Anatomical study of *Solanum nigrum* L. from Solanaceae family growing in Iraq

Muazaz Azeez Al-Hadeethi\(^1\), Ali T Al-Taie\(^2\) and Areej A. Farman Al-Rawi\(^1\)

\(^1\)Department of Biology, College of Education of pure Sciences (Ibn Al-Haitham), University of Baghdad, Baghdad, Iraq.

\(^2\)Continuous Learning Center, Mustansiriyah University, Iraq.

*E-mail: muazaz.a.h@ihcoedu.uobaghdad.edu.iq*

**Abstract.** The most important features that we have reached through this study, are shown the cross-section of root were in the secondary growth stage and the epidermis of leaf were studded by stomata complex, the type of it was anomocytic that’s mean no have subsidiary cells around the guard cells, the mesophyll bifacial also the midrib region of leaf like the pear and the vascular bundle located in the center crescent in shape. The cross-sections of petiole ovate shape with two ears in the lateral side and the vascular bundles crescent in shape. The cross-section of fruits circular component of three-layer the outer layer pericarp, mesocarp, and the endocarp, surrounding the ovary or the seeds.

**Keywords.** *Solanum nigrum*, Solanaceae, Anatomy, Iraq.

1. Introduction

*Solanum nigrum*, the common name wolf grape, black nightshade or blackberry nightshade, also refer that it is an annual herbaceous plant belonging to the Solanaceae family, it is a widespread species that contain alkaloids and is considered toxic \([1]\). The species may reach a meter height, leaves are flat with white-colored flowers appear in numbers from four to ten, the fruits of the plant are green in the first place, and then they become black or blue, juicy, sweet when ripe, and contain many small kidney-shaped seeds, and are collected in the autumn, the plant distribute in fields, orchards, gardens, canal banks, deserted places, and spreads all over the world \([2]\). The whole plant contains Solanine, Asparagine, Lutein, Tannin, linoleic acid, and Palmitic acid, the plant is used medicinally as a sedative and skin softening agent. This plant began to be used since its anesthetic and paralytic effect on nerve endings was known. Fruit juice has a pain-relieving effect by letting a drop of the juice evaporate over the sore tooth \([3]\). \([4]\) refers that the fruits of the plant cause poisoning in children when they are eaten, especially if the fruits are not fully ripe and their color is between red and purple, and too much eating the loss of the latter cause of memory and consciousness and often leads to poisoning and then death because they contain steroidal alkaloids. The foliage also harms livestock when grazing on them. This is not recommended to use the plant internally due to its toxic effects, but it can be used externally to relieve some pain such as joint pain \([5]\). There are a few studies and data concerning the anatomy of *S. nigrum* in describing some species of the family Solanaceae only original anatomical characteristics...
have been given by [6]. [7] also studied the morphological and anatomical characteristics of vegetative parts of some species belonging to Solanaceae family like *S. nigrum*, *S. americanum*, *S. sarrachoides*, and *S. ptycanthum*. They noticed that they varied in relation to environmental conditions. As well as [8] refers to the Anatomical and Comparative study of selected wild species from the family Solanaceae in Iraq included *S. nigrum*. The aim of this study is to investigate the important anatomical features for the parts of the species *S. nigrum*, to recognize the tissues and cells, and to be able to distinguish between the other species in the same genus.

2. Materials and Methods

The species collected from the herbal garden at AL- Rashidiya city north of Baghdad (Latitude of Rashidiya: 33, 5528 (3333'10.080"N), Longitude of Rashidiya: 44, 3725 (4422'21.000"E)) at April 2019. The plant material was identified and authenticated by Flora of Turkey [9] and flora of Nouvelle Flore du Liban et de la Syrie [10]. Firstly the parts of plant like as root, stem, leaves and fruits were kept in formalin acetic acid alcohol (FAA) for 48 hours, which was prepared according to [11] as follow: 50 ml of Ethyl alcohol, 5 ml of Glacial acetic acid, 10 ml of Formaldehyde 37 to 40% concentration and 35 ml Distilled water, then the samples were washed by distilled water and were kept in 70% Ethyle alcohol. The epidermis of leaves was prepared according to [12] were peeling by a razor blade and washing with distilled water then put in 5% sodium hypochlorite for 5 mins to remove the chlorophyll pigment. The sectioning parts of root, stem, leaf, petiole, and fruit were done by hand section, the procedure was performed according to [13], the fresh material sectioned by a razor blade into thin and small pieces then put in 0.5% sodium hypochlorite for 5 mins to clear the tissue and remove the chlorophyll pigment. Finally all the samples are put on the slide and mounted by cover slides and fixed by Olympus KRÜSS light microscope then photographed using AmScope camera.

