



ISSN (E): 2277-7695

ISSN (P): 2349-8242

TPI 2024; 13(1): 110-115

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Received: 04-11-2023

Accepted: 09-12-2023

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## Macroscopic and microscopic analysis of the broccoli herb (*Brassica oleracea var. Italica* plenck)

**Boltaev Mizrob, Meliboeva Shokhista and Jalilov Fazliddin**

**Abstract**

The flora of Uzbekistan is rich in promising little-studied plants that are used in traditional medicine, but additional in-depth research is required to introduce them into medical practice using modern scientific methods. An interesting object for introduction into official medical and pharmaceutical practice is *Brassica oleracea var. Italica* Plenck, from the Brassicaceae family, whose extracts have powerful antioxidant, anti-inflammatory and +anti-cancer effects due to the content of biologically active compounds such as glucosinolates, sulforaphane and indole-3-carbinol. The morphological structure of the aerial part of broccoli was studied using digital microscopy. The anatomical and diagnostic features of this plant are described.

**Keywords:** *Brassica oleracea var. Italica* Plenck, medicinal plant materials, morphoanatomical features, standardization

**1. Introduction**

All over the world preference is given to natural plant products, as medicines and vegetables for the prevention and treatment of various diseases due to their less painful effects. The human diet contains a larger and more diverse group of plant bio-actives than drugs, and they are often unaware that many drugs are derived from compounds originally found in plant foods. Numerous epidemiological studies show that Brassica vegetables in general, and broccoli in particular, protect against cancer in humans, as they are rich sources of glucosinolates and are also high in flavonoids, vitamins, and mineral nutrients [1, 2].

Cultivated varieties of *Brassica oleracea* L. share a genome of nine chromosomes and represent an outstanding diversity of morphotypes, including broccoli (*var. Italica* Plenck), Brussels sprouts [*var. gemmifera* (DC.) Zenker], cabbage (*var. capitata* L.), cauliflower (*var. botrytis* L.), collard greens (*var. medullosa* Thell.), kohlrabi (*var. gongylodes* L.), and several endemisms. All of them probably formed in the process of human domestication, starting from the ancestor of a simple leaf type (*Kale, var. Viridis* L.), which led to a delay in development, an increase and a morphological change in above-ground organs (inflorescences, leaves, stems or buds) [3, 4].

Broccoli (*Brassica oleracea var. Italica* Plenck) is an annual crop belonging to the Brassicaceae family, which is a relative of Brussels sprouts, white cabbage, cauliflower and leaf cabbage. The name "broccoli" comes from the Italian "Broccoli", which means the flowering top of the cabbage [5, 6, 7].

Broccoli can grow in a variety of climates and geographic areas; this suggests a significant impact not only on the yield potential, but also on the various qualitative characteristics of broccoli (aroma, texture, taste, etc.) and on the levels of their health-promoting compounds [8].

It grows up to 60–90 cm tall and forms an upright branching thick green stem with leathery, oblong blue-gray or green basal leaves. At the ends of the central axis and branches (stems) of broccoli there are dense green edible clusters of flower buds (flowers) which, if not harvested, bloom four-petaled yellow flowers and produce silky fruits. The inflorescences and upper stems form the inflorescence (head) of broccoli, which is a commonly consumed organ [9, 10]. The development of a head of broccoli is an important factor in determining their phytochemical composition, since significant changes occur at this stage [11].

Broccoli heads have long been considered an essential part of a well-balanced healthy eating plan. It is a low calorie vegetable (34 kcal (~142 kJ)/100 g fresh weight (raw)) and a rich dietary source of minerals (calcium, phosphorus, potassium and sodium), vitamins (B, C, E, K, U), fibers and many other healthy molecules, including carotenoids ( $\beta$ -carotene and lutein), flavonoids (kaempferol), hydroxycinnamic acids (derivatives of sinapic and caffeoylquinic

acids) and, in particular, glucosinolates [12].

This variety of cabbage is considered a natural anti-cancer anti-carcinogenic vegetable and is known in folk and traditional medicine due to the presence of high concentrations of indole-3-carbinol (I3C), which is used to treat breast cancer and a number of other diseases [13].

