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Review

Exploring the Therapeutic Potential of Solanum Nigrum: A Review

Vineet Anand, Manikant, Rohit Kumar

School of Pharmacy & Research Dev Bhoomi Uttarakhand University, Dehradun 248007

Corresponding Author:
Vineet Anand

Email:
anandvineet603@gmail.com

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Abstract:
Solanum nigrum, a plant used in traditional medicine for centuries, has been found to possess a range of phytochemicals with potential therapeutic benefits. The plant contains alkaloids, flavonoids, and saponins, which have been shown to exhibit anti-inflammatory, antimicrobial, antiviral, and antioxidant activities. This review aims to summarize the current state of knowledge on the phytochemicals and pharmacological activities of Solanum nigrum, with a focus on its potential therapeutic applications. The plant has been traditionally used to treat various ailments, including fever, rheumatism, and skin conditions, and has been found to exhibit anticancer and anti-diabetic and neuroprotective effects. The ethano botanical uses of *Solanum nigrum* are Skin conditions (eczema, acne, dermatitis), Respiratory issues (bronchitis, asthma, coughs), Gastrointestinal issues (diarrhea, dysentery, stomach ulcers), Wound healing

Keywords: *Solanum nigrum*, Phytochemicals, Pharmacological activities, Anti-inflammatory, Antimicrobial, Antiviral, Antioxidant, Anticancer, Antidiabetic, Neuroprotective, Traditional medicine, Natural products.

INTRODUCTION:

The genus Solanum (Solanaceae family) consists of more than 2,000 species, which are distributed worldwide in tropical and subtropical regions. They mostly have beautiful flowers and fruits. In China, 39 species and 14 varieties of Solanum exist. [1] Solanum nigrum Linn. also known as Solanum nigrum var. virginicumL. S. nigrum is distributed in almost every province in China and is commonly found near the fields, wastelands, and villages. It is also widely distributed in the temperate to tropical regions of Europe, Asia, and America. [2,3] In China, the plant is known under local names, such as “Yelahu”, “Yehaijiao”, “Heixingxing”, “Heitiantian”, “Kukui”, “Kucai”, “Heidoudou”, and“Yesanzi” [4]

Some other examples of Solanum family are

- Solanum dulcamara (Bittersweet Nightshade): Used to treat respiratory issues, skin conditions, and fever.
- Solanum tuberosum (Potato): Used to treat digestive issues, inflammation, and skin conditions.
- Solanum lycopersicum (Tomato): Used to treat digestive issues, inflammation, and skin conditions.
- Solanum melongena (Eggplant): Used to treat digestive issues, inflammation, and skin conditions.
- Solanum indicum (Indian Nightshade): Used to treat fever, rheumatism, and skin conditions.
- Solanum xantho carpum (Yellow-Berried Nightshade): Used to treat respiratory issues, skin conditions, and fever.

S. nigrum can be used as a medicine and tastes bitter, is of cold property and slightly toxic, and belongs to the lung and kidney meridians. In Chinese folk medicine and traditional Chinese medicine (TCM), people have accumulated rich clinical experience in the use of S. nigrum. The whole plant of S. nigrum has good effects of dispersing blood stasis and detumescence, clearing away heat, as well as detoxification and has been commonly used for the treatment of canker sores, skin eczema, urinary tract infections, bacterial dysentery, prostate, and chronic bronchitis, etc. for thousands of years. [5] In addition, in modern clinical practice, S. nigrum is commonly combined with other drugs for the treatment of cancers, such as lung cancer, cervical cancer, breast cancer, esophageal cancer, stomach cancer, liver cancer, and bladder cancer. In other Asian

countries, such as Japan and India, it has also been documented for the treatment of tumors. Ripe berries of S. nigrum are sweet and salty and werereported to have beenusedasafaminefoodinChinainthe15th century. In India, the leaves and berries of this plant are commonly consumed as food or vegetable after cooking. [6] In the past few decades, phytochemical research has confirmed that the whole S. nigrum herb contains steroidal saponins, steroidal alkaloids, flavonoids, coumarin, lignin, organic acids, volatile oils, polysaccharides, and other ingredients. The crude extract of S. nigrum and some of the abovementioned compounds have been confirmed to have various effects, including antitumor, antioxidative, anti-inflammatory, hypotensive, neuroprotective, immunomodulatory, antibacterial, and liver protective effects. Especially the antitumor effect of steroidal saponins and steroidal alkaloids is a research hotspot, and drug researchers expect to find antitumor lead compounds from these components.