3. Results and Discussion

3.1. Cross section of root

The shape of the outline root is circular, and in the secondary growth stage, that’s mean that this stage consists of the first annual ring in the plant. The root covered by the periderm, the thickness of it reached to 16.2 µm followed by several rows of parenchyma tissues longitudinal and ovate cells known the cortex and they are interspersed the cells of the cortex the ordinary schizogenous intercellular spaces and the thickness of it 25.4 µm. The vascular cylinder is consist of xylem and phloem, the thickness of it 266.7 µm, the pith located in the center of the stem filled with parenchyma cells and the thickness of it reached to 75.8 µm (Figures 1).
3.2. Cross section of stem

The shape of the outline stem is tetragonal, the cross section of the stem consists of a uniseriate epidermis covered by cuticle, the cuticle thickness 3.4 µm and the epidermis thickness 18.9 µm, and the cortex consists of 2 layers, the first one is located under the epidermis and consist of the collenchyma tissue and after it comes the second layer of parenchyma tissues, the thickness of cortex 34.7 µm. The vascular bundles are collateral and open and take the shape of a stem, consist of xylem and phloem, the vascular thickness is 107.9 µm, the pith located in the center of the stem filled with parenchyma cells and the cells circular and the ordinary schizogenous intercellular space among it (Figures 2), the result agrees with [6].

3.3. Study of leaves

The epidermis of the leaf shows the stomata complex, the type of stomata was anomocytic that’s mean it has no subsidiary cells around the guard cells, the guard cells are kidney shaped and the anticlinal walls of epidermal cells are wavy, (Figures 3), this agrees with [7] who refer that the stomata of these species are anomocytic to anisocytic, somewhat larger in S. nigrum, which can be explained by its polyploidy. The transfer section of the leaf consists of the upper and lower uniseriate epidermis, the upper epidermis is covered by cuticle with the thickness ranging from 2.1 µm, also the cells of upper epidermis ovule shape and the thickness of it is 35.5 µm, while the thickness of the lower epidermis is 20.4 µm. The leaf described as the bifacial mesophyll consists of palisade layers and spongy layers, the thickness of palisade layers was 95.5 µm and the thickness of spongy layers was 153.7 µm (Figures 4). The midrib region of the leaf have a pear-like shape, the epidermis is covered with the eglandular uniseriate and multicellular trichomes followed by the cortex and the vascular bundle located in the center have crescent in shape ranged to 195.5 µm include xylem and phloem (Figures 5), the results agree with [14].
**Figure 3.** Surface view of epidermis in the species *Solanum nigrum*.

**Figure 4.** Leaf blade cross section of *Solanum nigrum*.

**Figure 5.** Cross section of leaf midrib of *Solanum nigrum*.
3.3.1. Petiole cross section:

The cross sections of petiole ovate shape with two ears in the lateral side, the epidermis was uniseriate covered with a cuticle, the average thickness of it 1.5 µm and many unicellular and uniseriate trichomes diffuse on it, the average thickness of the petiole epidermis reached to 16.5 µm. And below the epidermis, the cortex is located, the average thickness of the cortex ranged from 38.2 µm. Whilst the vascular bundles are crescent in shape and are found in the center of the pith which consists of xylem and phloem (Figures 6), the results agrees with [8].

![Figure 6. Petiole cross section of Solanum nigrum.](image)

3.4. Cross section of fruits and seeds:

The cross section of the fruits have circular component of three layers; the outer layer is known as the pericarp, followed by the mesocarp, and the endocarp, which (the endocarp) is the inner layer surrounding the ovary or the seeds (Figures 7).

![Figure 7. Fruit cross section of Solanum nigrum.](image)
4. References

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