WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 15, 1842-1862. Review Article ISSN 2277–7105

A STUDY AND REVIEW OF SOLANUM NIGRUM PLANT

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Article Received on
21 June 2025,

Revised on 11 July 2025,
Accepted on 01 August 2025

DOI: 10.20959/wjpr202515-38011

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ABSTRACT

Solanum nigrum L., commonly known as black nightshade or Makoi, is a medicinal plant belonging to the family Solanaceae. It contains a wide range of bioactive compounds including glycoalkaloids, glycoproteins, polysaccharides, and polyphenolic compounds like gallic acid, catechin, and rutin. The plant exhibits diverse pharmacological activities such as antibacterial, antifungal, anti-inflammatory, anti-cancer, antioxidant, anti-pyretic, and cytotoxic effects. Traditionally, different parts of the plant are used for treating various ailments. Antibacterial studies have demonstrated the plant's efficacy against gram-negative pathogens, indicating its therapeutic potential. While reddish-brown fruits are edible, the black ones are considered toxic and are not used medicinally. It is used in the treatment of diseases like rheumatism, tuberculosis, skin disorders, asthma, and liver ailments. This article presents a comprehensive and systematic overview of the botanical, traditional uses, phytochemical compositions, pharmacological properties, clinical trials, and toxicity of Solanum nigrum to provide the latest information for further exploitation and application of S. nigrum in functional foods and medicines.

INTRODUCTION

Solanum nigrum, commonly known as "Black nightshade", belongs to the Solanaceae family and is called "Manathakkali" in Tamil. It has long been valued for its medicinal properties, particularly in the treatment of pediatric ailments linked to infant mortality, such as febrile

convulsions, eye diseases, rabies, and chronic skin conditions.[1] Traditionally, it has also been used to treat various illnesses, including cancer, acute nephritis, urethritis, leucorrhea, sore throat, toothache, dermatitis, eczema, carbuncles, and boils. To date, approximately 188 chemical constituents have been identified in S. nigrum, with major bioactive compounds including steroidal saponins, alkaloids, phenols, and polysaccharides. The plant has a bitter taste, is slightly toxic, and is considered to have cooling properties in traditional medicine.[2]

Figure 1: Schematic Representation of Solanum Nigrum.

In countries such as India and Japan, S. nigrum has been documented for its use in the treatment of tumors. Its fruits, which are sweet and salty, were historically consumed as famine food in 15th-century China. In India, the leaves and berries are typically cooked and eaten as vegetables.[2]

Plant extracts have been used to treat ulcers and other skin conditions. The berries and flowers are also used to manage asthma and excessive thirst, in addition to serving as laxatives, appetite enhancers, and general tonics.[3]

In Tamil Nadu, the leaves are traditionally used to treat mouth ulcers during the winter season. In North India, boiled leaf and berry extracts are used to treat jaundice and other liver-related disorders.[3] Furthermore, natural compounds found in Solanum nigrum may help prevent inflammation and may also inhibit cancer cell growth by preventing protein denaturation. Solanum nigrum is commonly found in both waste lands and cultivated lands across various parts of the world. It is considered a common plant and serves as a reservoir of phytochemicals with significant pharmacological activities. Solanine, a key compound, is

primarily present in members of the Solanaceae family, particularly in potato and nightshade plants.

TAXONOMY OF SOLANUM NIGRUM

Taxonomy of Solanum nigrum (Black Nightshade)

1. Basic Classification

Kingdom: Plantae

Division: Magnoliophyta (Flowering plants)

Class: Magnoliopsida (Dicotyledons)

Genus: Solanum

Species: Solanum nigrum

2. Detailed Classification

Division: Embryophyta

Sub-division: Angiospermae

Class: Dicotyledonae

Order: Tubiflorae

Sub-order: Solanales

Family: Solanaceae

Genus: Solanum

3. Expanded Classification

Kingdom: Plantae (Plants)

Sub-kingdom: Tracheobionta (Vascular plants)

Super-division: Spermatophyta (Seed plants)

Division: Magnoliophyta (Flowering plants)

Class: Magnoliopsida (Dicotyledons)

Subclass: Asteridae

Order: Solanales

Genus: Solanum (Nightshade)

Species: Solanum nigrum L. (Black nightshade)

Authority: Linn.[1]

4. Vernacular Taxonomy

Division: Embryophyta

Sub-division: Angiospermae

Class: Dicotyledonae

Order: Tubiflorae

Sub-order: Solanaceae

Family: Solanaceae

Genus: Solanum

Figure 2: Schematic Representation of Fruits In Solanum Nigrum.

