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# Extraction Isolation and Phytochemical Investigations on Various Parts of Solanum Nigrum

**Sovindra Kumar Pal[*1], Rahul Shukla[1]**

[1]School of Pharmaceutical Sciences, Shri Venkateshwara University Gajraula, Amroha, India

***Corresponding Author**

Sovindra Kumar Pal

School of Pharmaceutical Sciences, Shri Venkateshwara University Gajraula, Amroha, India

Email ID: psovindra@gmail.com

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**ABSTRACT**

This study focused on the phytochemical evaluation of Solanum nigrum extracts prepared using various solvents. The main objective was to identify the bioactive substances in the extracts, including sterols, fatty acids, waxes, chlorophyll, essential oils, fatty acids, lipophilic carotenoids, flavonoids, phenolic acids, glycoalkaloids, tannins, terpenoids, glycosides, and steroids. The study found that Solanum nigrum contains glycoalkaloids, such as solanine and solamargine; flavonoids, such as quercetin and rutin; and triterpenoids, such as β-sitosterol. Extraction yields depend on the plant material, solvent, and chemical composition of the extract. ..

***Keywords***: *Solanum nigrum, phytochemicals, flavonoids, extraction.*

## 1. INTRODUCTION

Pharmacology, the study of drug action, is a vital field that connects biology and medicine. Medicinal plants have been a cornerstone of pharmacological research, providing a plethora of bioactive compounds that serve as leads for drug development. Among these, the Solanum genus stands out because of its rich diversity and extensive use in traditional medicines. The genus Solanum, which belongs to the Solanaceae family, comprises over 1,500 species that are distributed globally. Known for their medicinal properties, several Solanum species have been employed in traditional medicine for centuries, treating ailments ranging from inflammation to infectious diseases. Understanding the pharmacological potential of these species requires a comprehensive analysis of their phytochemical constituents and bioactivities. Solanum species exhibit a wide range of morphological diversity, which has been categorised into several sections and sub-sections within the genus. This section delves into the detailed botanical classification and geographical distribution of key species such as Solanum nigrum, Solanum tuberosum, and Solanum melongena. Mapping their distribution provides insights into the environmental conditions that influence the phytochemical profiles. The pharmacological activities of Solanum species are primarily attributed to their diverse phytochemical composition. Alkaloids, glycoalkaloids, flavonoids, and saponins are the key bioactive Advanced phytochemical analysis techniques, such as chromatography and mass spectrometry, have facilitated the identification and quantification of these compounds, shedding light on their potential therapeutic roles. Research has revealed a myriad of pharmacological activities in Solanum species, including anti-inflammatory, antimicrobial, antioxidant, and anticancer activities. This section summarises the existing literature on these activities and highlights the underlying mechanisms of action. For instance, the glycoalkaloid solanine has demonstrated significant anticancer potential by inducing apoptosis in cancer cells. Solanum species have a rich history of use in ethnomedicine. Traditional healers use these plants to prepare remedies for various diseases. Ethnobotanical studies provide valuable information on traditional knowledge and practices associated with Solanum species, which can guide contemporary pharmacological research. Documenting these uses underscores the cultural significance of these plants in various regions. Despite extensive research, several gaps remain in our understanding of the pharmacological potential of Solanum species. Thus, more in-depth studies on less-explored species and their bioactive compounds are required. However, the mechanisms underlying these pharmacological effects have not been fully elucidated. Addressing these gaps forms the rationale for the current study, which aims to explore the pharmacological properties of selected Solanum species in greater detail. The primary aim of this study was to investigate the pharmacological activities of selected Solanum species and to identify the bioactive compounds responsible for these effects. The specific objectives include conducting phytochemical analyses, evaluating pharmacological properties in vitro and in vivo, and elucidating the mechanisms of action of these compounds. Hypotheses will be formulated based on the preliminary data and tested using rigorous experimental protocols. The findings of this study have the potential to contribute

significantly to the fields of pharmacology and medicinal chemistry. By uncovering new bioactive compounds and elucidating their mechanisms of action, this study paves the way for the development of novel therapeutic agents. Furthermore, this will enhance our understanding of the medicinal value of Solanum species and promote their sustainable use and conservation. [1-15]

## 2. RESULT

### *Collection of plant material*

#### *Collection, Identification and powdering*

Solanum nigrum plants were collected from the native Meerut region in October. Its identity was confirmed by matching it with a specimen herbarium at the IP College, Bulandshahr. The roots, stems, leaves, aerial parts, and fruits of Solanum nigrum were washed, shade-dried, coarsely powdered, and stored in an airtight container for further studies.