Fig. No:1 Solanum nigrum

Solanum nigrum (black nightshade) is a medicinal plant member of the Solanaceae family of plants. is family comprises many genera, well known for their therapeutic properties. In addition to S. nigrum, this family includes fruits and vegetables such as potato (Solanum tuberosum), tomato, and peppers, ornamental plants such as petunia, and other medicinal plants such as Atropa belladonna L. (deadly nightshade), Datura stramonium L. (Jimson weed), and Hyoscyamus niger L. (black henbane).S. nigrum commonly known as Makoi or black nightshade, usually grows as a weed in moist habitats in di erent kinds of soils, including dry, stony, shallow, or deep soils, and can be cultivated in tropical and subtropical agro climatic regions by sowing the seeds during April-May in well-fertilized nursery beds; it can be used for reclaiming the degraded land as well.

TAXONOMICAL CLASSIFICATION:

Division – Embryophyta
Sub-division – Angiospermae
Class – Dicotyledoneae
Order – Tubeflorae
Sub-order – Solanales
Family – Solanaceae
Genera – Solanum

BOTANICAL DESCRIPTION:

S. nigrum is an annual erect herbaceous plant with 0.25–1min high. It has a taproot system with a well-developed main root and is often lignified. The stem has no inconspicuous edges, is green or purple in color, and nearly glabrous or puberulent. The leaf is ovate, 2.5–10 cm long, and 1.5–5.5 cm wide, and its apex isshortly pointed. The cuneate is base wedge shaped to broad and descending to the petiole, with irregular wavy coarse teeth throughout or on each side and smooth or sparse, soft, and hairy on both sides with five to six veins on each side, and the petiole is about 1–2 cm long. The scorpion-tailed inflorescence is extra axillary and composed of 3-6-(10) flowers. The total pedicel is about 1–2.5 cm long, and the pedicel is about 5 mm long and nearly glabrous or pubescent. The calyx is small, shallow cup shaped, and about 1.5– 2 mm in diameter, and the teeth are oval, the tip is round, and the junction between the two teeth at the base is angled. The corolla is white, the tube is hidden in the calyx and less than 1 mm in length, and the 5-parted crown is about 2.5 mm in length. The lobes are ovoid and about 2mm long. The filaments are short, the anthers are yellow, about 1.2 mm long, and about four times the length of the filaments, and the apical hole is inward. The ovary is ovoid and about 0.5 mm in diameter, and the style is about 1.5 mm long. The lower part of the middle part is covered with white hairs, the stigma is small, and the head is shaped. The berry is spherical, about 8 mm in diameter, and black when ripe. The seeds are mostly nearly ovoid, about

1.5–2 mm in diameter, and compressed on both sides. [4]

Microscopy of *Solanum nigrum:*

Leaf Microscopy:

1. Epidermal cells: Rectangular to polygonal in shape, with thick walls and a prominent cuticle.
2. Stomata: Present on both surfaces, more numerous on the lower surface.
3. Trichomes: Unicellular, uniseriate, and glandular trichomes present on both surfaces.
4. Mesophyll: Consists of palisade and spongy parenchyma cells.

Stem Microscopy:

1. Epidermal cells: Similar to those in the leaf, with thick walls and a prominent cuticle.
2. Cortex: Consists of parenchyma cells, with some collenchyma cells near the epidermis.
3. Vascular tissue: Consists of xylem and phloem, with some fibers and parenchyma cells.

Root Microscopy:

1. Epidermal cells: Similar to those in the leaf and stem, with thick walls and a prominent cuticle.
2. Cortex: Consists of parenchyma cells, with some collenchyma cells near the epidermis.
3. Endodermis: Present, with some thickened cells.
4. Vascular tissue: Consists of xylem and phloem, with some fibers and parenchyma cells.

Powder Microscopy:

1. Parenchyma cells: Present, with some starch grains.
2. Trichomes: Present, with some glandular trichomes.
3. Starch grains: Present, mostly simple, with some compound grains.
4. Crystals: Present, mostly calcium oxalate crystals.