The use of drugs and dietary supplements made from broccoli is recommended for atherosclerosis (the presence of pectins that can remove toxic substances and cholesterol from the body, and fiber that removes cholesterol and improves intestinal motility), diseases of the stomach, liver. The pollen of a flowering plant, infused in warm honey water, is an effective drug for the treatment of radiation sickness. Sprouted broccoli seeds have been found to act as a prophylactic anti-carcinogenic agent, preventing the development of cancer cells. This is due to the maximum accumulation of glucosinolates, in particular sulforaphane (Sulforaphane), especially in the early growing season [6].

The isothiocyanates present in cruciferous vegetables known as sulforaphane in these green leafy vegetables are known to effectively prevent and treat various types of cancer such as prostate cancer, breast cancer, colon cancer, skin cancer, bladder cancer, and oral cancer [14].

In animal models and in vitro, sulforaphane also exerts antihypertensive, anticancer, cardioprotective, and hypocholesterolemic properties, as well as bactericidal properties against *Helicobacter pylori*. Supplementation of type 2 diabetics with broccoli sprouts with a high content of sulforaphane resulted in an increase in the total antioxidant capacity of plasma and a decrease in the index of oxidative stress, lipid peroxidation, serum triglycerides, the ratio of oxidized low-density lipoprotein (LDL) / LDL-cholesterol, serum insulin, insulin resistance and highly sensitive C-reactive protein in serum. Sulforaphane can prevent nephropathy, diabetes-induced fibrosis, and vascular complications [15, 16].

The tartaric acid contained in broccoli inhibits the conversion of carbohydrates into fats and cholesterol in overweight and obesity. The use of such drugs and dietary supplements is recommended in the treatment of gastric ulcer and duodenal ulcer, cleansing the body of toxins, eliminating dysbacteriosis, flatulence and dyspepsia. Juice from fresh leaves is also recommended for these diseases. With peptic ulcer of the stomach and duodenum, pain disappears or decreases, vomiting, nausea, heartburn, and constipation stop. In diseases of the liver (hepatitis, angiocholitis), dyspepsia disappears (digestion disorders), appetite improves. *Helicobacter pylori* infection is the most important etiological factor in almost all non-drug gastric and duodenal ulcers. Scientific research and experience in the use of broccoli in these pathologies shows high efficiency, including antibiotic-resistant forms of *Helicobacter pylori* [6].

The purpose of our work was to conduct a macro- and microscopic analysis of broccoli grass (*Brassica oleracea* L.), to establish diagnostic features that will form the basis of methods for identifying raw materials during standardization as one of the stages of pharmacognostic analysis of plant materials harvested in the conditions of the Samarkand region.

## 2. Planning (Methodology) of research

On fig. 1 shows a graphical representation of the study planning process.

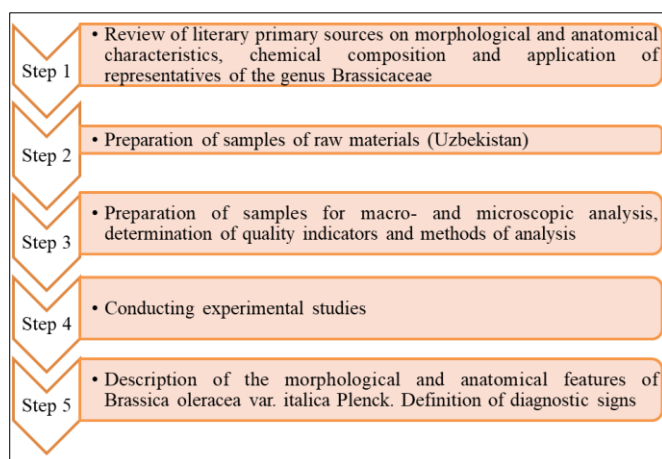


Fig 1: Planning of the research

## 3. Materials and Methods

The material for the study was broccoli grass (Supplier "YAKKA-BURGUT" farm, Samarkand region, Jambay region), harvested in November 2022.

The raw materials were dried at room temperature [17] in a well-ventilated room for ten days and stored in paper bags.

The studies of raw materials were carried out in March-April 2023. Macro- and microscopic studies of raw materials were carried out according to the method of State Federal University 2.8.23 "Microscopic study of medicinal plant materials" [18-21].