### *Pharmacognostical evaluation*

The roots, stems, leaves, aerial parts, and fruits of Solanum nigrum were subjected to microscopic evaluation. Quantitative standards, such as moisture content, total ash value, alcohol-soluble extractive value, and water-soluble extractive value, were also determined.

### *Microscopy*

The stomatal index, vein islet number, and power microscopy were used for plant identification. This was performed according to the procedure described. The values are presented in Table 1.

**Table 1: Values of leaf constant**

| S.N. | Name of Constant | Solanum nigrum Upper Epidermis | Solanum nigrum Lower Epidermis |
|---|---|---|---|
| 1. | Stomatal Number | 6 | 167 |
| 2. | Stomatal Index | 7% | 18% |
| 3. | Palisade ratio | 4 | 4 |
| 4. | Vein-islet number | 22 | 22 |
| 5. | Veinlet termination number | 13 | 13 |

### *Upper Epidermis and Lower Epidermis Constants*

Extraction of plant material

Extraction was performed at both pilot and laboratory scales.

Pilot scale extraction

The dried powdered root, stem, leaf, aerial part, and fruit of Solanum nigrum (30 g) were successively extracted with 300 ml of petroleum ether, ethyl acetate, chloroform, and ethanol. Finally, the obtained marc was used for aqueous extraction by boiling the air-dried marc in water. All extracts were concentrated, and their yields were determined. The results are presented in Table 2.

**Table 2: Pilot-scale extraction of various parts of Solanum nigrum.**

| S.N. | Plant part | Extracts | Wt. of drug used (10gm) | Qty. of solvent used(ml) | Wt of extracts (Gms) |
|---|---|---|---|---|---|
| 1 | Root | Pet.ether | Successive extraction by soxhlet extractor | 300 | 0.13 |
| | | Ethyl acetate | | 300 | 2.6 |
| | | Chloroform | | 300 | 4.8 |
| | | Ethanol | | 300 | 7.2 |
| | | Aqueous | | QS | 8.7 |
| 2 | Leaf | Pet.ether | Successive extraction by soxhlet extractor | 300 | 0.6 |
| | | Ethyl acetate | | 300ml | 5.7 |
| | | Chloroform | | 300ml | 0.5 |
| | | Ethanol | | 300ml | 6.2 |
| | | Aqueous | | QS | 9.6 |
| 3 | Stem | Pet.ether | Successive extraction by soxhlet extractor | 300 ml | 0.8 |
| | | Ethyl acetate | | 300ml | 3.6 |
| | | Chloroform | | 300ml | 1.6 |
| | | Ethanol | | 300ml | 7.2 |
| | | Aqueous | | QS | 10.1 |
| 4 | Aerial parts | Pet.ether | Successive extraction by soxhlet extractor | 300 ml | 0.8 |
| | | Ethyl acetate | | 300ml | 0.9 |
| | | Chloroform | | 300ml | 2.5 |
| | | Ethanol | | 300ml | 4.2 |
| | | Aqueous | | QS | 7.3 |
| 5 | Fruit | Pet.ether | Successive extraction by soxhlet extractor | 300 ml | 0.7 |
| | | chloroform | | 300ml | 1.8 |
| | | Ethyl acetate | | 300ml | 1.5 |
| | | Ethanol | | 300ml | 12.6 |
| | | Aqueous | | Quality Sufficient | 11.2 |

Preliminary Phytochemical studies

Preliminary Phytochemical studies of Solanum nigrum.