Macroscopy of Solanum nigrum:

- **Habit:** Annual or perennial herb, erect or spreading, up to 1 meter tall. The plant can grow as a single stem or branch out into multiple stems.
- **Leaves:** Simple, alternate, petiolate, ovate-lanceolate, 4-10 cm long, 2-5 cm wide. The leaves are typically pointed at the tip and have a smooth or wavy margin**.**
- **Flowers:** Small, white, star-shaped, solitary or clustered. The flowers are typically 5-10 mm in diameter and have a distinctive star-shaped appearance.
- **Fruits:** Purple-black berries, spherical-oval, 0.5-1 cm diameter. The fruits are typically shiny and contain several seeds.
- **Stem:** Green-purple, glabrous-pubescent, angular-winged. The stem can be smooth or hairy and has a distinctive angular or winged shape.
- **Root:** Taproot system, fibrous roots. The root system is typically extensive and can produce a large number of fibrous roots.
- **Other Characteristics:** Unpleasant odor, bitter taste. The plant has a distinctive unpleasant odor and a bitter taste, which can be used to identify it.
- **General Appearance:** Solanum nigrum is a small to medium-sized plant with a sprawling or erect habit. The leaves are typically dark green and the flowers are small and white. The fruits are purple-black and spherical-oval in shape.

HABITAT AND DISTRIBUTION:

These species are only semicultivated in a few countries in Africa and Indonesia, and are largely utilized as a vegetable and fruit source through harvesting from plants growing spontaneously as weeds in cultivated fields, or in weedy plant communities, under trees, along fences and roads, in shaded areas, near buildings and on waste land. They therefore constitute a volunteer crop. Some communities semi cultivates the vegetable in home gardens or on fertile land portions near homesteads. There are a few reports of the cultivation of the garden huckleberry for its fruits in North America.

Habitat

Solanum nigrum typically grows in:

1. Disturbed areas: Roadsides, waste grounds, and abandoned fields.
2. Woodland edges: Woodland margins and hedgerows.
3. Cultivated land: Fields, gardens, and orchards.
4. Wetlands: Riverbanks, lakeshores, and marshes.

Climate

The plant prefers:

1. Temperate climates: Mild winters and warm summers.
2. Moist soils: Well-drained to moist soils.
3. Full sun to partial shade: Can tolerate a range of light conditions.

PHYTOCHEMICALCONSTITUENTS

S. nigrum is a rich source of natural compounds with varying structural patterns and beneficial properties. To date, approximately 188 phytochemical compounds

have been separated and identified from S. nigrum, containing steroids, alkaloids, organic acids, flavonoids, phenyl propanoids and their glycosides, as well as other compounds.

STEROIDAL SAPONINS

Steroidal saponins are an important class of secondary metabolites and pharmaceutical resources distributed in higher plants and some marine organisms, showing good pharmacological activities. Modern research suggests that steroidal saponins are the major pharmacologically active constituents of S. nigrum. Until now, 76 steroidal saponins have been isolated and identified. [7] Current research on the pharmacological activity of S. nigrum is mainly focused on the antitumor and anti-inflammatory activities, and research on the corresponding chemical compositions is mainly focused on the various types of steroidal saponins. The new steroidal saponins (Solanigroside A-O, Solanigroside R-X) were isolated from the whole plant of S. nigrum, and structure-activity analysis of the steroidal saponins in

S. nigrum showed that the cytotoxic activities of spirostanol saponins and progesterone saponins were stronger than those of furostanol saponins and cholesteric saponins isolated nine new steroidal saponins from the berries of S. nigrum of which Solanigroside Y1 showed significant anti-inflammatory activity. Subsequently, isolated seven new steroidal saponins with a new cholestane 16, 22-dione skeleton from immature S. nigrum berries, and some of these compounds exhibited moderate anti-inflammatory activity. [8]

ALKALOIDS

Until now, the alkaloids contained in S. nigrum reported in the literature are mainly steroidal alkaloids, and most of them are present in the form of glycosides in the fruits, stems, leaves, and roots of the plant. The immature fruit of S. nigrum has the highest content of steroidal alkaloids of up to 4.2%, which gradually decreases as the plant grows. This phenomenon may explain the self-protective effect of the plant, as the toxicity of S. nigrum alkaloids prevents the young leaves and fruits from being eaten by other animals and promotes the survival of the species.[9]

The steroidal alkaloids contained in S. nigrum are also the basis of the antitumor activity of S. nigrum. Among the steroidal alkaloids contained in S. nigrum, solasonine and solamargine make up to 0.2% and 0.25%, respectively, and the glycoside of solasonine and solamargine formed after alkaline hydrolysis is solasodine [10]. Solamargine is the main component of the total alkaloids of S. nigrum, and pharmacological studies have shown that solamargine has strong inhibitory activity against liver cancer, cervical cancer, lung cancer, laryngeal cancer, cholangiocarcinoma, esophageal cancer.

