

# Preliminary Phytochemical and Pharmacognostical Screening of Leaves of *Solanum indicum*

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## Abstract

**Introduction:** *Solanum indicum* (also known as *S. violaceum* Ortega or *S. anguivi* Lam.) is a medicinal plant that is utilized in Indian medical systems such as Ayurveda, Siddha, and Unani to treat a variety of ailments. An attempt has been made to highlight this folk herbal medicine through the present study, which will assist in standardization for quality, purity, and sample identification.

**Materials and methods:** Thus, this study is an attempt to present an overview of pharmacognostic and phytochemical evaluation reported on this plant. Various standardization parameters like morphological characters, microscopic evaluation, physico-chemical evaluations (foreign matter, loss on drying, ash values, extractive values), preliminary phytochemical screening, TLC fingerprint, qualitative HPTLC of the extract and fluorescence analysis of powdered crude drug were carried out and the qualitative parameters were reported.

**Results:** The physicochemical parameters such as moisture content, ethanol- and water-soluble extractive, total ash, acid insoluble ash value were determined. Phytochemical screening showed the presence of alkaloids, flavonoids, phenols, saponins, tannins, steroids, and terpenoids in the ethanolic extracts of leaf of this plant.

**Conclusion:** The present study on pharmacognostical, physicochemical and phytochemical standards could be useful information for authentication and preparation monograph for *S. indicum*.

**Keywords:** Pharmacognostic, Phytochemical chromatography profile, Fluorescence, Microscopic, Physicochemical

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## Introduction

Medicinal plants are one of the sources of natural products for the treatment and management of debilitating diseases. Regardless of much advancement in the field of medicine, plants still remain the main source of drugs, not only in Ayurveda but also in modern medicine. Almost 12,000 plants are known to have medicinal properties out of 248, 000 identified species of higher plants. The use of plant extracts and isolated pure compounds has provided the basis for the production of herbal medicines and phytopharmaceutical compounds.<sup>[1]</sup> For a healthcare product to be globally accepted, it must be scientifically validated to ascertain its level of purity, potency, efficacy and safety. The World Health Organization has provided standard parameters to assess the quality, safety, and efficacy of herbal plant including physicochemical and phytochemical evaluation of crude drugs.<sup>[2]</sup> Various steps are involved in setting these pharmacognostic standards for the purpose of formulating a monograph of a crude drug. The quality assessment of medicinal plants is of great importance in order to justify their acceptability in the conventional system of medicine.<sup>[3]</sup> Uniformity of quality is promoted by the use of standards, which are numerical qualities by which the quality of herbs may be assessed.

Pharmacognostic evaluation is the primary step to deciding identity and to consider the quality and purity of the part of the plant used in various formulations. Physicochemical parameters are also essential for the standardization and quality control of ayurvedic drugs. The phytochemical analysis provides important information about different types of primary and secondary metabolites present in the herbs.<sup>[4]</sup> Various secondary metabolites present in a plant are responsible for the healing effects of such plants. With the growing alertness amongst consumers, natural antioxidants are attracting the attention of customers and researchers.<sup>[5]</sup> Plants are considered a readily available natural source of antioxidants. However, comprehensive screening for phytochemicals in most of the therapeutic plants still needs to be done. According to the World Health Organization, the macroscopic and microscopic description of a medicinal plant is the first step towards establishing the identity and the degree of purity of such materials and should be carried out before any tests are undertaken.<sup>[6]</sup>

*Solanum indicum* Linn. Commonly referred to as a Badi, the Sanskrit words Bhatkataiya (Hindi) and `Brihati` are used in the Ayurvedic medical system as a single drug or as a one-drug combination with other medicines. It could be a much-forked perennial below a stinging shrub. The

