Azerbaijan Journal of Botany, 2024, 1(1): 37-43 https://doi.org/10.30546/ajb.2024.1.020

MICROSCOPIC ANALYSIS OF CONSTANT AND DIAGNOSTIC ANATOMICAL STRUCTURAL INDICATORS OF THE *NASTURTIUM OFFICINALE* R. BR. SPECIES

L.Z. Gurbanova*, S.N. Rahimova
Azerbaijan State Agrarian University, Ataturk Avenue, 450, AZ2000, Ganja, Azerbaijan
E-mail: lala.qurbanova78@list.ru

The article provides information on the main characteristics determined as a result of the microscopic study of covering, parenchyma, meristem, mechanical, transmission tissues of the species *Nasturtium officinale* R.Br. During the research, the preparations made from the root, stem and leaves of the plant were studied in a BLM-210 LCD digital microscope in accordance with the anatomical methods and the anatomical characteristics of the species were determined. The main goal of the research was to determine the constant and diagnostic signs for the determination of the species. Anatomical studies have shown that the covering tissue of the plant is poorly developed. Chloroplasts are found in the epidermis, which is a rare occurrence in the plant kingdom. Poor development of cambium and mechanical tissues was also found. The studied anatomical indicators can be considered a diagnostic sign for this species.

Keywords: axix cylinder, chlorenchyma, endodermis, parenchyma, pericycle

INTRODUCTION

Aquatic plants (hydrophytes) play a primary role for other inhabitants of aquatic ecosystems. Aquatic plants are indicators of the state of aquatic ecosystems and are sensitive to negative changes. Therefore, it is necessary to be more attentive to aquatic plants and ecosystems, to prevent pollution of aquatic habitats to preserve rare plants. *Nasturtium officinale* R.Br. is a perennial herb that belongs to the family *Brassicaceae* of the dicotyledonous class. The roots of the plant that come out of the part of the stem that is in the water are constantly bending and straightening as a result of the water movement. Such action greatly contributes to the aeration of the plant. The stem is bare, cylindrical, and upright, sometimes lying on the ground, in some cases it is a climber and sometimes it is a creeper. The leaves are long-stalked, with feathery sections. The fruit has a long stem. Seeds are arranged in two rows. They are very small. It blooms in May and June. Fruits are produced in July and August [Serebryakov, 1952; Flora of Azerbaijan, 1953].

It is spread from the fields to the middle mountain belt in plains of Samur-Davachi, Absheron, and Kura-Araz plain in Azerbaijan. It is mainly found on the banks of the Kura river, in streams, on the shores of artificial lakes, in small streams, rivers, canals, and sometimes in swamps of Western Azerbaijani regions. It is more common in fresh waters, while some are completely surrounded by water and and some grow on the banks of the water. The plant is very important. Its young leaves are used as food, and especially eaten with cheese and bread. Leaf juice contains iron, iodine, phosphorus, and is rich in potassium, fat and alkaloids. Its seeds contain mustard oil and glucoside. The plant forms very dense forests in water areas. Animals are not fed with them. It has a toxic effect on farm animals. Especially horses are poisoned more quickly. Therefore, it is used in the preparation of drugs in pharmacology [Musayev, 2007; Tylik, 2014].

MATERIALS AND METHODS

The stem, leaves, and roots of the plants growing under natural conditions in the area were taken after reaching full morphological maturity. The purpose of our research is the identification of constant anatomical features

of *Nasturtium officinale*. For anatomical studies, the vegetative organs of the taken plant were fixed with 70% alcohol. Then, temporary preparations were made according to the generally accepted anatomical method and were used for terminology and anatomical descriptions [Evert, 2015; Humbatov, 2017; Tutayug, 1972].