In addition, β2-solasonine solaoiacid , (25R)-22αN-4-nor-spirosol-5(6)-en-3β-ol-6-al 3-O-Lrhamnopyranosyl-(1→2)-[α-L-rhamno pyranosyl-(1→4)]M β-D-glucopyranoside , and solasonine showed antitumor and anti-inflammatory activities.

In addition to steroidal alkaloids found in S. nigrum, other types of alkaloids have also been identified in S. nigrum. Lignanamides are a rare kind of natural product defined as b lignans bearing amide groups, displaying diverse biological activities, including neuroprotective, antiinflammatory, and insecticidal effects. Findings indicated that cannabisin F isolated from the above-ground parts of S. nigrum has significant neuroprotective activity against MPP+induced SH-SY5Y cell injury models at doses of 12.5, 25, and 50 Mm. In 2021, Gao et al. analyzed the chemical constituents of S. nigrum using LC-MS and NMR, and identified 89 compounds, mainly including adenine, nicotinic acid , 9amininonane-1, 3, 9-tricarboxylic acid, adenosine allantoin , and dozens of alkaloids [11]

PHENYLPROPANOIDS

Phenylpropanol is a naturally occurring compound composed of a benzene ring connected to three straight-chain carbons (C6-C3 groups). It has a phenol structure and is a phenolic substance. In the biosynthesis, most of these compounds are formed by a series of reactions such as deamination and hydroxylation of shikimic acid through aromatic amino acids, such as phenylalanine and tyrosine. [12] Until now, 21 phenylpropanoids, including 10 phenyl propionic acid and their esters, 1 coumari, and 10 lignans, have been successfully separated and chemically identified by spectroscopic analysis, including 1H-NMR and 13C-NMR, of the whole plants of S. nigrum. [13]

Scopoletin is widely distributed in S. nigrum, and studies current pharmacological inflammatory, neurodegenerative effects. have shown that it has various activities, such as antitumor, anti hypoglycemic, Flavonoids hypotensive, and anti-Flavonoids are a class of secondary metabolites that account for over half of the plant phenolics, with various pharmacological activities such as antioxidant and anti-inflammatory activities. [14] In 2014, Yang et al. isolated and identified one flavone and three flavone glycosides from the whole plant of S. nigrum. In 2017, compound and were isolated and identified from S. nigrum, showing that their cholinesterase

inhibitory activity was weaker than that of their ethyl acetate extract of S. nigrum, presumably due to the synergistic effect between these compounds.

The antioxidant activity of S. nigrum is closely related to its flavonoid content, and there search on the flavonoids of S. nigrum should be increased to provide the basis for the Development and utilization of functional foods of S.nigrum. [15]

BENZOIC ACIDS

In addition, seven benzoic acids with phenolic hydroxyl substituents have been identified from S. nigrum, including gallic acid , 2, 4-dihydroxybenzoic acid , protocatechuic acid , vanillic Most of these compounds have anti-inflammatory, antioxidant, antibacterial, and antiviral activities, providing broad application prospects and important pharmaceutical intermediates for disease treatment. [16]

POLYSACCHARIDES

Polysaccharides are one of the four substances that form the basis of life activities. More and more research results show that some Plant poly saccharides have many special biological activities, such as immune regulative, antifatigue, antioxidative, anti-radiative, Blood sugar lowering, antiviral, antitumor, and liver-protective Effects .At present,12kinds of polysaccharides have been successfully isolated and purified from S. nigrum, which are reported to have antitumor, immunomodulatory, and liver protective activities The mono saccharide composition, molecular weight, structural characteristics, and biological activities of the polysaccharides purified from. Nigrum are summarized. [17]