plant grows mainly within the nice and cozy warm parts, 1500 meters above sea level. All plant parts, viz. berries, leaves, roots, seeds, and stem of this species are utilized in the traditional system of medication and are useful in various diseases like bronchitis, asthma, dry cough, rhinitis, dysuria, leucoderma, sexual disorders, insomnia, cardiac weakness and pruritus.<sup>[7]</sup> The plant has been documented in Chinese folk medicine as an anti-inflammatory and wound-healing agent and as an analgesic for toothache, rhinitis and carcinoma.<sup>[8]</sup> The species is among the ten medicinal plants whose roots are principally employed in the preparation of Dashmularishta, a well-established Ayurvedic drug utilized in the treatment of fatigue and oral sores. Phytochemical profile of *S. indicum* reported the presence of alkaloids, flavonoids, phenols, and steroids. Clinical studies on anti-asthmatic and curing dental inflammation revealed the effective therapeutic potential of *S. indicum*. Exploration of assorted pharmacological effects from *S. indicum* emphasized the possible use of bioactive compounds to develop novel therapeutic drugs. It's a promising approach in search and development of the trendy & stylish medicine, supported by traditional medicinal knowledge.<sup>[9]</sup>

The current work also provides the first insight into the phytochemical composition of *S. indicum* leaves, which has been studied and analyzed using different chromatographic techniques. Further, all this information could also be used as a standard of quality control in order to promote a parameter of authenticity for *S. indicum*.

## Materials and methods

### Plant collection and authentication

The fresh plant leaves of *Solanum indicum* were collected in the month of December 2025, from Saharsa, District, Bihar, India. The botanical identification of the plant sample was done by Prof. (Dr) Muhammad Arif, Department of Pharmacognosy & Phytochemistry, Faculty of Pharmacy, Integral University, Kursi Road, Lucknow, U.P., India. A voucher specimen (designated Herbal/20/02/07/2025) has been placed in the herbarium of the Faculty of Pharmacy, Integral University, Lucknow. The plant material was washed under running tap water, air-dried, and powdered using a blender, and kept in a glassware container for analysis.

### Chemicals, reagents and solvents

All chemicals, solvents and reagents used were of analytical grade.

### Pharmacognostical evaluation

#### Organoleptic evaluation

It refers to the evaluation of plant material by color, odor, taste, shape, texture, etc. Different dried parts of *S. indicum* were considered for macroscopical evaluation.<sup>[10]</sup>

#### Macroscopic study

Morphological characteristics were carried out on the freshly plants material, such as color, size, odor, taste, surface characteristic and fracture were examined using the terms and outlines given in the Indian Herbal Pharmacopeia.<sup>[11]</sup> The organoleptic characters were observed, noted and photographs were taken in the original environment.

#### Microscopic study

Microscopical characteristics were an evaluation to the mature, fresh and healthy different plant parts as leaf, stem, and powder. The plant material was put between the pith, and several fine sections were cut with the help of a sharp razor. The sections obtained were cleared using chloral hydrate solution. The powder microscopical was prepared using a small amount of the leaves powder were placed on a glass slide containing one to two drops of chloral hydrate solution. After placing the cover slip, it was warmed gently on a spirit lamp to remove air bubbles and then examined under the microscope. Different tissues were observed under the microscope and photographed.<sup>[12,13]</sup>

#### Preparation of extract

The leaves of *S. indicum* (500 g) were shade dried, coarsely powdered and extracted exhaustively with methanol in a Soxhlet apparatus. The methanolic extract of the plant was concentrated on a steam bath and dried under reduced pressure to get 13.6 g of dark brown mass.

#### Quantitative investigation

Quantitative leaf microscopy to determine palisade ratio, stomata number, stomata index, Vein-islet number and vein-let termination number was carried out on epidermal strips.<sup>[14]</sup>

#### Physicochemical evaluation

Physicochemical parameters of samples for loss on drying, moisture content, total ash, water-soluble and acid-insoluble ash value were performed according to the official methods prescribed in the Indian Herbal Pharmacopeia and the WHO methods on quality control for medicinal plant materials. The extractive values (alcohol, water, and ether soluble) of the powdered drug were determined according to the methods described in Indonesian Herb Pharmacopeia.<sup>[15-17]</sup>