Anatomical photos were taken with a digital microscope. During the preparation of temporary preparations, the material was freshly cut and stained and placed in distilled glycerine. In order to stain the sections, the thinnest sections were transferred to a clean glass and a small amount of aqueous dye solution was added to it through a pipette. After a few minutes, the section was washed repeatedly with water and a solution of 50% ethyl alcohol until free of excess dye [Algan and Toker 2004; Barykina et al., 2004; Humbatov et al., 2015]. Prepared anatomical preparations were studied in BLM-210 LCD digital (modern microscope) microscope. Reagents, dyes and auxiliary methods were used for preparation of samples and determination of structural elements. Glycerin was used by adding two parts of glycerin to one part of water to make the color of living preparations transparent [Alexandrov, 1966; Gasimov et al., 2010].

RESULTS AND DISCUSSION

Anatomical structure of the root Nasturtium officinale R.Br.

Covering tissue: the outside of the root is covered with a layer of epiblem. Epiblem cells are very small in size, a few parts are round in shape, and most of them are prosenchyme type. Their sheaths are very thin and have a conductive property. In connection with this, the suction wires have been reduced. Epiblema cells densely located with each other and with aerenchyma cells.

Aerenchyma tissue: the bark part of the root is held by well-developed aerenchyma. Directly under the epiblem, there is a layer of a large volume, round shape aerenchyma cells are located. There are chain-shaped shoots formed by voluminous aerenchyma cells smaller from those cells towards the central cylinder. Around the central cylinder, aerenchyma cells become much denser and somewhat denser in shrinks. This is the reason why the aerenchyma shoots are well connected to the central cylinder. Each chain-shaped shoot has one or two layers of aerenchyma cells, which are round and thin-glazed cells. There are large air gaps between aerenchyma shoots.

Transmission tissue: the gear mesh elements are located in the central cylinder. Central cylinder is surrounded by a layer of endoderm cells. Endoderm cells are of circular in shape, and its edges are the same thickness on all sides. Issuer cells are very clearly distinguished. They are circular in shape, xylem rays are mainly located in front part. A pericycle is of one layer. The cells are relatively large, polygonal in shape, it has a thin shell, and loses its activity quickly. Xylem is located in tetrarch type rays. In each xylem there are two, sometimes three large water pipes. In the protogylem, there are small water tubes. In the center of the root there are small, round-shaped parenchyma cells, which binds its elements together well. Phloem is well developed compared to xylem. Phloem occupies elements among each xylem ray. Polygonal, thin glabrous sieve tubes are more clearly visible in phloem, and very small volume neighboring cells elements accompany them. Phloem elements are relatively densely located.

Mechanical tissue: The root lacks mechanical tissue. Relative to the root, the cells that give strength to the root are always in a state of turgor, all the layers of the endoderm cells are equally thickened, the central cylinder elements are densely arranged, and the layers of the water tubes are much thicker. As can be seen, the anatomical structure of the root of the medicinal fern plant is very similar to the structure of native aquatic plants (Fig. 1).

Anatomical structure of the stem Nasturtium officinale R.Br.

Covering tissue: unlike other plants, the epidermis is two-layered. Having two layers of the epidermis can be considered a rare phenomenon in the world. The double layer of the epidermis