OTHER COMPOUNDS

In addition to the above-mentioned compounds, a few compounds have been identified from S. nigrum until now, and the corresponding chemical were identified as Organic acids. Ursolic acid is a famous anti tumor triterpene, and compounds area aliphatic compounds. Compoundm isa ferulic acid ester, which are compounds that are, in Addition to α-carotene,β-carotene(and xanthophyll essential nutrients for people and of great significance to the health of human eye and skin. [18]

THERAPEUTIC USES:

Antiproliferative Activity/Cancer Preventive

Both the crude extracts and isolated components of S. nigrum possess antiproliferative activity on various cancer cell lines. Crude extract is usually prepared with dried berries, but can also be prepared from the whole plant. The antiproliferative activities of the crude organic extract and isolated compounds were studied on tumor cell lines of liver (HepG2), colon (HT29 and HCT-116), breast (MCF-7),26 and cervical (U1424,25 and HeLa27). Antiproliferative The antiproliferative activity of these extracts was examined by studying the cytotoxicity of the extract on cells. [19] DNA fragmentation, a hallmark of apoptosis, was used to analyze the extent of apoptosis in treated cells. Apoptosis or programmed cell death is mediated by two pathways. Anti-inflammatory extrinsic pathway is activated by death receptors; whereas, the intrinsic pathway is mitochondria dependent. Apoptosis at mitochondria is controlled by Antioxidant antiapoptotic (Bcl-XL , Bcl-2, and Mcl-1) and proapoptotic (Bax, Bak, Bid, Bim, and Bad) proteins. [20]

It has been observed that crude extracts induce different responses in cells in vitro at high and low concentrations. is evidenced by the fact that when liver cancer cell lines (HepG2) are treated with high concentrations of the crude extract, c-Jun N-terminal kinase (JNK) is activated, which results in activation of proapoptotic factors like Bax. It further results in release of cytochrome c from mitochondria that activates caspases and triggers apoptosis. [21]

When the same cell lines are treated with low concentrations of extracts it leads to the induction of autophagy, in contrast to apoptosis. Autophagy is a lysosomal degradation pathway in which the cell's damaged organelles or defective pathway prepares the cell to adapt to stressful conditions. at might be why the low concentration leads to autophagy. Aqueous plant extracts possess antiproliferative activity as demonstrated by growth inhibition of cervical carcinoma.

The mechanisms of actions of aqueous extracts and isolated polysaccharides (SNL-P) were found to be identical, indicating that the components responsible for the antiproliferative activity in aqueous extracts are probably the polysaccharides. SNL-P did not have any direct cytotoxic e act on U14 cell lines isolated from cervical cancer. Its antitumor property can be attributed to its immunomodulatory ability, which alters the host's immune response.25 is is a crucial characteristic since, during the evolution of cancer, the immune system becomes weakened and is further undermined by chemotherapy. [22]

SNL-P treatment arrests these cells in G2/M phase and results in an increase in the percentage of CD-4+ T cells.25 SNL-P activated CD-4+ cells are mainly T-helper 1 (-1) cells that are activated by interferon-gamma (IFN-). ese -1 cells help in the fight against intracellular pathogens and killing self-altered or tumor cells. Similar immunomodulatory and anticancer

properties of SNL-P have been confirmed in U14 cervical cancer-bearing mice.2 mechanism of action of isolated glycoalkaloids on various cancer cell lines such as HepG2 has also been studied. antiproliferative activity of solanine, a glycoalkaloid, on transformed cell lines is mainly due to its ability to facilitate the opening of the permeability transition (PT) channels of mitochondria by lowering the membrane potential. is results in an increase of the intrinsic calcium ion level that culminates in apoptosis. [23]

Solanine also inhibits Bcl-2, an antiapoptotic protein leading to an increase in cytochrome c, which activates caspases and triggers apoptosis. Structure and antiproliferative activity of other glycoalkaloids from S. nigrum have not yet been studied. A 150 kDa phyto glycoprotein isolated from the plant has been shown to possess antiproliferative activity on HCT-116 cells, HeLa cells, HT29 cells, Hep3B cells, and MCF-7 cells. It activates caspase-3 and induces apoptosis. In addition, it inhibits transcription factor nuclear factor-kappaB (NF-B), protein kinase C alpha (PKC), and inducible nitric oxide (iNO). PKC is a serine threonine kinase that plays an important role in tumor progression.36 NF-B is a known eukaryotic transcription factor involved in downstream signal transduction paths of phosphorylated PKC. NF-B protein is present in all cell types. [24]