#### Fluorescence character

The fluorescence character of leaf powder was determined using Kokoski's standard method. The powdered leaves were extracted with different solvents like *n*-hexane, dichloromethane (DCM), and ethanol in the cold maceration technique for 24 hr; the sample was filtered, and the filtrate was observing any specific fluorescence. A small quantity of the powder and extracts was examined by treating the leaf powder with acidic, basic, organic, and inorganic solvents, viz. 50% sodium hydroxide, 50% sulphuric acid, 50% HCl, ammonium hydroxide. After the treatment, the color change

was observed in daylight, long UV (365 nm), short UV (256 nm), sprayed by 5% H<sub>2</sub>SO<sub>4</sub>/ethanol.<sup>[18,19]</sup>

### Phytochemical Screening

Preliminary phytochemical screening for the detection of various compounds was carried out by using standard procedures described by Harborne and Khandelwal.<sup>[20, 21]</sup>

### Chromatographic Profile

The chromatographic profile was carried out using 10 g of powdered material and subjecting it in a Soxhlet apparatus, which was subjected to soxhlet extraction with 150 mL of methanol. The extracts were concentrated using a vacuum rotary evaporator. The TLC profile of the methanolic extract was performed using the standard method, and the R<sub>f</sub> values were determined. TLC profiling was carried out to confirm the presence of bioactive compounds in the extract. The three extracts were prepared on a stationary phase (silica gel 60 F<sub>254</sub> TLC plate), and as mobile phase, different solvents based on their polarity were used, for observing the chromatographic profile. These solvent systems were chloroform-methanol (9:1). The dried plates were observed under ultraviolet and visible light, followed by heating at 105°C for 5 to 10 minutes, and the R<sub>f</sub> values were determined.<sup>[22]</sup>

## Result

### Macroscopic and organoleptic description

The macroscopic and organoleptic description of leaves of *S. indicum* is presented in Tables 1 and 2 and Figure 1A-C.

### Microscopic study

The anatomical studies of leaves of *S. indicum* revealed the presence of various diagnostic features as depicted in

Figure 2. The leaf is dorsiventral, smooth and even with a fairly prominent midrib (Figure 2). In the adaxial part, the epidermis is prominent with squarish cells and a prominent cuticle. Beneath the epidermis occur about three layers of small collenchyma cells. Further below the collenchyma occur a few layers of wide, thin-walled parenchyma cells. The abaxial part of the midrib has epidermis similar to the adaxial side. The remaining ground tissue consists of wide, compact, thin-walled parenchyma cells. The vascular bundle is single and elliptical in cross-sectional view. It consists of parallel rows of xylem elements, which are angular, thin-walled, and narrow. Phloem occurs as a thin sheath along the abaxial side of the xylem. The lamina is uniform in thickness except for the places where lateral veins and veinlets are situated. The vein also projects slightly on the lower side. They have a small cluster of xylem and phloem with parenchymatous bundle sheath without extensions. The spongy mesophyll has four or a few layers of small, lobed cells which are interlinked with each other, forming wide aerenchymatous tissue. Calcium carbonate crystals of cystoliths are abundant in the adaxial epidermis of the leaf. The stomata are predominantly diacytic type with two subsidiary cells with their common walls at right angles to the stomatal axis. Glandular trichomes are occasionally seen in the epidermis.

### Quantitative leaf microscopy

The quantitative microscopy of the leaf of *S. indicum* for palisade ratio, stomata number, stomata index, vein-islet number and veinlet termination number, which are also of diagnostic importance, are presented in Table 3.

### Fluorescence studies of powdered drug

The fluorescence characteristics of powdered and extracts drug were studied in visible light and UV light (254 and 365 nm) after treatment with various reagents. The results are represented in Table 4. The physico-chemical characters of powdered leaves of *S. indicum*, such as total alcohol soluble

**Table 1:** Macroscopic characteristic features of *S. indicum*

Habit	<i>A petite, erect, prickly bush or biennial spiny shrub</i>
Leaves	Leaves sub-entire oblong shape, thorny, and hairy on both sides
Stem	Stem is stout and the branches are covered with minute stellate brown hairs.
Roots	The root system is typically fibrous and extensive.
Calyx	Calyx is nearly 1.2 cm long, densely hairy and prickly
Corolla	Corolla is pale purple, 2-2.3 cm long, lobes deltoid, acute hairy outside
Flowers	Flowers occur in racemose, extra-axillary cymes.
Pedicels	Pedicels are 6-13 mm long, stellately hairy, and prickly.
Flowering	September to October
Fruits	Fruits (berries) are globose, and glossy after those are mature. Fruiting takes place in between November and December.
Seeds	Seeds are small, many, and discoid.