VERNACULAR NAMES OF SOLANUM NIGRUM

Australia: Black nightshade, Black berry

Cameroon: Kumbo (Banso)

Europe: Black nightshade, Annual nightshade, Garden nightshade, Common nightshade

France: Morelle noire

Italy: Solanum nigrum, Solatro

Russia: Paslen cherny

Germany: Schwarzer Nachtschatten

New Zealand: Black nightshade

South Africa: Nightshade (Cape Province)

Tanzania: Sunga (Swahili)

India: Manathakkali

Sanskrit: Dhanvashaka[7]

MORPHOLOGY OF SOLANUM NIGRUM

MACROSCOPY

Solanum nigrum Linn. is an annual plant that grows to a height of 25–100 cm. It possesses pubescent (hairy) stems, pale yellow bark, and dark black, irregularly shaped fruits. The flowers usually have five or more petals. The leaves are green, alternate, and measure about

4–7.5 cm in length and 2–5 cm in width. They exhibit natural shapes ranging from oval to heart-shaped. The petiole is approximately 1–3 cm long, with noticeable marginal teeth and an uneven base.

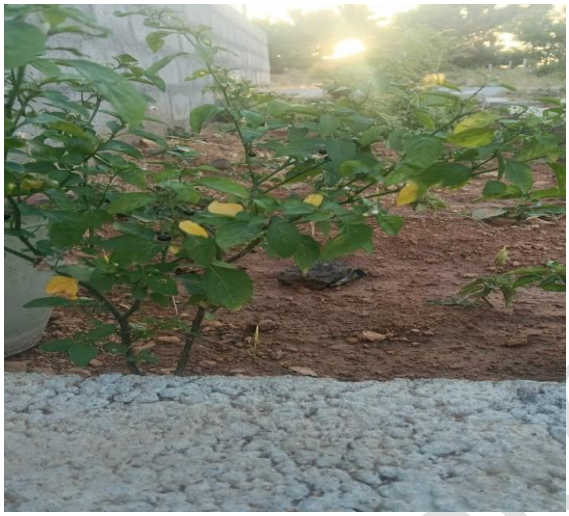


Figure 3: Schematic Representation Of Plant of Solanum Nigrum.

MICROSCOPY

The leaf epidermis is single-layered and comprises oval or tangential cells. A cuticle layer covers the epidermis, and glandular and wart-like trichomes may be present. The epidermis remains single-layered, while collenchyma may appear in two to three layers. The midrib cross-section reveals oval-shaped epidermal cells and spherical parenchyma cells with thin wall

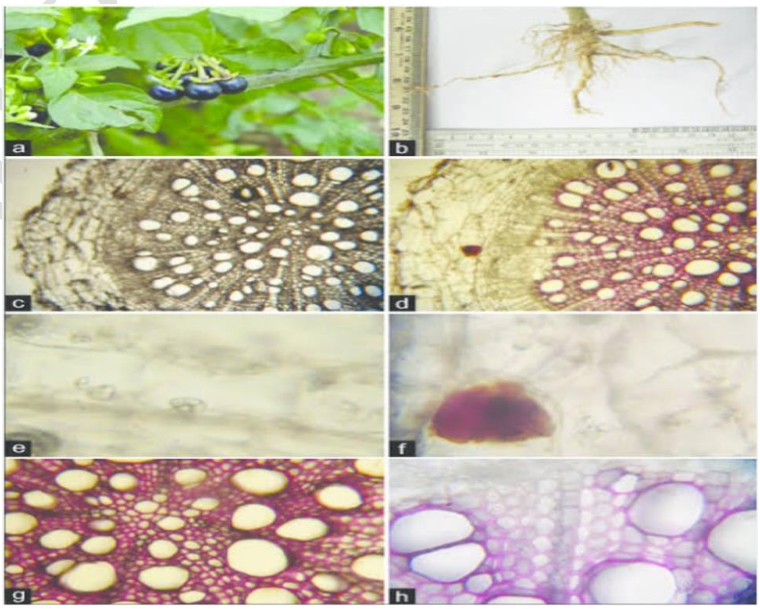


Figure 4: Microscopic Characteristics of Solanum Nigrum.

Solanum nigrum (Black nightshade) is not only valued for its medicinal properties but also recognized for its nutritional richness, particularly in vitamins and minerals. These nutrients play a crucial role in supporting overall health and enhancing the therapeutic potential of the plant.[5]

Figure 5: Macroscopic Characteristics of Solanum Nigrum.