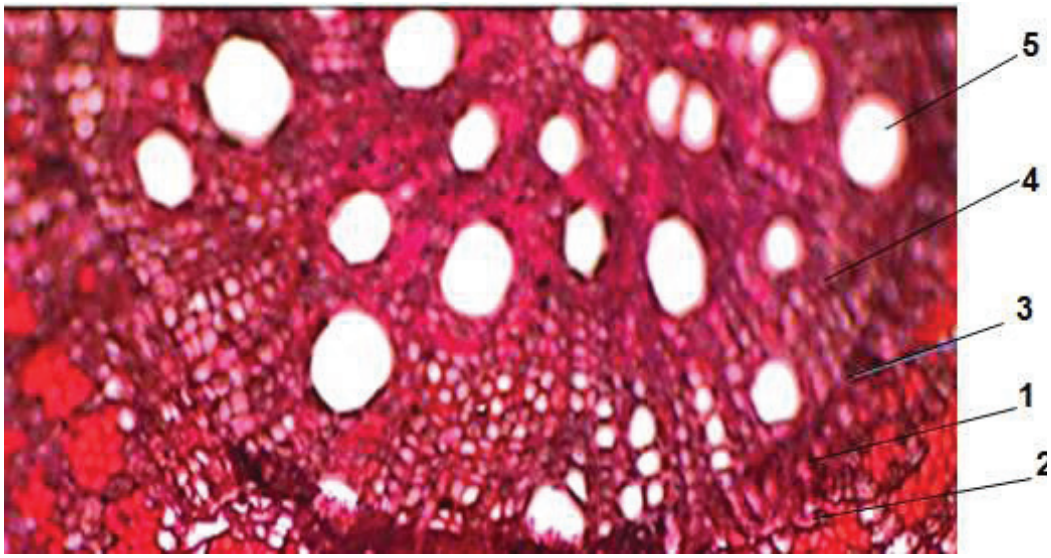

Figure 1. Anatomical structure of the root of *Nasturtium officinale* R.Br.: 1 - axix cylinder; 2 - endodermis; 3 - pericycle; 4 - phloem; 5 - xylem.

gives strength to the body, which lacks mechanical tissue. The cells in both layers of the epidermis are the same size. They are round in shape and but the lower epidermal cells are relatively thin sheathed. The cells of the lower and upper epidermis are not located on a radius and alternate, which causes the layers of the epidermis to be well connected to each other. Epidermal cells do not have chloroplasts. Upper epidermis is covered with a thin layer of cuticle and there are no mouthpieces.

Parenchyma tissue: most of the area of the stem is occupied by parenchyma tissue. The stem has chlorenchyma and main parenchyma tissue. Chlorenchyma covers about one-third of the stem, starting immediately below the epidermis. Chlorenchyma cells are round cells with thin sheaths. They are rich in chloroplast. They are larger than epidermal cells. It has many intercellular spaces. Those gaps play the role of air reserve. But the air spaces are small compared to other aquatic plants. This is due to the presence of the body in the atmosphere.

Main parenchyma: occupied most of the stem. Starting after the chlorenchyma, it occupies the area of the stem up to the central cavity. Parenchyma tissue is separated from chlorenchyma by a layer of endoderm. Endoderm cells are very small and thin. Underneath the endoderm are small polygonal parenchyma cells, which are well connected to each other with the endoderm. From that small volume of parenchyma cells towards the center of the stem, there is a much larger volume of polygonal parenchyma cells with a thin sheath. These cells are relatively densely located. It should be noted that since the main air reservoir in the plant stem is the central space, there are very few air spaces between the parenchyma cells, and the dense arrangement of the main parenchyma is due to the lack of mechanical tissue. The cavity in the center of the stem was formed as a result of the disintegration of the parenchyma cells. In addition, between the water tubes in the transmission balls, there are small, polygonal, thin-walled parenchyma cells that connect the elements of the ball to each other.

Transmission tissue: along the stem there are a number of transmission balls, they are surrounded by endoderm on the upper side, parenchyma cells of small volume on the sides, and main parenchyma cells on the lower part. So the balls are well connected to each other. In a fully developed tuber, the xylem contains several large water tubes, some of which have not yet thickened their sheaths. As shown above, the

water tubes are connected together by small, closely spaced parenchyma cells, phloem has polygonal shape, thin sheath, relatively large sieve tubes and very small neighboring cells. Gear balls are almost well developed. This is due to the presence of well-developed aerial organs of the plant (Fig. 2A).

Meristem tissue: consists of cambium located between phloem and xylem in the transmitting nodules. Cambium is composed of two, sometimes three layers. Cambial cells are very small in size and have a thin sheath. The form is of the prosenchyma type the cambium is almost the same has lost its function. The trunks are annual they do not thicken at the expense of the cambium.