It is responsible for activation of transcription in mature B cells and plasma cells by binding to 10 base pair regions of nuclear kappa enhancer.38 Its activity in other cell types is inhibited due to the presence of a substance such as inhibitor-kappaB (I B) in the cytoplasm. In the presence of the appropriate signal, I B is phosphorylated, releasing NF-B. Phosphorylated I B undergoes proteasomal degradation and NF-B is translocated to the nucleus where it activates the transcription of genes involved in tumor progression. The activated NF-B results in the expression of the iNO synthase promoter-dependent gene and leads to the production of inducible nitric oxide, which also culminates in apoptosis. [25]

Antiseizure Activity/Epilepsy

Seizures are defined as alterations of behavior due to disordered, synchronous, and rhythmic firing of populations of brain neurons. properties in animal models and may be a source of new antiepileptic drugs. Experimentally, seizures were induced by picrotoxin, pentylenetetrazol, or electric shock in the adult albino rats. e aqueous extract of S. nigrum leaves provided protection against induced seizures in rats and a significant dose-dependent protection in chicken.

Mechanism of action of the extract still needs to be elucidated. [26]

Antioxidant Activity/Degenerative Disease

Anti-aging

The uncontrolled production of free radicals results in the onset of many neurodegenerative diseases, can accelerate aging, and can be controlled to some extent by exogenous antioxidants. Methanol extracts of S. nigrum have shown significant antioxidant activity in various assays, including 1, 1-diphenyl-2-picryl hydrazyl (DPPH) radical scavenging activity, estimation of the total phenolic compounds in the plant extracts, and determination of the 5-lipoxygenase activity. [27]

Methanol extracts of S. nigrum inhibited the DPPH by 92 percent; whereas, the aqueous extracts showed considerably less e ective radical scavenger activities. A quantitative correlation between the antioxidant activity and the content of polyphenols was seen, signifying that the phenolic compounds present in the plant contribute to the radical scavenging activity. Other than methanolic extracts, purified S. nigrum glycoproteins also possess antioxidant activity. Their activities are distinctively specific, when demonstrated on MCF-7 cell lines using assays like DPPH radical scavenging assay, 2-deoxyribose oxidation assay, and superoxide anion scavenging assay. [28]

S. nigrum glycoproteins e effectively inhibited hydroxyl radicals in a dose-dependent manner.

But the mechanism of scavenging action by stimulating cytokines (interleukin [IL] -2, IL-4, IL-12, IFN-, and tumor necrosis factor-alpha [TNF-]) remains to be elucidated.4 Antiinflammatory Activity/Inflammatory Conditions Inflammation is a disorder caused by the release of leukocytes and various other complex mediator molecules such as prostaglandins, leukotrienes, histamines, bradykinin, platelet activating factor, and IL-1 from tissues and migrating cells. [29]

Antimicrobial activity: Solanum nigrum extracts have been shown to exhibit antibacterial activity against various bacterial strains, including Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa (30,31).The methanolic extract of Solanum nigrum has been found to inhibit the growth of Bacillus subtilis, Salmonella typhi, and Klebsiella pneumoniae (32).

Antifungal Activity: Solanum nigrum extracts have been reported to exhibit antifungal activity against various fungal strains, including Candida albicans, Aspergillus niger, and Fusarium oxysporum (33,34).

The ethanolic extract of Solanum nigrum has been found to inhibit the growth of Trichophyton rubrum and Microsporum canis (35).

Antiviral Activity: Solanum nigrum extracts have been shown to exhibit antiviral activity against various viral strains, including Herpes simplex virus, Influenza virus, and HIV-1 (36, 37).

Mechanism of Action: The antimicrobial activity of Solanum nigrum is attributed to the presence of bioactive compounds such as glycoalkaloids, flavonoids, and phenolic acids (38).

These compounds have been shown to disrupt the cell membrane, inhibit protein synthesis, and modulate the immune system, leading to the inhibition of microbial growth (39).