CHEMICAL CONSITUENTS OF SOLANUM NIGRUM

1. ALKALOIDS OF SOLANUM NIGRUM

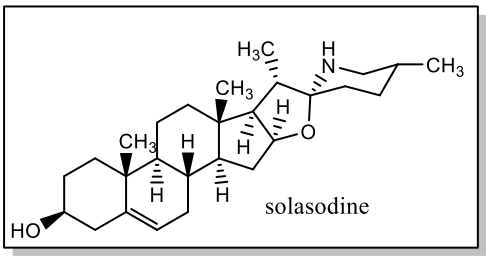
Solanum nigrum Alkaloids Solanum nigrum (black nightshade) is rich in alkaloids, particularly steroidal glycoalkaloids, which are the plant's primary bioactive and defensive compounds

Major Alkaloids

Determined Approximately 95% of the total alkaloid content, particularly in unripe berries, is solanine, the most prevalent alkaloid. It is a glycoalkaloid made up of three sugars and the aglycone solanidine. Two important steroidal glycoalkaloids, solasonine and solamargine, are mostly present in immature fruits, with solamargine being the main constituent. In some cancer models, both have shown potent anticancer efficacy.

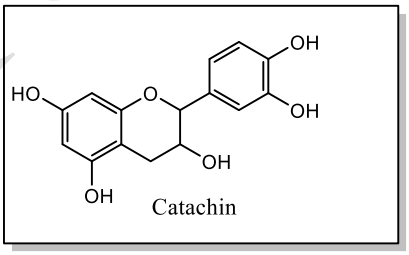
2. SOLASODINE

The physiologically active aglycone that results from the hydrolysis of solasonine and solamargine. Solanigrine, solasodamine, solavioline, and a number of recently discovered steroidal alkaloids are examples of other alkaloids[6].



3. CATECHIN OF SOLANUM NIGRUM

One prominent polyphenolic component in Solanum nigrum (black nightshade) that contributes to its pharmacological and antioxidant properties is catechin. Other phenolics, such as epicatechin, gallic acid, protocatechuic acid, and caffeic acid, are present in addition to catechin. Catechin contributes to the plant's general bioactivity, which includes anti-proliferative and antioxidant properties, together with rutin and naringenin. Catechin's Chemical Structure: The chemical description of catechin, a flavon-3-ol, is (2R, 3S). Triole-3,5,7-triol-2-(3,4-dihydroxyphenyl)-3,4-dihydro-2H-chromene. Its structure includes a dihydropyran heterocycle (C ring) and two aromatic rings (A and B). There are hydroxyl groups on the A and C riboses at positions 3, 5, and 7(A and C rings) and 3,4(B rings).

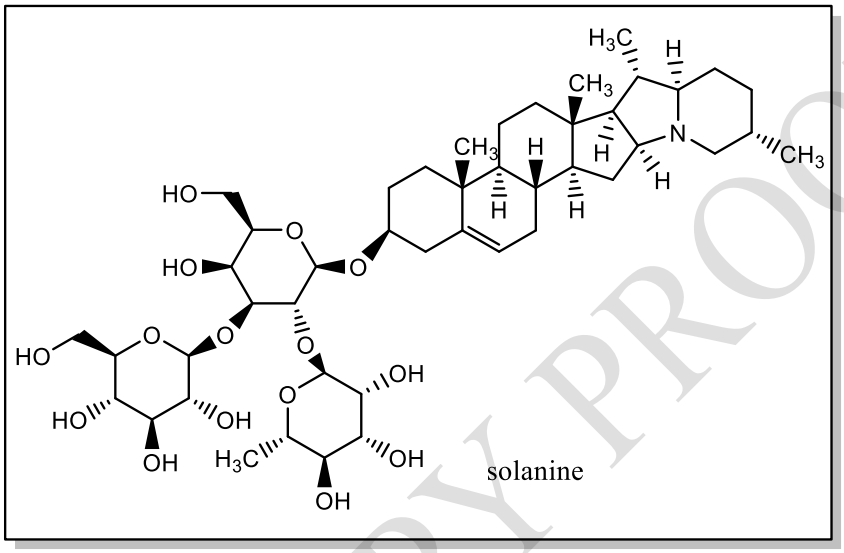


4. STEROIDAL GLYCOSIDES OF SOLANUM NIGRUM

The primary steroidal glycosides (sometimes referred to as glycoalkaloids) found in Solanum nigrum are solanine, solasonine, and solamargine. Among these substances are the widely distributed Solanigrine and many recently identified steroidal saponins, such as solanigrosides C–H. Black nightshade,

