Research Article

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PHARMACOGNOSTIC EVALUATION OF THE LEAF, STEM AND ROOT OF KAKMACHI (*SOLANUM NIGRUM* LINN.)

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ABSTRACT

The pharmacognostical evaluation of *Solanum nigrum* Linn., commonly known as black nightshade, was undertaken to establish its botanical identity and quality parameters. The study focused on the macroscopic and microscopic examination of the plant's leaf, stem, and root parts. Macroscopic analysis revealed that the leaves were simple, alternate, and ovate with entire margins. The stems were herbaceous, cylindrical, and branching, while the roots were thin, tap root, and branching. Microscopic examination revealed unique anatomical features for each part. The leaf showed dorsiventral mesophyll with hypo-amphistomatous and anisocytic stomata and glandular trichomes. The stem exhibited an epidermis with unicellular trichomes, collenchyma, and scattered vascular bundles. The root displayed a typical dicot root structure with cork cells, endodermis, pericycle, and xylem vessels. These findings contribute to the pharmacognostical standardisation of *Solanum nigrum* Linn., aiding in its authentication, quality control, and formulation of herbal medicines. The detailed macroscopic and microscopic characteristics described in this study can serve as reference standards for the identification and quality assessment of *Solanum nigrum* Linn. in herbal drug preparations.

Keywords: Pharmacognostical, *Solanum nigrum* Linn., Macroscopic, Microscopic

INTRODUCTION

Solanum nigrum Linn., also known as Black Nightshade or Makoi in Ayurveda, is a globally distributed herbaceous perennial renowned for its medicinal properties. It belongs to the Solanaceae family and is widely utilised in traditional medicine systems such as Ayurveda. Commonly found in arable land, gardens, and nitrogen-rich soil levels[1], it serves various purposes, including leafy herbs, vegetables, and fruit sources. Its leaves are consumed widely as food in regions like Africa and Southeast Asia. In Ayurveda, it is noted for its antiseptic and anti-dysenteric properties and is used internally for conditions like cardiac pain and gripe[2]. Additionally, it is employed to treat infants' abdominal upsets and anthrax pustules. The plant exhibits emollient, diuretic, and laxative properties and is considered antispasmodic and narcotic[3]. Extracts from the plant have shown effectiveness in treating cirrhosis of the liver and as an antidote to opium poisoning.[4] Furthermore, its alcoholic extract demonstrates activity against bacteria such as *Staphylococcus aureus* and *Escherichia coli*.[5]

Despite its widespread use, confusion persists regarding the precise identification of black nightshade taxa, especially where consumption as food is common. Hence, current investigations aim to establish a macroscopic and microscopic profile of *Solanum nigrum* Linn. leaves, stem and roots, aiding drug identification, standardisation, and differentiation from potential adulterants.

MATERIALS AND METHODS

Collection of the sample

Fresh leaves of *Solanum nigrum* Linn. were collected from the campus of Shri Dhanwantry Ayurvedic College and Hospital, Chandigarh, India, in March 2024. The plant was washed under running tap water and blotted dry.

Panchendriya Pareeksha (Organoleptic examination) of the fresh drug

Table 1: Organoleptic evaluation of the fresh drug *Solanum nigrum* Linn.

Pareeksha (Examination)	Root	Stem	Leaf
Shravanendriya (Auditory)	Without sound	Without sound	Without sound
Sparshanendriya (Tactile)	Smooth with lateral branches	Smooth or with sparse hairs	Smooth or with fine hairs
Chakshurendriya (Visual)	White	Green to purplish	Dark green
Rasanendriya (Taste)	Bitter	Bitter	Bitter
Ghranendriya (Odour)	Nothing characteristic	Nothing characteristic	Nothing characteristic

Macroscopic and Microscopic evaluation

Macroscopic characters like shape, size, and margins were recorded as per visual observation. Microscopic evaluation of the micrometric assessment of leaves, stems, and roots was done by slide preparation after transverse sectioning using a dissecting kit and sections were visualised under a compound microscope before and after staining with safranin.

RESULTS

Transverse section of Root of *Solanum nigrum* Linn.

