they can be pear-shaped, cylindrical, club-shaped, long, rounded. The eyes on the tuber are lumpy, are spirally arranged. The weight of one tuber averages 20-60 g. Topinambur tubers have no skin and therefore wither quickly. The stem is erect and strongly sprawling, height ranges from 40 cm to 4 m tall, can branch, sometimes slightly purple in colour, with hairs on the outside. The leaf of the earth pear resembles the sunflower, but the leaf size is smaller than it. The leaves are simple, lobed [4].

3.1.2 Anatomical structure of the leaf

Leaves of the plant in the lower part of the stem are suprotic, in the middle and upper parts alternate. Leaf length is 6.47±0.29 cm, width is 3.58±1.06 cm, margins are toothed, lower and upper parts of the leaf have secretory glands and simple hairs.

The thickness of the upper epidermis is 25.93±0.81 μm, the cells are elongated, oval-shaped, the surface wall has a thick sheath, hairy and glandular-hairy. The most important part of the leaf lamina is the assimilating mesophyll tissue, which has a well-defined columnar shape and is divided into loose parenchyma. The cells of the columnar parenchyma are oval, columnar in shape and arranged perpendicularly to each other in the epidermis (Table 1). It is without intercellularity, rich in chloroplasts, and 61.95±1.47 μm thick. Thickness of loose parenchyma 69.2±1.79 μm, cells different in size, ribbon-shaped, sheaths thin, chlorophyllous, intercellular clear, inclined to the lower epidermis, 3-4 rows irregularly arranged. Conducting tissue is collaterally closed, forms the base of the nerve in the leaf and

occurs as separate tracheid elements between mesophyll cells. The cells of the lower epidermis of the leaf are smaller in shape compared to the upper ones, 16.1±0.52 μm thick, the sheath is thin, the scales are at the level of the epidermis (Figure 1).

Table 1. Anatomical parameters of the leaves of the plant.

Name growth	Epidermal thickness, micron		Mesophyll thickness, μm	Columnar mesophyll		Friable mesophyll	
	top yi	lower yi		quantitative row	thickness layer, μm	quantitative row	thickness, μm
Helianhus tuberosus L.	25,93 ±0,81	16,1 ± 0,52	136,37 ±1,67	1	61,95±1,47	3-4	69,2 ±1,79

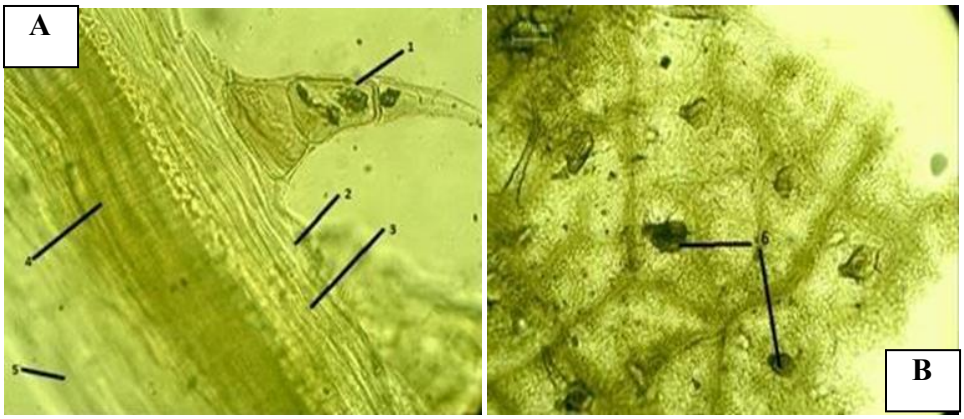

Fig. 1 Anatomical structure of the leaf of *Helianthus tuberosus* L. A - epidermis view, B - surface crushed preparation of leaf:1 - hair, 2 - upper epidermis, 3 - columnar mesophyll, 4 - loose mesophyll, 5 - lower epidermis, 6 - glandular hairs.

3.1.3 Anatomical structure of the stem

The transverse section of the stem is concave, finely toothed. The outer separating multicellular simple and "glandular" pubescent. Epidermal cells are 17.36±0.47 μm thick, rounded, ribbed maximally thickened, cavities narrowed, single row, cutinous on the outside, multicellular simple hairs (Table 2).

Table 2. Anatomical parameters of the plant stem.

Plant name	Epidermis thickness, μm	Thickness of the primary shell, μm	Endoderm thickness, μm	Thickness of sclerench we, μm	Conductive area of their bundles $x10^3$ μm^2	Xylem area $X10^{-3}$μm^2	Parenchyma rod diameter μm
Helianthus tuberosus L.	17,36 ±0,47	230,86 ±1,33	18,26±0,53	109,18±2,85	160,31±5,27	169±0,08	45,84±2,17

Beneath the epidermis, 4-5 rows of angular collenchyma cells are located on its faces. The primary sheath part of the stem is extensive, has a thickness of 230.86±1.33 μm, cells are rounded, oval in shape, sheaths are thin, formed by 9-11 rows of parenchyma. The inner border row has starchy receptacles, cells are clearly expressed, they are rounded or oval in shape, thin- walled, arranged in a chain. The central circumference of the stem is a discontinuous conductive bundle with an area of 160.31±5.27 μm2, the volumes are somewhat identical, arranged in two tiers. They are covered by a sclerenchymal cap or sheath with 11-14 outer and 5-7 rows of inner ones. The cambium on the stem is preserved only as a bundle. Phloem elements of conducting bundles have a narrow volume, located outside the tubes of cambium and xylem.