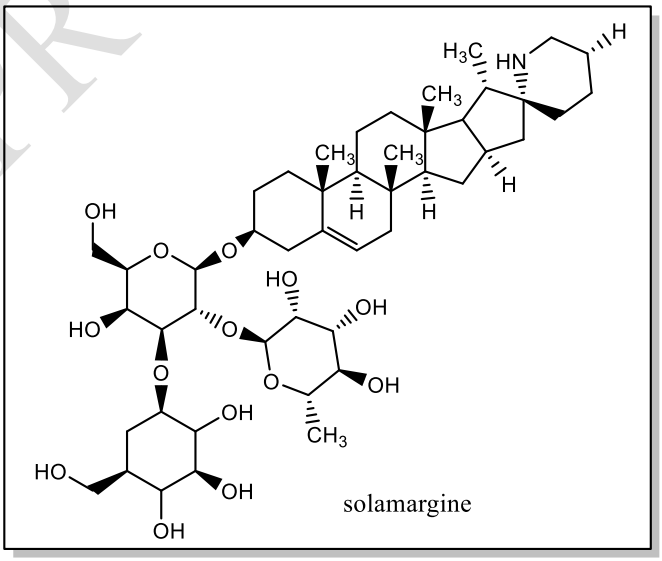
5. SOLANINE IN SOLANUM NIGRUM

Solanum nigrum, contains solanine, which is a commonly used... Black nightshade, or Solanum nigrum, is a common medicinal plant that is abundant in bioactive substances, particularly the toxic glycoalkaloid solanine. As a natural defense mechanism, solanine is found throughout the plant, but it is most abundant in unripe berries. With almost 95% of the total alkaloidal content, it is the most prevalent alkaloid in Solanum nigrum.[9]



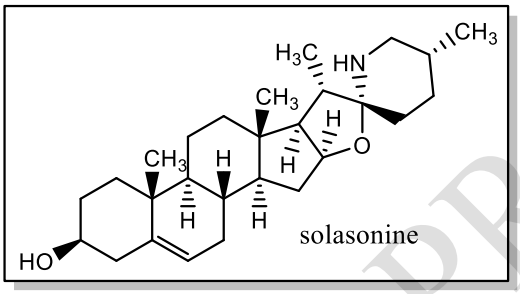
6. SOLAMARGINE OF SOLANUM NIGRUM

The plant Solanum nigrum has a bioactive steroidal alkaloid glycoside called solamargine. They have significant pharmacological properties, especially anticancer activity.[8]



7. SOLASONINE OF SOLANUM NIGRUM

Solanum nigrum's solasonine A steroidal alkaloid backbone (solasodine) makes up solanine. Solanum nigrum, sometimes known as black nightshade, has a significant steroidal glycoalkaloid that is known for its pharmacological properties, especially its anticancer effects. A steroidal alkaloid core (solasodine) is joined by a glycosidic bond to a trisaccharide (solatriose: glucose, galactose, and rhamnose) to form solasonine. This class of alkaloids shares cyclopentanoperhydrophenanthrene skeleton, which serves as the basis for the steroidal core.[6]



8. SOLANIGRINE OF SOLANUM NIGRUM

A steroidal alkaloid called Solanigrine is present in Solanum nigrum, also known as black nightshade, a plant that has been extensively researched for its pharmacological and traditional medicinal applications.

9. SOLANIGROSIDES OF SOLANUM NIGRUM

Solanum nigrum Solanigrosides are a class of steroidal saponins that were extracted from Solanum nigrum and are known to have a variety of pharmacological properties, such as antiviral, anti-inflammatory, and anti-cancer properties. These substances are some of the plant's primary bioactive components.[8]

10. RUTIN OF SOLANUM NIGRUM

Black nightshade, or Solanum nigrum, contains rutin, a well-known flavonoid glycoside, as well as other polyphenolic substances like epicatechin, gallic acid, protocatechuic acid, catechin, and caffeic acid. The notable antioxidant, hepatoprotective, anti-tumor, immunomodulatory, and anti-cancer properties of the plant are attributed to the presence of rutin. These benefits lend credence to Solanum nigrum's historic applications in the treatment of inflammation, ulcers, liver diseases, and other ailments.

11. SAPONINS OF SOLANUM NIGRUM

Steroidal saponins are the main pharmacologically active components of Solanum nigrum. Solanigrosides (A–O, R, X, Y), nigrumnin's, and degalactotigonin are important saponins. These saponins have strong antioxidant, anti-inflammatory, and anti-tumor properties.[8]

12. TANNINS OF SOLANUM NIGRUM

Tannins are polyphenolic substances that have anti-inflammatory, antibacterial, and antioxidant qualities. The presence of tannins in different extracts of Solanum nigrum (black nightshade), which contribute to its therapeutic properties, has been confirmed by numerous investigations.