Macroscopic Features

Taproot with few branches and numerous small lateral roots, externally smooth, pale brown; bark is thin, easily peeled off, exposing pale-yellow wood (outer surface- bark is light brown; inner surface- whitish and soft). Taproot is long and woody smooth, pale brown and varies with thickness. Few lenticels are found towards the basal part of the root.[6]

Microscopic Study

The root exhibits a cork consisting of 2-4 rows of tangentially elongated cells. [Figure 1] The cork zone is thin, with a few rows of cells and brownish walls. Phellogen is not distinctly seen.[7] The cortex comprises large, slightly elongated, thin-walled cells containing patches of oval to round starch grains, either single or, in rare cases, with two or three components. [Figure 2] The phloem consists of thin-walled polygonal cells, with uniseriate phloem rays filled with starch grains. [Figure 3] The xylem comprises vessels and parenchyma, with vessels arranged in groups of 2-4 in radial rows. [Figure 4] The parenchyma is thick-walled and contains prismatic crystals of calcium oxalate and cells with tannin content. The medullary rays are composed of thin-walled, radially elongated cells.[8] medullary rays are many, mostly uniseriate, nearly straight and reach up to the cortex.[9]

Transverse section of Leaf of *Solanum nigrum* Linn.

Macroscopic features

Leaves are simple, exstipulate, alternate or in unequal pairs at a node, petiolate, thin and membranous, ovate or ovate-lanceolate, entire or sometimes sinuate to dentate lobed or occasionally toothed, somewhat tapering at both ends though with more acute or even acuminate tip, up to about three and a half inches long and two inches broad. Petiole is less than an inch in length.[10]

Microscopic study

The leaf exhibits upper and lower epidermises composed of round to oval cells covered with a cuticle. The epidermis bears warty and glandular trichomes, with 2-3 layers of collenchyma present on both surfaces. [Figure 5] The parenchyma is 4-6 layered, thin-walled, and contains small intercellular spaces. A centrally placed arc-shaped bicollateral vascular bundle is present. [Figure 6] The lamina is dorsiventral, with both upper and lower epidermises being single-layered and comprised of oval to tangentially elongated cells covered with a thick cuticle. The palisade parenchyma is single-layered, while the spongy parenchyma is 4-6 layered and contains chloroplasts, along with intercellular spaces. [Figure 7] Some vessels with thickenings are located beneath the palisade parenchyma. The central vascular bundle is shallow and arc-shaped, bicollateral, with phloem towards the lower epidermis and xylem towards the upper epidermis. [Figure 8] Metaxylem is towards the lower epidermis, while the protoxylem is towards the upper epidermis, accompanied by some xylem fibres.[11]

Transverse section of Stem of *Solanum nigrum* Linn.

Macroscopic features

Stem are greenish black cylindrical.

Microscopic study

The stem's cross-section features a uniseriate epidermis covered by a cuticle. [Figure 9] The cortex comprises two layers: the first, located under the epidermis, consists of collenchyma tissue, followed by a second layer of parenchyma tissues. [Figure 10] The vascular bundles are collateral, open, and consist of xylem and phloem. [Figure 11] The pith, located in the centre of the stem, is filled with circular parenchyma cells with ordinary schizogenous intercellular spaces among them. [Figure 12][12]

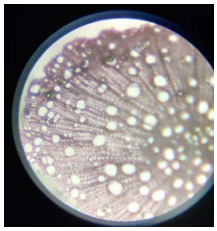

Figure 1: Cork consisting of 2-4 rows of tangentially elongated cells

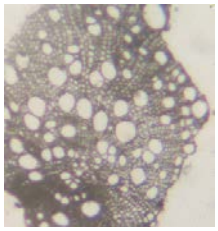

Figure 2: Oval to round starch grains

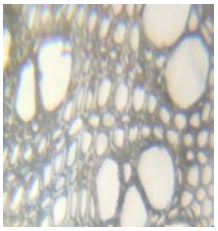

Figure 3: Uniseriate phloem rays

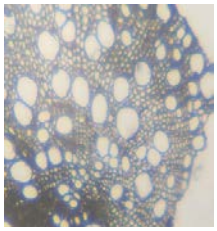

Figure 4: Xylem is made up of vessels and parenchyma

Figure 1-4: T.S. of Root of *Solanum nigrum* Linn.