Mechanical tissue: there are no mechanical tissue elements in the structure. This situation makes it much easier to float in water. Its tubular structure, two layers of epidermis, and parenchyma cells give strength to the trunk. Compared to other aquatic plants, it is densely located, the transmission balls are connected with each other by small parenchyma cells, as well as the elements of the ball are well connected with each other. As you can see, the lack of mechanical tissue has led to a dense arrangement of cells in the stem (Fig. 2B). It should be

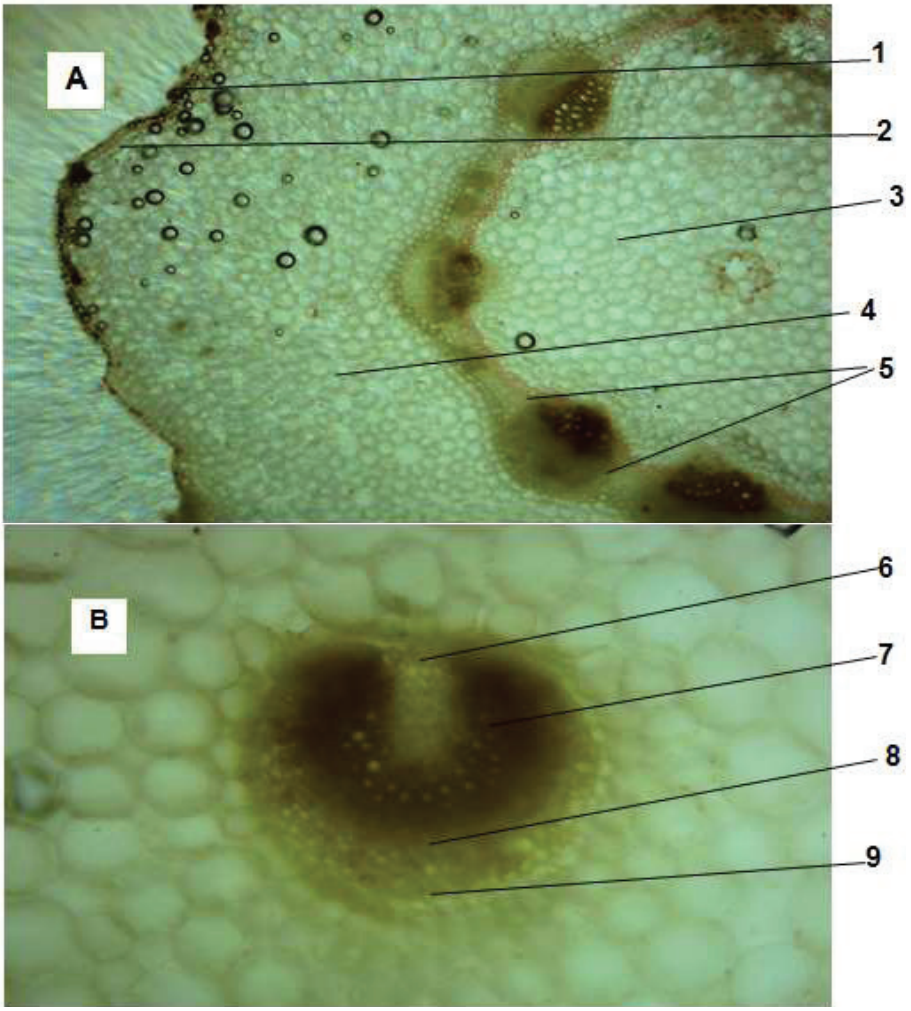

Figure 2 (A, B). Anatomical structure of the stem of *Nasturtium officinale* R.Br.: A - cross section of trunk: 1 - cuticle; 2 - epidermis; 3 - main parenchyma; 4 - intercellular spaces; 5 - fibro-vascular bundle; B - fibro-vascular bundle: 6 - phloem parenchyma; 7 - xylem; 8 - kambi; 9 - phloem.

noted that there is not much difference between the stem completely surrounded by water and the stem of plants growing on the shore. However, there is a considerable difference in the anatomical structure of their leaves, which will be mentioned below.