13. GLYCO PROTEINS OF SOLANUM NIGRUM

The glycoproteins I and II (150 kDa and 100 kDa) and glycoprotein III (210 kDa) are found in the fruits, stems, and leaves. These glycoproteins are composed of about 69.74% carbohydrates and 30.26% protein, with a high proportion of hydrophobic amino acids like glycine and proline. Glycoproteins from Solanum nigrum have demonstrated strong antioxidant, cytotoxic, diuretic, and antipyretic activities, including growth inhibition of cancer cell lines such as MCF-7 and HT-29, and free radical scavenging effects. Extraction is typically done by ammonium sulfate precipitation and affinity chromatography.

14. POLYSACCHARIDES OF SOLANUM NIGRUM

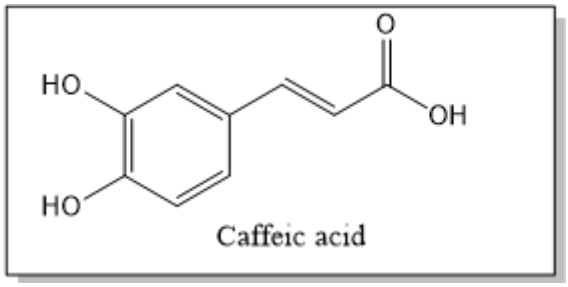
Crude polysaccharides isolated from S. nigrum stems—have shown immunomodulatory and anti-tumor effects. The carbohydrate content of these polysaccharides ranges from about 46% to 65%, fitting the typical profile for Solanaceae family polysaccharides. These polysaccharides can suppress tumor progression and modulate immune responses in preclinical models.

15. CHLOROGENIC ACID OF SOLANUM NIGRUM

Chlorogenic acid is a major phenolic compound found in the leaves of Solanum nigrum (Black Nightshade). Multiple studies confirm Its abundance and significant contribution to the plant's antioxidant activity

16. CAFFEIC ACID OF SOLANUM NIGRUM

Caffeic acid is a key polyphenolic compound identified in Solanum nigrum (Black Nightshade), contributing to its antioxidant and pharmacological activities.



Caffeic acid

VITAMINS AND MINERALS IN SOLANUM NIGRUM

VITAMINS PRESENT

Vitamin A (Retinol equivalents)

Supports eye health, immune function, and skin integrity.

Vitamin C (Ascorbic acid)

A powerful antioxidant that helps boost immunity, promote collagen synthesis, and protect against oxidative damage.

Vitamin B1 (Thiamine)

Essential for energy metabolism and nervous system function

Vitamin B2 (Riboflavin)

Aids in cellular respiration and energy production.

Vitamin B3 (Niacin)

Involved in DNA repair, energy transfer, and maintaining healthy skin.

Vitamin E (Tocopherol)

Acts as a fat-soluble antioxidant, protecting cells from oxidative stress.[10]

MINERALS PRESENT

Iron: Important for hemoglobin formation and oxygen transport in the blood.

Calcium: Vital for bone health, muscle contraction, and nerve signaling.

Phosphorus: Supports bone strength and energy metabolism.

Magnesium: Involved in enzyme activation, nerve function, and muscle relaxation.

Potassium: Regulates fluid balance, muscle contractions, and nerve signals

Zinc: Plays a key role in immune function, wound healing, and cellular metabolism.

Sodium: Helps maintain fluid balance and nerve transmission.[11]

TOXICITY

Solanum nigrum L. (family: Solanaceae), commonly known as Black Nightshade, is a medicinal plant widely used in traditional medicine for its hepatoprotective, anti-inflammatory, antioxidant, and anticancer properties. However, its toxic potential remains major concern, primarily due to the presence of glycoalkaloids, especially solanine and solamargine.

Toxic Constituents

The toxic compounds primarily responsible for its adverse effects include:

- Solanine
- Solamargine
- Solasonine
- Chaconine
- Solanidine

These glycoalkaloids can disrupt cell membranes, inhibit cholinesterase activity, and cause gastrointestinal, neurological, and systemic toxicity.

Reported Toxic Effects

1. Hepatotoxicity

High doses of extracts or glycoalkaloids have been shown to cause liver damage in animal studies. Histopathological changes such as hepatic necrosis and inflammation have been reported.

2. Neurotoxicity

Symptoms include drowsiness, confusion, dizziness, and, in severe cases, coma.

Mechanism: Inhibition of acetylcholinesterase leads to neurotransmitter imbalance.

3. Gastrointestinal Toxicity

Nausea, vomiting, abdominal pain, and diarrhea are commonly observed in both animals and humans after ingestion of unripe berries or leaves.

4. Reproductive Toxicity

Some studies in rats have shown fetal resorption, reduced litter size, and teratogenic effects.