Qualitative chemical tests for different extracts of Solanum nigrum were carried out, and the tests showed the presence of alkaloids, sterols, sugars, flavonoids, and phenols in different fractions of the root, leaf, stem, aerial part, and fruits. (Table 3)

Phytochemical Constituents and Results by Solvent Here summarised in table:

**Table 3: Phytochemical screening of different Solanum nigrum L. extracts.**

| Solvent | Roots | Stem | Leaves | Fruits |
|---|---|---|---|---|
| Petroleum Ether (Non-polar) | Sterols, fatty acids | Waxes, chlorophyll, essential oils | Waxes, chlorophyll, essential oils | Fatty acids, lipophilic carotenoids |
| Ethyl Acetate (Moderately Polar) | Alkaloids, phenolics | Flavonoids, terpenoids | Phenolic acids, flavonoids, alkaloids | Flavonoids, phenolic acids, glycoalkaloids |
| Chloroform (Intermediate Polar) | Alkaloids, intermediate-polarity phenolics | Alkaloids, terpenoids | Alkaloids, chlorophyll, moderate-polarity phenolics | Alkaloids, carotenoids |
| Ethanol (Polar) | Tannins, glycosides, flavonoids | Flavonoids, tannins, alkaloids | Glycosides, tannins, chlorophyll | Phenolics, flavonoids, glycosides |
| Aqueous (Highly Polar) | Polysaccharides, soluble phenolics | Tannins, water-soluble alkaloids | Phenolics, soluble proteins | Sugars, organic acids, water-soluble alkaloids |

**Table 4: Onset of Chemical Constituents in various solvents of Solanum nigrum.**

The presence of these constituents was analyzed for further investigation of their isolation and pharmacological activity.

| S.N. | Plant part | Onset of presence of Chemical Constituents in various solvents |
|---|---|---|
| 1 | Root | 11 |
| 2 | Leaf | 14 |

| | | |
|---|---|---|
| 3 | Stem | 12 |
| 4 | Aerial parts | 11 |
| 5. | Fruits | 13 |

**Figure 1: Onset of the presence of Chemical Constituents in various solvents of Solanum nigrum.**

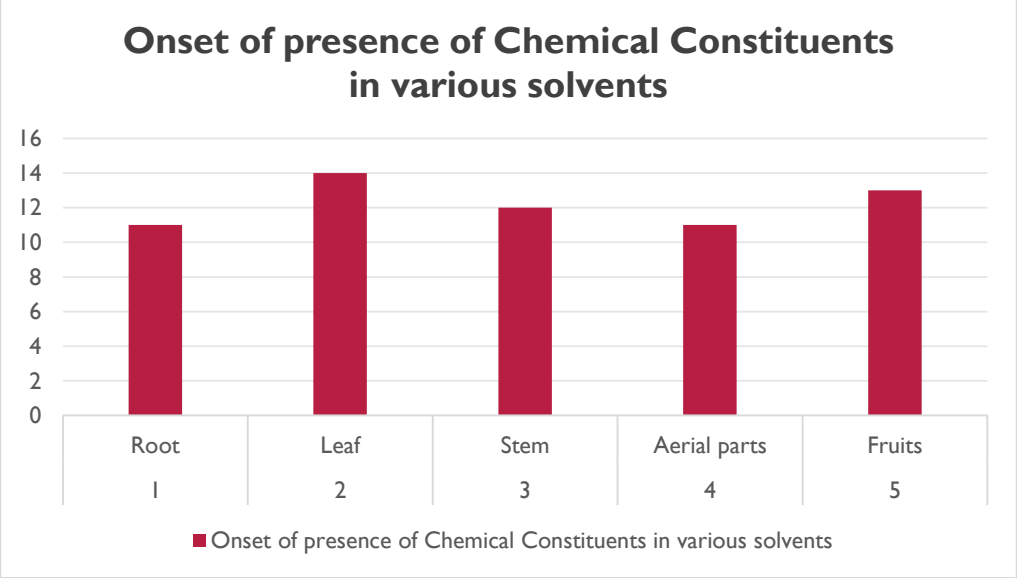
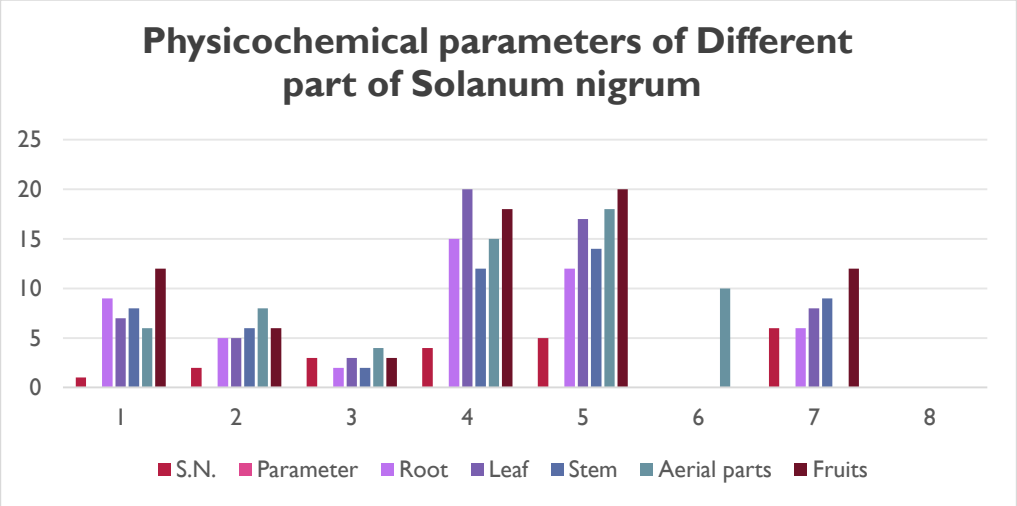