Anatomical structure of the leaf Nasturtium officinale R.Br. (Fig. 3).

Covering tissue: the lower and upper part of the leaf of the medicinal fern that grows on the coast is covered with a layer of epidermis. The cells of the upper epidermis are circular in the middle vascular area of the leaf, and in the remaining areas, they are prosenchyma type. Cells are relatively small in size. Lower epidermal cells are round shaped cells, mostly small in size, but in some areas there are relatively large cells. The epidermis is covered with a thin cuticle. The lower and upper epidermis of the leaf has many nozzles. Mouthpiece cells are very small. In the leaf of a plant surrounded by water, the epidermal cells are relatively large, and there are no stomata. The presence of the leaf in the water caused the reduction of the mouthparts.

Parenchymal tissue: chlorenchyma occupies the main part of the mesophyll in both plants. Chlorenchyma is spongy. They are rich in chloroplasts. Glyphs are thin and round. However, in the leaf surrounded by water, the parenchyma is larger and more sparsely arranged, forming intercellular spaces.

Transmission tissue: transmission balls are occasionally found along the mesophyll of the leaf. Of these, the midrib of the leaf is fully developed. The parenchyma around the nodules is dense and thin, which binds the nodules well to the mesophyll. On the fern plant that grows on the coast, the balls are better developed. It has many water pipes. In leaves surrounded by water, there are relatively few water tubes. In the littoral plant, the water tubes are larger and the sheaths are much thicker. It is well developed in both plants. There are many closely spaced, polygonal sieve tubes. It has very thin neighboring cells. Both phloem and xylem elements are small, thinly sheathed, densely packed parenchyma surrounded by cells. Unlike the stem ball, the cambium is completely reduced. There is no mechanical tissue. The role of the armature of the leaf is the relatively dense arrangement of parenchyma cells, the fact that the water tubes have a relatively thick cover, and the epidermal cells are well connected to each other. So, in a leaf completely surrounded by water, there are no nozzles, the elements of the ball are somewhat poorly developed, and the parenchyma is quite sparse, while in the leaf that is in contact

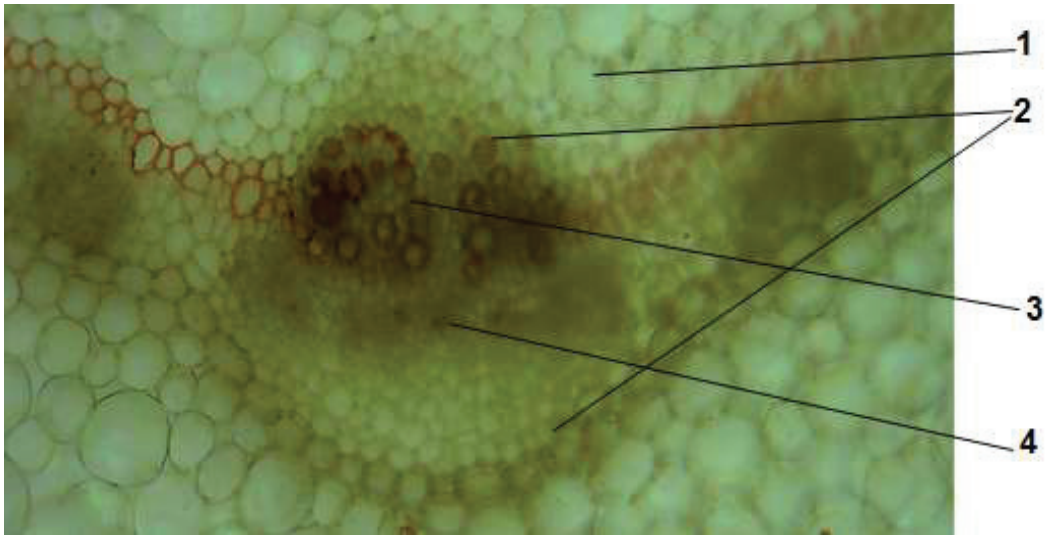

Figure 3. Anatomical structure of the leaf of *Nasturtium officinale* R.Br.: 1 - basis parenchyma; 2 - fibrovascular bundle; 3 - xylem; 4 - phloem.

with the atmosphere, there are nozzles, and the balls are well developed.The parenchyma is quite dense. In general, in the medicinal fern plant, a dense arrangement of cells compared to the rest of the aquatic plants, which is related to the complete reduction of the mechanical tissue is observed.