5. Cytotoxicity

While cytotoxicity can be beneficial in cancer therapy, nonspecific cytotoxic effects on normal cells are a concern at higher doses.

PHARMACOLOGICAL ACTIVITY OF SOLANUM NIGRUM:

Solanum nigrum exhibits diverse pharmacological properties that contribute to its traditional and therapeutic uses:

1. ANTI OXIDANT EFFECT

Ethanolic and methanolic extracts of S. nigrum demonstrate significant free radical scavenging effects in DPPH and ABTS assays. This activity is attributed to the presence of bioactive compounds such as phenolics and flavonoids.

Strong antioxidant effects including elevated antioxidant enzymes in the heart and stomach tissues, were demonstrated by methanolic and ethanolic extracts of Solanum nigrum fruits and berries.[2]

2. ANTI INFLAMATORY EFFECT

Methanolic and ethanolic extracts of Solanum nigrum demonstrated robust anti-inflammatory activity in experimental rat models, especially in carrageenan-induced and egg white-induced hind paw edema tests. Doses ranging from 100 to 500 mg/kg showed dose-dependent suppression of inflammation, comparable to standard drugs such as diclofenac sodium and indomethacin. This activity is believed to result from the inhibition of prostaglandin synthesis and suppression of cytokine-mediated inflammatory responses, supported by the presence of bioactive flavonoids and glycoalkaloids in the plant.[2]

3. HEPATO PROTECTIVE ACTIVITY

Solanum nigrum aqueous and methanolic extracts were evaluated for their ability to prevent liver damage caused by carbon tetrachloride (CCl_4). They dramatically reduced the levels of bilirubin and liver enzymes in the blood. Reduced liver lesions were confirmed by histopathological investigations. These findings highlight its potential for hepatoprotection.[2]

4. ANTI CANCER ACTIVITY

Solanum nigrum shows strong anticancer potential in a methanolic extract. MTT assays and the trypan blue dye exclusion method demonstrated a significant cytotoxic effect in a concentration-dependent manner on HeLa (human cervical cancer) cell lines. Reduced cell

viability was also demonstrated by the trypan blue dye exclusion method. Ethanolic extracts showed notable cytotoxicity in brine shrimp lethality assays, with LC_{50} values of 160 µg/ml and 63.10 µg/ml. These findings suggest that S. nigrum may have oncological potential through DNA intercalation, apoptotic induction, or cellular proliferation inhibition.[7]

5. ANTI FUNGAL ACTIVITY

The plant's antifungal efficacy has been assessed using agar diffusion methods. Ethanolic seed extracts show strong activity against fungi such as Penicillium notatum, Aspergillus niger, and Fusarium oxysporum. In comparison, the ethyl acetate root extract shows lower activity (zone of inhibition ~4–4.5 mm).

6. ANTI SEIZURE ACTIVITY

Aqueous leaf extracts demonstrated significant anti-seizure properties in multiple animal models (chicks, mice, rats). The extracts provided dose-dependent protection against seizures induced by electric shock, picrotoxin, and pentylene tetrazole. Activity was potentiated by amphetamine, indicating possible GABAergic or dopaminergic mechanisms.[12]

7. ANTI DIABETIC ACTIVITY

Solanum nigrum exhibits promising antihyperglycemic effects in streptozotocin-induced diabetic rats by enhancing insulin secretion and improving pancreatic β-cell function. Solanum nigrum shows promise in preventing diabetes. In Sprague Dawley rats, aqueous and hydroalcoholic extracts of different plant parts especially the leaves and fruits have shown hypoglycemic action. Similar to the common medication metformin, doses of 200 and 400 mg/kg body weight dramatically lowered blood glucose levels in a dose-dependent manner. There were no noticeable effects from the stem extract.[8]

Additionally, albino rats' blood glucose levels were significantly lowered after receiving an oral ethanolic extract dose of 250 mg/kg body weight for five to seven days. These findings support S. nigrum's potential as a natural anti-diabetic drug, particularly when used consistently.[8]

8. ANTI MICROBIAL ACTIVITY

Extracts of S. nigrum demonstrate broad-spectrum antimicrobial effects against both gram-positive and gram-negative bacterial strains, supporting its role in the treatment of microbial infections(2).Solanum nigrum leaves, seeds, and roots exhibited broad-spectrum antibacterial

and antifungal activity in a variety of extracts (methanol, ethanol, chloroform, ethyl acetate, and water). It works well against both gram-positive and gram-negative bacteria, such as Shigella, Klebsiella pneumoniae, Pseudomonas aeruginosa, E. coli, and Staphylococcus aureus.