**Table 2:** Organoleptic evaluation of leaves of *S. indicum*

Plant parts	Organoleptic characters			
	Color	Odor	Taste	Texture
Leaves of <i>S. indicum</i>	Light greenish	Characteristic	Acrid	Soft & hairy

**Table 3:** Quantitative microscopy of leaves of *S. indicum*

Parameters	Range
Palisade ratio	14.15
Stomatal number upper surface	20.28
Stomatal number lower surface	22.28
Stomatal index upper surface	14.4
Stomatal index lower surface	23.4
Vein- islet number	25.4
Veinlet termination number	27.2

**Table 4:** Fluorescence analysis of leaves of *S. indicum*

Chemical used	Daylight hours	Ultraviolet light	
		254 nm	366 nm
Crude herbal drugs	Chocolate color	Greenish	Greenish
1N Hydrochloric acid	Greenish	Greenish	Olive green
50% Hydrochloric acid	Greenish	Greenish	Olive green
HNO <sub>3</sub> (50%)	Chocolate color	Olive green	Greenish
H <sub>2</sub> SO <sub>4</sub> (50%)	Faintly cherry	Greenish	Greenish
1N Sodium hydroxide	Greenish	Greenish	Olive green
Aluminium sodium hydroxide	Greenish	Olive green	Cherry
CH <sub>3</sub> OH	Yellowish	Light brown	Greenish
C <sub>6</sub> H <sub>6</sub>	Greenish	Olive green	Yellowish
CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub>	Chocolate color	White	Greenish
FeCl <sub>3</sub>	Chocolate color	Greenish	Olive green
1% KOH	whitish	Greenish	Greenish

extractive, water soluble extractive, ash value, acid insoluble ash, water-soluble ash, loss on drying, swelling index, and foreign matter, are presented in Table 5.

#### Preliminary phytochemical screening

Preliminary phytochemical screening of the methanolic extract of the leaf of *S. indicum* showed alkaloids, flavonoids, phenols, saponins, tannins, steroids, and terpenoids. The presence of the constituents from the *S. indicum* plants was presented in Table 6.

#### Chromatographic profile

A TLC profile was done for the methanolic extract of the leaf of *S. indicum*, which showed several spots indicating the presence of a number of chemical constituents. TLC pattern of methanolic extract showed five spots with Rf values 0.11, 0.29, 0.41, 0.52, and 0.72 using the solvent system chloroform-methanol (9:1), detected at UV 366 nm (Table 7 & Figure 3).

## Discussion

The macroscopic and microscopic description of a medicinal plant is the first step towards identification and determination of purity of such materials and should be carried out before any tests are undertaken. Ash values are helpful to determine the quality and purity of a crude drug, especially in the powdered form. The objective of the ash values of plant material is to determine the inorganic matter present in the drug.<sup>[23]</sup> On incineration, the crude drugs leave ash, usually consisting of sulfates, phosphates, carbonates, and silicates of sodium, potassium, calcium, and magnesium. Ash values of powdered leaves of *S. indicum* were found 13.6%, which indicates that the crude drug is clean and free from dirt and sandy material.<sup>[24]</sup> The extracts of crude drugs are indicative of approximate measures of their chemical constituents. Many solvents are used for the extraction

**Table 5:** Physico-chemical analysis of leaves of *S. indicum*

Quantitative parameter	Values obtained (%) w/w
Alcohol soluble extractive	9.86
Water-soluble extractive	16.6
Total ash	8.2
Acid-insoluble ash	1.48
Water-soluble ash	8.2
Loss on drying	8.6
swelling index	2.1
Foreign matter	1.20