As a result of the research, it was found that the covering tissue of the plant is poorly developed, the appendages in it are few. Epidermis cells have chloroplasts, which is one of the rare phenomena in the world of plants. All sheaths of the endoderm are equally thickened. The cambium is very poorly developed, which is explained by the fact that most of the aboveground organs of aquatic plants live for one year, and there is no need for the special activity of the cambium. A very poor development of the mechanical tissues of the plant was observed. In general, the reduction of mechanical tissues in aquatic plants caused the role of armature to be transferred to other tissues. Thus, the good development of the endoderm and the gathering of the transmitting tissue mostly in the center helps to fulfill the function of the mechanical tissue in the plant. Research has confirmed that the larger the terrestrial organs are in wetland plants and the more they are in contact with the atmosphere, the more xeromorphic signs develop in them. Different types of water basins, lakes, rivers, marshes are spread in the regions of Azerbaijan, which are rich in aquatic plants. Aquatic plants spread in those basins have considerable importance in culture and economy. They form the food and living conditions of aquatic fauna, and are used as fodder in animal husbandry. All this shows that it is necessary to use aquatic plants more effectively, to achieve their protection and increase.

REFERENCES

Algan G., Toker J. (2004) Plant anatomy and morphology laboratory book. Ankara. A.S. Faculty of Biology, 137 p. [Algan G., Toker C. (2004) Bitki hücresi ve bitki morfolojisi laboratuvar kitabı. Ankara. A.Ü.Fen Fakültesi Biyoloji Bölümü, 137 s.].

Barykina R.P., Veselova T.D., Devyatov A.G., Jalilova H.H., Ilyina G.M., Chubatova N.V. (2004) Handbook of Botanical Microtechnology. Fundamentals and methods. Moscow: Pub.MSU, 312 p. [Барыкина Р.П., Весёлова Т.Д., Девятов А.Г., Джалилова Х.Х., Ильина Г. М., Чубатова Н. В. (2004) Справочник по ботанической микротехнике. Основы и методы. Москва: Изд-во МГУ, 312 с.].

Evert R.F. (2015) Esaus plant anatomy. Moscow. Binom. Laboratory of knowledge, 600 p. [Эверт Р.Ф. (2015) Анатомия растений Эзау. Москва. Бином. Лаборатория знаний, 600 с.]

Flora of Azerbaijan (1953) Baku: Publishing house of academy of Sciences of Azerb. SSR, IV vol., 401 p. [Флора Азербайджана (1953) Баку: Изд-во АН Азерб. ССР. IV том, 401 с.]

Gasimov N.A., Alieva N.Sh., Takhirli S.M., Abdueva S.M. (2010) Plant anatomy. Baku: CBC, 388 p. [Qasımov N.A., Əliyeva N.Ş., Tahirli S.M., Abduyeva S.M. (2010) Bitki anatomiyası. Bakı: CBC, 388 s.]

Humbatov Z.I. (2017) Plant anatomy and morphology. Baku, 691 p. [Hümbətov Z.İ. (2017) Bitki anatomiyası və morfologiyası. Bakı, 691 s.]

Humbatov Z.I., Aliyev B.M., Aliyeva İ.F. (2015) Botany teaching and research methods. Baku, 160 p. [Hümbətov Z.İ., Əliyev B.M., Əliyeva İ.F. (2015) Botanikadan tədris və tədqiqat metodları. Bakı, 160 s.]