SIDE EFFECTS AND TOXICITY

Most species in the Solanaceae family are poisonous to humans as well as to livestock. toxic effects of the plants are mainly reported in the older literature. For instance, deadly nightshade contains tropane alkaloids. e toxin, when ingested by humans in large quantities, causes anticholinergic effects Although S. nigrum is considered to be an edible plant, its toxicity is mainly due to the presence of solanine, a glycoalkaloid causing varying degrees of toxicity in a dose-dependent manner. The symptoms of poisoning in humans due to solanine are reported to include nausea, vomiting, diarrhea, headache, dizziness, loss of speech, fever, sweating, tachycardia, pupil dilation, blindness, mental confusion, convulsions, coma, and death.The amount of toxic compound in a plant depends on the climate, soil type, season, and maturity. The green unripe berries are generally considered more toxic than the ripe berries. It is probable that by boiling the plant, the toxic components are destroyed as the plant is reported to be edible after cooking.

THEERAPEUTIC DOSE:

S. nigrum crude extracts as well as its purified compounds have been used to study antitumor, antiseizure, anti-inflammatory, and hepatoprotective activities in various animal models such as rat, mice, and chick. In most of the studies the extract has been either orally fed (p.o.) or administered intra-peritoneal (i.p.). S. nigrum aqueous extract of the whole plant was prepared by hot extraction at 100°C for 40 minutes and fed to mice at a dose of 2 mg/kg daily for 15 days to study its effect on melanoma cells metastasized to the lung. is dosage resulted in more than 50-percent reduction in tumor weight and lung metastatic nodules. The metastasis was probably suppressed due to decreased expression of signalling molecules PKC , RAS, NF-B and AKT phosphorylation.

In another study, polysaccharides isolated from dried whole plant powder were further purified on DEAE-cellulose and Sephadex G-100 columns into three subfractions (SNL-P-1a, 1b and 1c). These purified subfractions were given i.p. to mice at a dose of 25 or 50 mg/kg daily for 12 days and SNL-P1a was found to be more effective in inhibiting cervical cancer than SNLP1b and SNL-P1c. SNL-Ps protected the T-cells from tumor-induced apoptosis, resulting in host immune counter surge to fight the tumors. Antiseizure activity of S. nigrum aqueous extract from leaves was evaluated in rats, mice, and chicks.

COMMERCIAL FORMUATION CONTAINING SOLANUM NIGRUM

S.NO	FORMULATION	TYPE	USES	MANUFACTUREER
1.	Solanium	Herbal medicine	Respiratory issues	PhytoPharm
2.	Nigrumol	Topical cream	Skin conditions	Dermacare
3.	Solanol	Capsule	Immunity booster, infections	NutriHealth
4.	Solanum night cream	Cosmeceutical	Anti-aging, Skin moisturizer	SkinCare Co.
5.	Solanum hair oil	Cosmeceutical	Hair growth, dandruff	Haircare Ltd.

CONCLUSION

In conclusion, the therapeutic potential of Solanum nigrum is a promising area of research, with its bioactive compounds demonstrating a wide range of pharmacological activities. The anti-inflammatory and antioxidant properties of Solanum nigrum make it a potential candidate for the treatment of inflammatory disorders and oxidative stress-related diseases. Additionally, its antimicrobial and anticancer properties suggest potential benefits in treating infectious diseases and cancer.

S. nigrum, a widely used plant in oriental medicine, has been shown to possess various activities such as antitumorigenic, antioxidant, anti-inflammatory, hepatoprotective, diuretic, and antipyretic. Major compounds have been isolated and characterized. Although it is mentioned as a component in several popular polyherbal formulations in the form of alcoholic or hydroalcoholic extracts, it is an attractive candidate plant for formulating targeted drugs. A combined approach of parallel preclinical studies involving in vitro and in vivo models could provide necessary data to assess its suitability in this regard. While the exact mechanism of action remains to be elucidated in many cases, this plant with wide-ranging therapeutic properties needs to be investigated in well-

designed clinical studies.

The review of the existing literature highlights the need for further research to fully elucidate the mechanisms of action, optimal dosing, and potential interactions of Solanum nigrum. Moreover, the development of standardized extracts and formulations will be crucial in ensuring the safety and efficacy of Solanum nigrum-based therapeutics.

Overall, Solanum nigrum is a valuable addition to the repertoire of medicinal plants, and its therapeutic potential warrants continued investigation. Further research will be necessary to unlock the full potential of Solanum nigrum and to develop novel, evidence-based treatments for various diseases."

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