3.1.4 Anatomical structure of the root

A horizontal slice of the root sprout has a rounded shape. The root from outside is of the same shape, thick-skinned, covered with exoderm formed from a number of cells. The primary sheath is 212.03±3.52 μm thick, the volume covers 65-70 per cent of the root. Its parenchymatous cells are thin-filamentous, of different sizes, rounded, deviated polygonal shape, 7-8 rows. The innermost boundary layer of the sheath the entoderm cells have the same shape, forming one row of dense chains (Table 3).

Table 3. Anatomical parameters of the plant root.

Plant name	Thickness exoderm, μm	Thickness of the primary shell, μm	Diameter of the centre circle, μm	Area xylem tubes, x10-3μm2
Helianthus tuberosus L.	19,27±0,52	212,03±3,52	242,45±0.96	3,12±0,19

The central cylinder of the root is surrounded by a single-row thin-film parenchymatous pericycle. The central circle has a diameter of 242.45±0.96 μm. Underneath pericycle the distance between xylem rays is covered with primary phloem elements. The number of broadly hollow secondary xylem tubes is 5-7, and the number of narrow hollow tubes is 9-11; the total area of xylem tubes averages 3.12±0.19 μm2, and they are divided into four parts in the centre of the root. The xylem parenchyma is well developed (Figure 2 B).

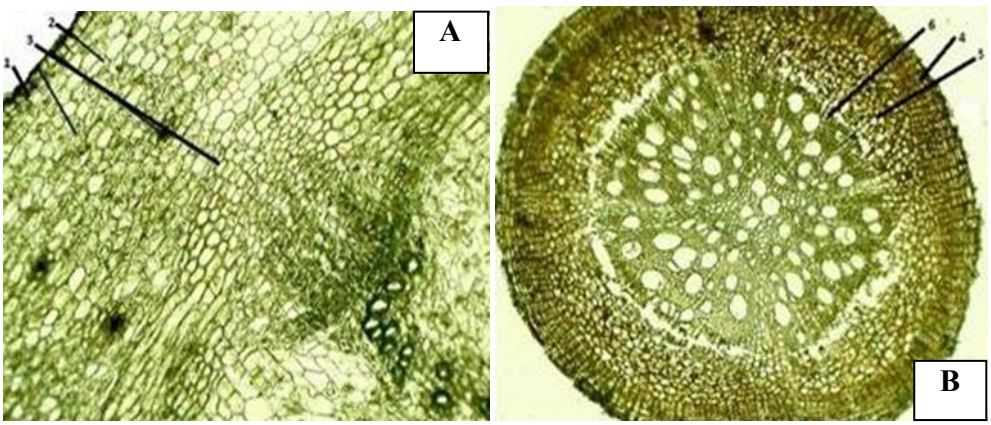

Fig. 2. Anatomical structure of the root of Helianthus tuberosus L. A - vertical view of the horizontal section of the root, B - general view of the horizontal section of the root: 1 - upper epidermis, 2 - mesophyll, 3 - conducting bundle, 4 - exoderm, 5 - primary sheath, 6 – xylem.

4 Conclusion

To develop morphological-anatomical and diagnostic features of topinambur herb, a extensive study of medicinal raw materials was carried out. The botanical description of wild species of *Helianthus tuberosus* L. plants was given, and the anatomical structure of leaf, stem, underground parts of topinambur was revealed. On the basis of the obtained data the main diagnostic features were revealed, which allowed to carry out the diagnosis of raw materials. The following diagnostic markers were determined: simple unicellular hairs characteristic of *Helianthus tuberosus* L. leaves, simple unicellular glandular hairs, multicellular: arrangement of hairs from 3 to 8 and anomocytic type of stomata.

The study of morphological-anatomical and distinctive characteristics of topinambour herb allowed us to develop a comprehensive approach to the analysis of medicinal raw materials. The obtained results open prospects for improvement of methods of unprocessed materials examination, which can be applied in further studies in the field of botany, pharmacognosy and medicine. Also allow not only to develop a integrated approach to the analysis of medicinal primal matter, but also to expand our understanding of the biological features of the plant. The identified diagnostic features become the basis for quality control of primary resources, which can lead to improved quality of medicinal preparations, increase the effectiveness and safety of medicinal products. Our results represent a confirmation of the validity of the author's claims, since the analysis of morphological-anatomical and diagnostic features of topinambur revealed key characteristics that confirm its medicinal value. These data not only support the author's assumptions, but also show new perspectives for further research confirming the safety of topinambur for medicinal use. The analysis of the plant represents an important step in understanding the medicinal properties of topinambur and its potential impact on human health. It creates the basis for more in-depth studies of its efficacy and safety in medical practice. Such research may contribute to the development of new drugs and therapies, as well as to the improvement of existing approaches to the therapy of various diseases.

Authors' contribution

Writing – Review & Editing, T. U.; Formal Analysis, A. D.;Resources, A. E. and G.Y.;Methodology, A. N.

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