Musayev M.G. (2007) Analysis of flora of fresh water basins in Kura-Araz valley. Proceedings of Institute of Botany of ANAS, Vol. XXVII, p. 103-108. [Musayev M.Q. (2007) Kür-Araz ovalığındakı şirin su hövzələri florasının təhlili. AMEA Botanika İnstitutunun elmi əsərləri, XXVII cild, s. 103-108]

Serebryakov I.G. (1952) Morphology of vegetative organs of higher plants. Moscow: Sov. Science, 392 p. [Серебряков И.Г. (1952) Морфология вегетативных органов высших растений. Москва: Сов. наука, 392 с.]

Tutayuq V.X. (1972) Plant anatomy and morphology. Moscow: Publishing house “Higher School”336 p. [Тутаюк В.Х. (1972) Анатомия и морфология растений. Москва: Изд-во «Высшая школа», 336 с.]
Tylik K.V. (2014) Aquatic biological resources and aquaculture. Moscow: Morkniga, 137 p. [Тылик К.В. (2014) Водные биоресурсы и аквакультура. Москва: Моркнига, 137 с.]
Alexandrov V.G. (1966) Plant Anatomy. Moscow: Science, 431 p. [Александров В.Г. (1966) Анатомия растений. Москва: Наука, 431 с.]

Микроскопический анализ константных и диагностических анатомо-структурных показателей вида *Nasturtium officinale* R.Br.

Л.З. Гурбанова, С.Н. Рахимова
Азербайджанский Государственный Аграрный Университет, пр. Ататюрка 450, AZ2000, Гянджа, Азербайджан

В статье приведены сведения об основных признаках *Nasturtium officinale* R.Br., определенных в результате микроскопического исследования покровных, паренхимных, меристемных, механических и проводящих тканей. В ходе исследований анатомическими методами в цифровом микроскопе BLM-210 LCD были изучены препараты, приготовленные из корня, ствола и листьев растения, и определены анатомические особенности вида. Основной целью исследований было определение постоянных и диагностических признаков, используемых при определения вида. Анатомические исследования показали, что покровная ткань растения развита слабо. Хлоропласты находятся в эпидермисе, что является редким явлением в царстве растений. Обнаружено также слабое развитие камбия и механических тканей. Изученные анатомические показатели можно считать диагностическими признаками для данного вида.

Ключевые слова: центральный цилиндр, хлоренхима, эндодермис, паренхима, перицикл

Nasturtium officinale R.Br. növünün konstant və diaqnostik anatomik struktur göstəricilərinin mikroskopik analizi

L.Z. Qurbanova, S.N. Rəhimova
Azərbaycan Dövlət Aqrar Universiteti, 450, Atatürk prospekti, AZ2000, Gəncə, Azərbaycan

Məqalədə *Nasturtium officinale* R.Br. növünün örtücü, parenxim, meristem, mexaniki, ötürücü toxumalarının mikroskopik tədqiqatı nəticəsində müəyyən edilmiş əsas əlamətləri haqqında məlumat verilir. Tədqqiqatların aparılması zamanı anatomik metdolara uyğun olaraq bitkinin kök, gövdə və yarpaqlarından hazırlanmış preparatlar BLM-210 LCD rəqəmsal mikroskopunda tədqiq edilmiş və növün anatomik xüsusiyyətləri müəyyən olunmuşdur. Tədqiqatın əsas məqsədi növün təyini üçün konstant və diaqnostik əlamətlərin müəyyən edilməsi olmuşdur. Aparılmış anatomik tədqiqatlar göstərmişdir ki, bitkinin örtücü toxuması zəif inkişaf etmişdir. Epidermisdə xloroplastlara rast gəlinir ki, bu da bitki aləmində nadir rast gəlinən bir hadisədir. Həmçinin kambinin və mexaniki toxumaların zəif inkişafı aşkar edilmişdir. Tədqiq olunmuş anatomik göstəricilər bu növ üçün diaqnostik əlamət hesab edilə bilər.

Açar sözlər: mərkəzi silindr, xlorenxim, endodermis, parenxim, peritsikl