Significant antifungal activity was seen against strains of Aspergillus niger, Fusarium, Candida albicans, and Trichophyton. Additionally, extracts suppressed infections associated with plant illnesses and diabetes, indicating broad usefulness.[2]

9. ANTI ANALGESIC ACTIVITY

The plant shows significant dose-dependent analgesic activity in experimental animal models, with effectiveness comparable to standard pain-relieving drugs at higher doses. Its traditional use for pain relief is supported by experimental evidence, and the mechanism is believed to involve both central and peripheral pathways.[13]

Acetic acid-induced writhing in animal models and Eddy's hot plate were used to validate analgesic effects. Significant pain alleviation equivalent to diclofenac sodium was achieved by the ethanolic extract, particularly at 500 mg/kg. This supports its long-standing application in the treatment of inflammation and pain.

10. IMMUNOSTIMULANT ACTIVITY

Solanum nigrum methanol extract markedly increased neutrophil activity, antibody titers, and IgG concentration. Lower death rates were observed in those treated with ethanol and methanol, indicating immunostimulatory qualities that may be helpful in the treatment of infectious illnesses.[13]

11. ANTI-HCV(HEPATITIS C VIRUS) ACTIVITY

S. nigrum seeds and methanol extract exhibited antiviral activity against HCV viruses. The extract inhibits HCV replication by interfering with the expression of NS3 protease, a critical viral enzyme in liver cells. The results also indicated potential synergy with interferon therapy, highlighting S. nigrum as a promising natural antiviral agent.

At non-toxic concentrations, extracts of Solanum nigrum seeds in methanol and chloroform reduced the replication of the Hepatitis C virus (HCV) by more than 50%.[14]

12. ANTI ULCER ACTIVITY

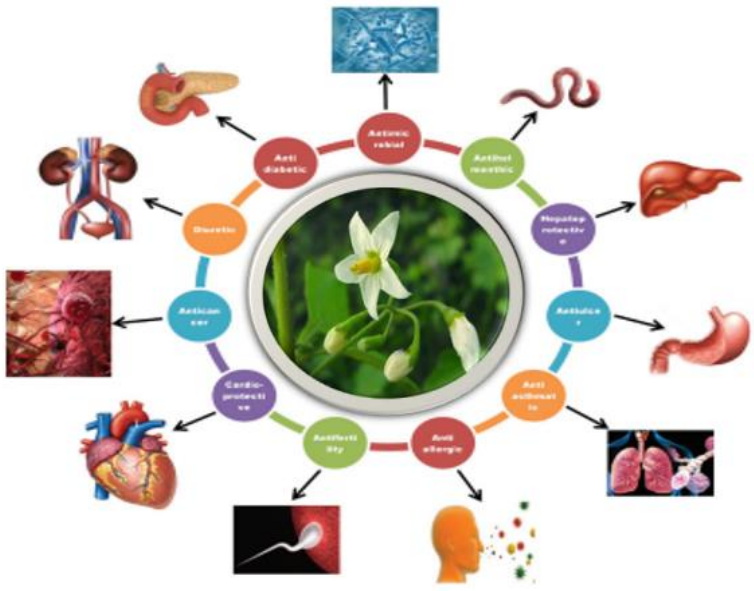
The gastroprotective effects of methanolic berry extracts of S. nigrum were studied in rats subjected to aspirin-induced ulcers. The extract reduced lipid peroxidation and restored antioxidant enzyme levels (e.g., superoxide dismutase, catalase) in gastric tissues. This suggests the role of S. nigrum as a free radical scavenger that protects the gastric mucosa from oxidative injury and supports its use in the management of peptic ulcers[14]. Rats' stomach ulcers caused by aspirin were prevented by the methanolic extract of Solanum nigrum berries. It decreased lipid peroxidation and markedly restored antioxidant enzyme levels.[14]

13. CARDIO PROTECTIVE ACTIVITY

"Methanolic berry extracts were evaluated for cardioprotective effects against in vitro global ischemia-reperfusion injury. Administered at doses of 2.5 mg/kg and 5.0 mg/kg, the extract significantly reduced cardiac tissue damage, as indicated by biochemical markers and histological assessments. Although dose-independent, the cardio-protective activity may be attributed to antioxidant mechanisms and vascular protective effects, indicating potential therapeutic use in cardiac disorders."