Macroscopic studies were performed visually and with a magnifying glass. The study of the anatomical structure of broccoli (*Brassica oleracea* L.) was carried out on samples of whole and chopped raw materials in accordance with the requirements of the State Pharmacopoeia. The stems were fixed in a mixture of 96% ethanol – glycerol – purified water (1:1:1). The structure of stems and leaves was studied in cross sections. The epidermis of the organs was examined from the surface according to conventional methods and clarified with chloral hydrate P [21, 22, 23].

Studies of transverse and longitudinal sections, epidermis and preparations from the surface were performed using an OBE 114 digital microscope, ODC 241 flatbed camera (WF15X eyepieces, x40/0.65, x10/0.25 objectives) with preinstalled software. The results were recorded in the form of a photograph.

## 4. Research results and discussion.

**Morphological (Macroscopic) features.** To identify the morphological features used broccoli herb variety Monaco F1 - a late-ripening hybrid. Broccoli grass was collected based on the climatic conditions of the region in the second half of November. The average weight of Monaco F1 broccoli heads is 700 g. They are round in shape (rarely dome-shaped), very dense, but at the same time juicy green. The "bumpiness" of the surface is not very pronounced. Integumentary leaves are absent. Plant height 55–90 cm, branched root, cylindrical stem (Fig. 2, 2b). The leaves are lyre-pinnately divided, lyre-pinnate-lobed, large, on long petioles up to 25–30 cm, ovate or rounded, dark green in color with a gray coating. The leaf blade is smooth and shiny, the edges are varied, wavy to slightly curly (Fig. 2, 2c). The puff plate is shiny, smooth or slightly corrugated with wavy or curly edges; the stem is green, the leaves and stem are covered with a waxy coating. The main stem ends with an inflorescence head. When the

apical inflorescence is removed, lateral heads develop in the axils of the leaves, which increases the yield. The inflorescence consists of tightly pressed to each other closed green buds up to 15-20 cm in diameter (Fig. 2, 2a). Flower brushes are long. The flowers are yellow, rarely white, with a limb from round to narrow oval, suddenly tapering into a nail.

The fruit is a bilocular pod. Seeds are round, dark brown to black, small. The smell is weak. The taste is bitter.



**Fig 2:** General view of broccoli



**Fig 2a:** Broccoli inflorescences

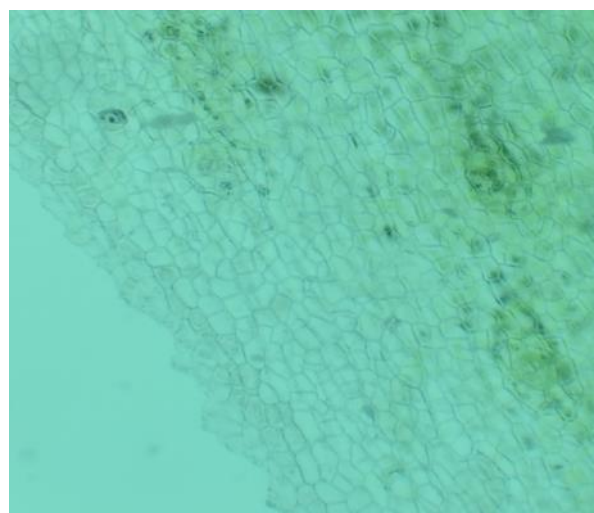


**Fig 2b:** Cross section of the stem

### Features of the anatomical structure of the broccoli herb.

**Stem.** The epidermis of the stem is straight-walled, the cells are 4-6-angular. The stomata are quite numerous, characteristic of the cruciferous family, anisocytic type: the guard cells are surrounded by three unequal peristomatal cells (Fig. 3). Stomata are rounded, slightly flattened and slightly elongated (Fig. 3) [24, 25].

The stem of the beam type of structure (Fig. 3.1). Under the single-layer epidermis (Fig. 3.1a) there is a 3-5-layer colenchyma of an angular or angular-loose type. The parenchyma of the cortex is large-celled collenchymatous, with a well-defined uneven thickening of the membranes.