**Table 5: Physicochemical parameters of Different part of Solanum nigrum.**

| S.N. | Parameter | Root | Leaf | Stem | Aerial parts | Fruits |
|---|---|---|---|---|---|---|
| 1 | Moisture content % | 9 | 7 | 8 | 6 | 12 |
| 2 | Total ash % | 5 | 5 | 6 | 8 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Water soluble ash % | 2 | 3 | 2 | 4 | 3 |
| 4 | Water soluble extractive value % | 15 | 20 | 12 | 15 | 18 |
| | Alcohol Soluble Extractive value % | 12 | 17 | 14 | 18 | 20 |
| 6. | Loss on drying | 6 | 8 | 9 | 10 | 12 |

**Figure2: Physicochemical parameters of Different part of Solanum nigrum.**




Moisture content were9, 7, 8, 6, 12; total ash were 5, 5, 6, 8, 6; water soluble ash were 2, 3, 2, 4, 3; water soluble extractive value 15, 20, 12, 15, 18; Alcohol soluble extractive value 12, 17, 14, 18, 20; loss on drying 6, 8, 9, 10, 12 for root, leaf, stem, aerial parts, fruits respectively.

**Table 6 Extractive Values of different parts of Solanum nigrum.**

***Extractive values***

The extractive values for the pet ether extracts were 3.74, 4.6, 5.6, 6.1, and 2.1; for chloroform, 4.64, 3.5, 4.2, 2.7, and 6.2; ethylthyl acetate, 6.53, 9.0,7.9, 3.8, and 8.4; for ethanol, 8.86, 7.3, 9.1, 1.8, and 4.0; and 3.3 for fruit, leaf, aerial part and stem respectively. (Table 6)

| S.N. | Solvent | Fruit | Root | Leaf | Aerial parts | Stem |
|---|---|---|---|---|---|---|
| 1 | Pet. ether | 3.74 | 4.6 | 5.3 | 6.1 | 2.1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Ethyl acetate | 6.53 | 9.0 | 7.9 | 3.8 | 8.4 |
| 3 | Chloroform | 4.64 | 3.5 | 4.2 | 2.7 | 6.2 |
| 4 | Ethanol | 8.86 | 7.3 | 9.1 | 1.8 | 4.0 |
| 5 | Aqueous | 5.53 | 7.2 | 6.3 | 7.9 | 3.3 |

Preliminary phytochemical studies of Solanum nigrum.