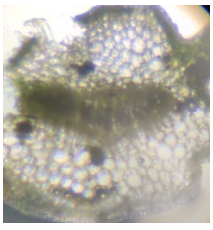

Figure 5: Epidermis bears warty and glandular trichomes

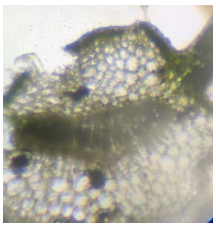

Figure 6: Arc-shaped bicollateral vascular bundle

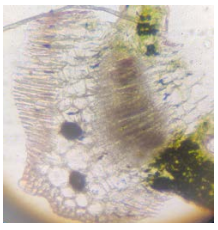

Figure 7: Spongy parenchyma contains chloroplasts with intercellular spaces

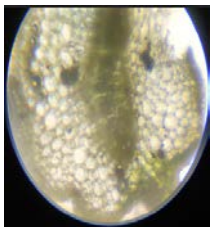

Figure 8: Phloem towards the lower epidermis and xylem towards the upper epidermis

Figure 5-8: T.S. of Leaf of *Solanum nigrum* Linn.

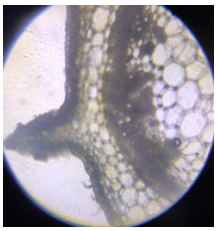

Figure 9: Uniseriate epidermis covered by a cuticle

Figure 10: Collenchyma tissue and parenchyma tissues.

Figure 11: Vascular bundles-xylem and phloem

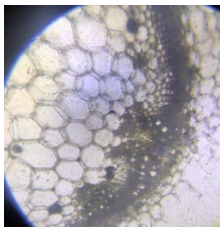

Figure 12: Pith filled with parenchyma cells

Figure 9-12: T.S. Section of Stem of *Solanum nigrum* Linn.

DISCUSSION

The main challenge facing the promotion of herbal products is the substitution and adulteration of herbal drugs. Adulteration refers to the mixing or replacing the original herbal material with inferior, defective, or harmful substances that do not meet official standards. This practice can involve using other parts of the same or different plant or incorporating entirely different substances. Some herbal adulteration occurs because of the negligence of herbal collectors and suppliers. This can include mistakenly collecting herbs from the wrong plant due to their similar appearance or colour. Additionally, a lack of knowledge about the collected herbs can contribute to unintentional adulteration.

A thorough pharmacognostic study is crucial, analysing plant morphology, phytochemicals, and physicochemical properties to identify and prevent adulteration. For example, *Solanum nigrum* Linn., *Phytolacca americana*, and *Ailanthus glandulosa* leaves are sometimes adulterated with belladonna herb leaves, differentiated by histological features like palisade ratio and calcium oxalate crystals. Micrometric leaf evaluation is vital for precise plant identification.

The present study includes sections that provide referential information for the correct identification and standardisation of *Solanum nigrum* Linn, focusing on its identity, purity, and quality. This information is derived from macroscopy, microscopy, physiochemical, and phytochemical parameters. Pharmacognostical studies highlight key features for identifying this plant material, such as single-layered palisade parenchyma, hypo-amphistomatous and anisocytic stomata[13-15], and multicellular warty and glandular trichomes. Phellogen is not distinctly seen in the root part, and sieve tubes and companion cells are not as large and clear in other species of *Solanum*. The cambium consists of a row of thin-walled rectangular cells. The presence of prismatic crystals of calcium oxalate, border pitted vessels, oil globules, and simple and compound starch grains are the striking characteristics of the identification of this plant material. The information in this study helps differentiate *S. nigrum* L. from the other closely related species of the Solanaceae family.

CONCLUSION

Solanum nigrum Linn, known as Kakmachi, is a botanically important plant in Guduchyadi varga. The aim of establishing a macroscopic and microscopic profile of *Solanum nigrum* Linn. leaves, stem, and roots to aid in drug identification, standardisation, and differentiation from potential adulterants is achieved through detailed examination and documentation of the plant's physical and anatomical characteristics. Macroscopic analysis involves observing the plant parts with the naked eye, noting their colour, texture, and other visible features. Microscopic analysis, on the other hand, delves into the cellular structure using a microscope, identifying specific cell types and arrangements unique to *Solanum nigrum* Linn. Compiling this information creates a comprehensive profile, serving as a reference for accurately identifying and standardising the plant material while distinguishing it from potential adulterants, ensuring the purity and quality of the drug.

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