**Fig 3:** Upper epidermis of the broccoli stem

The bundles are open collateral, rounded, of several sizes. They are surrounded by a 3-4-layer lining of small, with strongly thickened cellulose membranes of sclerenchyma cells (Fig. 3.2).

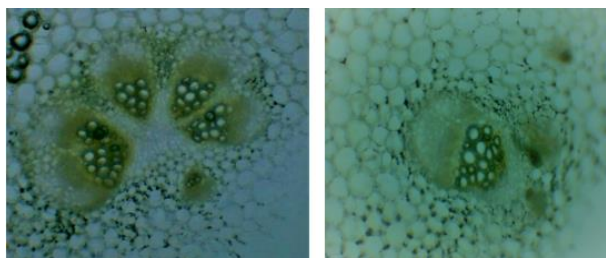
The thin-walled bast is very small-celled and poorly differentiated. Xylem is represented by rounded vessels in cross section with a small number of cells of woody parenchyma type (Fig. 3.2).



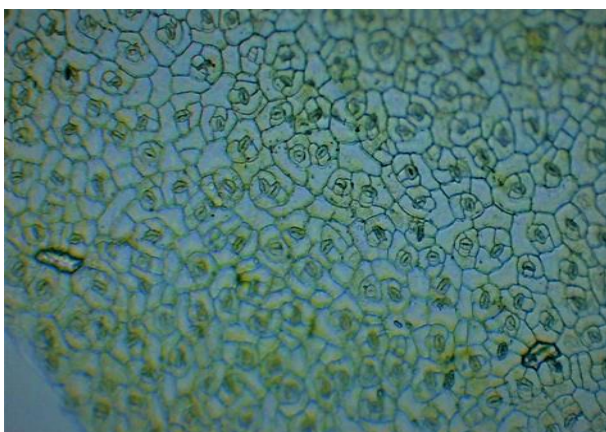
**Fig 3.1:** Cross section of a broccoli stalk

A characteristic feature for the stem is the presence of double bundles, one of which is located closer to the center and is much smaller, with the location of the leading tissues in a

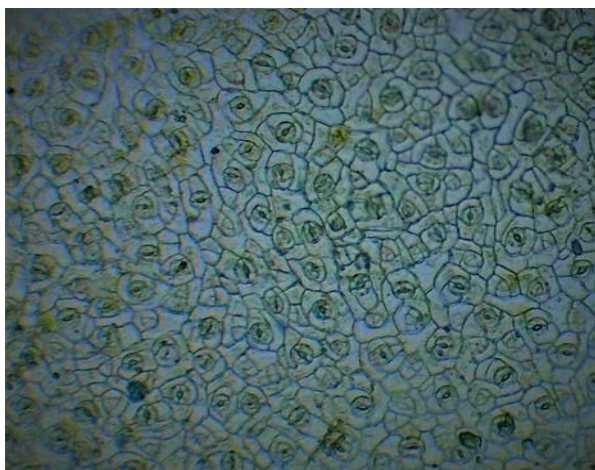
“mirror image” - xylem is closer to the outer edge, and phloem is closer to the center (Fig. 3.2). The core is large-celled, cells with slightly evenly thickened membranes, with 3-4-angled intercellular spaces (Fig. 3.2).



**Fig 3.2:** Collateral bundle of broccoli stem



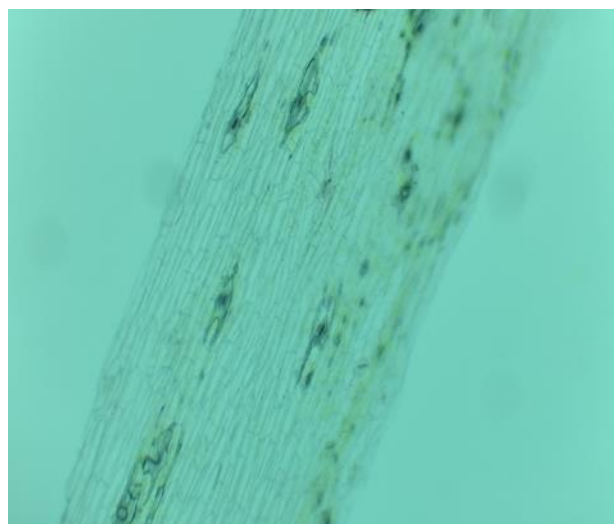
**Fig 3.3:** Upper epidermis of broccoli leaf blade