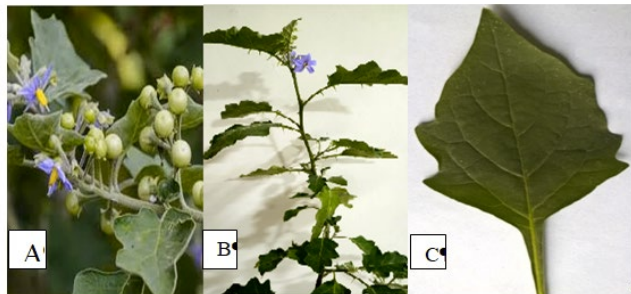
**Table 6:** Phytochemical screening of the methanolic extract of the leaves of *S. indicum*

S.No.	Constituents	<i>S. indicum</i>
1	Alkaloids	+++
2	Carbohydrates	+
3	Glycosides(Cardiac and Anthraquinone glycosides)	-
4	Phenolic compounds and tannins	+
5	Flavonoids	++
6	Terpenoids	+
7	Saponins	++
8	Sterols	++
9	Proteins	+
10	Resins	-

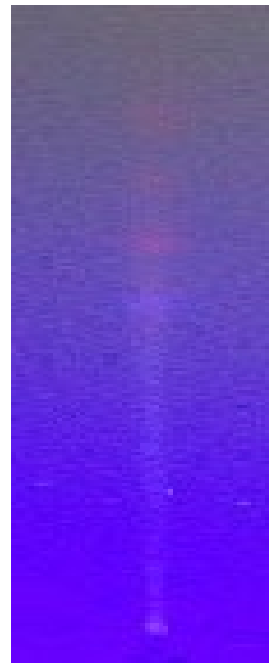
(+++)= Prominent; (++) = Medium; (+) = very less present; (-) = Absent.

**Table 7:** TLC profile of the methanolic extract of leaf of *S. indicum*

Extract	Solvent system	Number of spots detected	R <sub>f</sub> values	Visualizing agent
Methanolic extract of leaves of <i>S. indicum</i>	CHCl <sub>3</sub> : MeOH (9:1)	05	0.11, 0.29, 0.41, 0.52, 0.76	UV-366 nm

**Figure 1:** Exomorphic features of leaves of *Solanum indicum***Figure 2:** T.S. of leaves of *Solanum indicum*

of chemical compounds in a particular amount. Some compounds, i.e., coumarin and flavonoids, are studied for chemical components as well as for standardization of the plant materials.<sup>[25]</sup> The phytochemical screening of *S. indicum* confirms the presence of alkaloids, saponins, flavonoids, phenols, tannins, steroids, and terpenoids, which may be responsible substances for its pharmacology activities. TLC profiling of hydroethanolic extract has been carried out to achieve some chromatographic studies to confirm the presence of active components in *S. indicum*.<sup>[26]</sup> TLC profiling shows different spots with different R<sub>f</sub> values. The separation of phytochemicals in the TLC plate gives different R<sub>f</sub> values with different mobile phases. The difference in the R<sub>f</sub> values depends upon the polarity of the compound, so that the solvent system which analyzed appropriate is used for further isolation from the plant extract.<sup>[27,28]</sup> Phytochemical screening and TLC profile of crude extract can be very useful for developing the quality parameters. The *S. indicum* is one of the therapeutically important plants. Since long time, it has been used for the treatment of a variety of ailments, but the details of its quality attributes like pharmacognostic, phyto

**Figure 3:** TLC chromatogram of the methanolic extract of leaves of *Solanum indicum*

and physicochemical characteristics were not available.<sup>[29]</sup> There are no reports of pharmacognostic studies and phytochemical analysis of *S. indicum*, so it was envisaged that the above-mentioned studies would be worth and useful for the scientific community as well as commercial purposes.

## Conclusion

The pharmacognostic character, physicochemical constant, and the presence of several bioactive compounds could be a useful tool for the identification, authentication, and preparation of a suitable monograph of *S. indicum*. These data will serve as a reference for the quality control of the preparation of this plant. According to some researchers' reports, it is found that *S. indicum* is used widely to cure various diseases. Thus, the present study also helps to check the falsification of this important medicinal plant and to be significant and encouraging towards the goal of standardization.

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## Conflict of Interest

None declared by the authors.

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