## 3. DISCUSSION AND CONCLUSION

Black nightshade (Solanum nigrum) was pharmacologically evaluated by systematically examining its constituent elements to determine its identity, quality, and potential for therapeutic use.

The main objective of this study was to examine the extracts of S. nigrum using petroleum ether, ethyl acetate, chloroform, ethanol, and aqueous extracts. To identify the main bioactive substances in the extracts, solubility tests and other qualitative analyses were conducted. Sterols, fatty acids, waxes, chlorophyll, essential oils, fatty acids, lipophilic carotenoids, flavonoids, phenolic acids, glycoalkaloids, tannins, terpenoids, glycosides, and steroids were identified in the extracts after extraction.

Thin-Layer Chromatography (TLC) was used for the advanced analysis of Solanum nigrum extracts and isolated compounds to separate and identify the phytochemicals present in the extracts. The findings showed the presence of certain phytochemicals, including phenolics/tannins (0.2-0.5 in ethanol or aqueous extracts), flavonoids (0.3-0.7 in ethyl acetate or ethanol extracts), and steroids/terpenoids (0.2-0.6 in petroleum ether or chloroform extracts).

The bioactive components in the Solanum nigrum extracts were quantified using HPLC. Alkaloids, flavonoids, and phenols are the main chemical markers of Solanum nigrum. Standardised extract profiles included petroleum ether, ethyl acetate, chloroform, ethanol, and aqueous extracts. The effectiveness, consistency, and purity of the extracted components and extracts are guaranteed by standardisation. Depending on the gradient, the HPLC run duration ranged from 25–30 min.

The standardisation and testing of extracts from Solanum nigrum, a plant with phenolic, flavonoid, and antioxidant properties, are the main topics of this research. Plant roots, stems, leaves, fruits, and aerial portions were used to prepare the extracts. The findings demonstrated that Each solvent extract produced unique bands corresponding to various phytochemicals, with petroleum ether being the most prevalent. Polarity was used to further differentiate the extracts, with polar chemicals eluting after the nonpolar chemicals. Bioactive substances, including solanine, solamargine, flavonoids, and phenolic acids, were detected using HPLC chromatography. Steroids, chloroform extracts, flavonoids, phenolic acids, and tannins were identified as important phytochemicals. The study found that due to their alkaloid concentration, chloroform extracts had the most antibacterial and cytotoxic effects, whereas ethanol extracts had the highest antioxidant, phenolic, and flavonoid activities. Additionally, the extracts exhibited strong antioxidant activity, most likely because of the presence of tannins and phenolics.

The results showed that ethanol extracts, which contain higher levels of flavonoids and phenolic compounds, often exhibit the best antioxidant activity. The root and aerial portions exhibit varying outcomes depending on their composition. Because they include lipid-soluble chemicals, petroleum ether and chloroform extracts may exhibit considerable antioxidant activity, while generally having lower levels of antioxidant activity. Given their increased flavonoid and glycoside contents, the ethanol extracts of leaves and fruits are likely to have stronger analgesic and anti-inflammatory properties.

Alkaloids, flavonoids, and phenolic acids are among the possible bioactive substances that have been investigated in Solanum nigrum. These substances exhibit anticancer, antibacterial, anti-inflammatory, and antioxidant activities. The extracts included flavonoids, tannins, carbohydrates, and phytosterols, according to preliminary phytochemical analysis.

Petroleum ether is suitable for substances with intermediate lipophilicity and hydrophilicity because it can extract moderately polar substances, such as flavonoids, phenolic acids, alkaloids, and terpenoids. It is used to separate intermediate-polar secondary metabolites. Ethanol, a commonly used solvent, is effective and has low toxicity, making it suitable for extracting various bioactive substances, including tannins, flavonoids, glycosides, and alkaloids. Water-soluble substances, including proteins, polysaccharides, tannins, and phenolic acids, can be extracted using aqueous methods and are used in conventional herbal medicine.

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