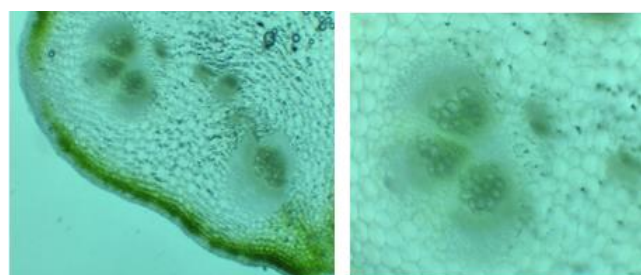
**Fig 3.4:** The lower epidermis of the leaf blade of broccoli



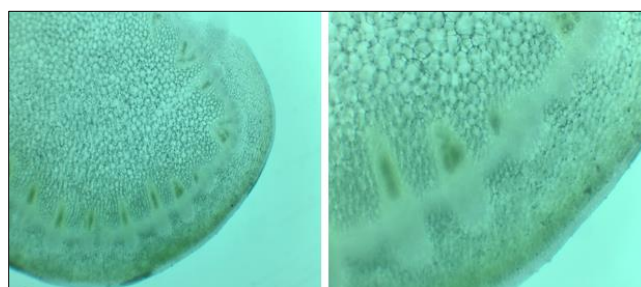
**Fig 3.5:** Epidermis above the vein on the underside of the broccoli leaf blade



**Fig 3.6:** Epidermis of the petiole of the leaf blade of broccoli



**Fig 3.7:** Cross section of the stalk of a broccoli leaf



**Fig 3.8:** Axis of the broccoli inflorescence (cross section).

Leaves of dorsiventral type. The upper epidermis of the leaf blade is straight-thin-walled, the cells are parenchymal in shape (Fig. 3.3). Stomata are arranged randomly, anisocytic type, ostoma cells 3, rarely 4. The subepidermal layer contains single crystals of calcium oxalate of a tetrahedral shape (Fig. 3.3).

The lower epidermis is distinguished by a large number of stomata of the same type of structure (Fig. 3.4). Above the vein of the epidermal cell are straight-walled proscymal forms (Fig. 3.5).

The leaf petiole on the adaxial side is pubescent with simple 1-6 cellular hairs of different lengths, thin-walled with a hook-like refracted apical cell.

The basic cells of the epidermis of the petiole are straight-walled proscymal in shape, the stomata are frequent, the stomatal gaps are oriented along the axis (Fig. 3.6). The type of stomatal apparatus is anisocytic, the perirespiratory cells of the epidermis are rounded. Under the epidermis there is an angular and angular-loose colenchyma up to 6 layers.

The bark is small-celled with thickened membranes (Fig. 3.7). The leading system is represented by numerous conducting

bundles of different sizes (Fig. 3.7), surrounded by sclerenchyma, the cells of which have rather large cavities. The phloem of the bundles is interspersed with single-row strands of sclerenchyma, represented only by a thin-walled bast. The xylem is scattered and vascular, large vessels are round in cross section, and small vessels are 4-angled. The core is large-celled, thin-walled, the cells are 5-6-sided (Fig. 3.7).

The axes of the inflorescence (pedicels) - on a transverse section under the epidermis (Fig. 3.8), the small-celled collenchyma is angular and angular-loose. The cortex is small-celled, the cells are rounded. The leading system is mainly represented by an unevenly developed ring of thick-walled bast and thin-walled bast. Xylem is represented by numerous vessels elongated in the radial direction, 1-2 and up to 5 cells each.

## 5. Conclusion

Macroscopic and anatomical identification parameters of broccoli. The morphological and anatomical features of stems, leaves and flowers (*Brassica oleracea* var. *Italica* Plenck) were studied taking into account the requirements of the European Pharmacopoeia. The diagnostic signs of the structure of the stems, leaves and inflorescences of the species were revealed, which were used as the main quality indicators in the standardization and identification of raw materials.

## 6. Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

## 7. Financing

The study was performed without financial support.

## 8. Data availability

manuscript has no associated data

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