14. ANTI DIARRHEAL ACTIVITY

The ethanolic fruit extract increased the latent time and decreased the frequency of defecations in mice with castor oil-induced diarrhea in a dose-dependent manner. These results provide credence to its application in the treatment of gastrointestinal conditions.[14]



ETHANOCLAIM USES

Ethnopharmacological (ethnobotanical/ethnomedicinal) uses of Solanum nigrum (Black Nightshade);

Solanum nigrum has been used traditionally in various cultures for centuries. Its ethnopharmacological uses are based on indigenous knowledge passed down through generations and are still practiced in many rural and tribal communities across Asia, Africa, and Europe. Here is a detailed summary:

1. Liver Disorders

- The plant is traditionally used to treat liver ailments, including jaundice, hepatitis, and general liver inflammation.
- Decoctions of the leaves or whole plant are commonly used.

2. Fever and Infections

- Leaf extracts are given to reduce fever, especially in cases of malarial or typhoid fevers.
- It also exhibits traditional use in treating bacterial and viral infections.

3. Respiratory Ailments

- Used in treating asthma, cough, bronchitis, and sore throat.
- Smoke from dried leaves or infusions made from leaves is inhaled or drunk.

4. Skin Diseases

- Applied topically for eczema, ringworm, psoriasis, ulcers, and insect bites.
- The juice or paste of fresh leaves is used for wound healing and inflammation.

5. Gastrointestinal Disorders

- Traditionally used as a digestive aid, to treat stomach ulcers, constipation, diarrhea, and abdominal pain.
- Leaf decoctions and fruit preparations are used.

6. Anti-inflammatory and Analgesic Uses

- Local communities use Solanum nigrum preparations for body aches, arthritis, and swelling.
- Paste from leaves is applied to painful areas.[15]

7. Diuretic and Kidney Health

- Used as a diuretic to help flush out toxins and aid kidney function.

- Juice or extracts are given in traditional medicine for urinary tract infections and renal problems.

8. Anticancer Folk Uses

- Some tribal healers in India and China use the plant for tumor treatments, especially for oral and abdominal growths.
- However, these uses are still under scientific investigation.

9. Women's Health

- Decoctions are used in the management of menstrual pain, irregular menstruation, and postpartum recovery.
- Also used as a galactagogue (to enhance breast milk production).

10. Antidote and Detoxifier

- Used traditionally as an antidote to snake bites or insect sting.[16]

PHARMACOKINETICS OF SOLANUM NIGIRUM

Pharmacokinetics refers to how a substance is absorbed, distributed, metabolized, and excreted (ADME) in the body. Although Solanum nigrum (Black Nightshade) is a traditional medicinal plant with extensive ethnopharmacological use, detailed pharmacokinetic studies are limited and mainly preclinical. However, some studies and constituent-specific investigations provide useful insights:

1. Absorption

- Solanum nigrum contains glycoalkaloids such as solanine and solamargine, flavonoids, polyphenols, and polysaccharides, which are variably absorbed depending on their structure.
- Glycoalkaloids are known for poor water solubility, which may limit their absorption in the gastrointestinal tract(20).
- Flavonoids and phenolics, especially in ethanol or hydroalcoholic extracts, may be better absorbed due to increased solubility and permeability.

2. Distribution

- Active compounds (especially solanine and solamargine) may bind to plasma proteins and distribute to various tissues.

- Animal studies have shown that these compounds accumulate in the liver, kidneys, and spleen, indicating their preference for organs involved in detoxification and metabolism[20].

3. Metabolism

- The metabolism of Solanum nigrum constituents is largely hepatic (liver-based).
- Solanine and related alkaloids undergo phase I and phase II metabolism, involving oxidation (cytochrome P450 enzymes) followed by conjugation (e.g., glucuronidation).
- Flavonoids and phenolics are metabolized by intestinal and liver enzymes, and their bioactivity may depend on their metabolites, which often retain or enhance therapeutic potential.[21]

4. Excretion

- Excretion is mainly renal (urine) and biliary (feces).
- Glycoalkaloids and polyphenolic metabolites are excreted both unchanged and as conjugated forms.
- Some studies also show enterohepatic recirculation, especially of flavonoids, which can prolong their presence in the system.[21]

CONCLUSION

Solanum nigrum L., commonly referred to as black nightshade or "Makoi," is a significant plant valued for its ethnopharmacological and medicinal applications. This evaluation reveals that the plant has a long-standing history of use as a conventional medicine worldwide, especially in Asia and Africa. It has been utilized for addressing various health concerns, such as liver disorders, allergic reactions, infections, cancer, and diabetes. Its therapeutic effects are ascribed to a variety of phytochemicals, including steroidal glycoalkaloids (like solanine, solamargine, and solasonine), flavonoids (such as catechin and rutin), polyphenolic substances (like chlorogenic and caffeic acid), saponins, tannins, alkaloids, glycoproteins, and polysaccharides. From a pharmacological standpoint, Solanum nigrum has shown multiple bioactivities.

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