

Evaluation of food products with integrated *Solanum nigrum*: A review

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Abstract

Solanum nigrum is a plant that belongs to the *Solanaceae* family. It is also known by the popular names Makoi and Black nightshade. *Solanum nigrum* contain different chemical components like, glycoproteins, Glycoalkaloids, polysaccharides, and polyphenolic chemicals like caffeic acid, epicatechin, rutin, gallic acid, catechin and protocatechuic acid. *Solanum nigrum* is well recognised to have a variety of therapeutic properties, like antibacterial, antifungal, anti-inflammatory, anticancer, and anti-oxidant activity. However, black-colored fruits are not used since they are harmful and not used for medical purposes. The root, complete plant, and leaves of this plant all have diverse characteristics. Food is made from fruits that have a reddish brown appearance. The study might come to the conclusion that *Solanum nigrum* berries and leaves both contain a sizable amount of nutrients and could be used as ingredients in different food preparation.

Keywords: *Solanum nigrum*, Medicinal, Antimicrobial activity, Anticancer activity, Chemical compounds, Food products, Nutritional Profile.

INTRODUCTION

A member of the Solanaceae family, *Solanum nigrum* (black nightshade) is used medicinally in different parts of the world. It is a species of *Solanum nigrum* and is frequently referred to as Makai, or black nightshade. Despite having its origins in Eurasia, individuals from America, Australia, and South Africa brought it to those regions. But it was discovered there at first. It is also accessible to countries like Colombia, India, Afghanistan, Bangladesh, Bhutan, Bangladesh, Indonesia, Iraq, Iran, Japan, Pakistan, Europe, North America, and South America. Additionally, in Himachal Pradesh, Uttar Pradesh, Uttarakhand, Tamil Nadu, and other locations in India it is cultivated. It spreads like a weed when used with horticulture supplies. Even without biological matter, it has a high mineral content, plenty of water, and is fertile.

Solanum nigrum can be grown in tropical and sub-tropical agro climatic zones by spreading seeds in well-fertilized nursery beds in April or May. It thrives as a weed in damp environments with a variety of soil types, including dry, rocky, or shallow soils (Kiran et al. 2009). It usually flourishes in soil that contains a lot of nitrogen. The pH range *Solanum nigrum* favors is 5.5 to 6.5. This plant has a height range of 25 to 100 centimeters. It is a perennial plant with hairs that resemble pubescence. It is recognizable by its pubescent stems and thin, pale-yellow bark. These are the qualities that it possesses.

S.nigrum is traditionally used in various systems of medicines for fever, pain, inflammation. The plant is also utilized in traditional Chinese medicines for a wide range of functions, including antitumorigenic, antioxidant, anti-inflammatory, hepatoprotective, diuretic, and antipyretic agents. *S.nigrum* has various constituents that are responsible for various activities. The major active compounds that *S.nigrum* contains are glycoalkaloids, glycoproteins, and polysaccharides. *Solanum nigrum* is used in various traditional purposes in different parts of India. As a result, it is frequently used as a tonic or supplement in Indian Ayurvedic medicine to treat and prevent metabolic diseases.

S.nigrum contains protein, vitamins, and minerals, as well as a number of natural bioactive substances such as steroidal lactones, glycosides, alkaloids, and flavonoids; it has a wide spectrum of medical potential. Around 80% of the world's marginal communities use medicinal herbs, which are important in delivering primary healthcare to rural residents. Since many modern medications are derived from these plants, they have been crucial to the growth of human civilization. Hence,

In light of the aforementioned research findings, the current inquiry has been carried out to evaluate the nutritional profile and food product development combining powdered *Solanum nigrum* leaf and berry.

Plant Profile

Nature provides pharmaceuticals in the form of herbs, plants, and algae that can be used to treat incurable diseases with no bad side effects. Because of a variety of factors, the study of plants for therapeutic reasons is an important component of pharmacological research in India.

Solanum nigrum has been used for many years to cure a number of illnesses, including fever, inflammation, and discomfort. According to Nyeem et al. (2017), *Solanum nigrum* plant is utilised for a variety of activities, including anticancer, antioxidant, anti-inflammatory, hepatoprotective, diuretic, and antipyretic compounds. Alkaloids, flavonoids, carbohydrates, glycosides, phytosterols, fixed oil and lipids, proteins, phenolic compounds, tannins, and saponins are only a few of the chemical components found in *Solanum nigrum* (Jain et al. 2011).

- The dried, entire plant of the *Solanum nigrum* Linn species is the source of *Solanum nigrum* biological origin.
- *Solanum nigrum* Linn belongs to the *Solanaceae* family.
- **Taxonomy of *Solanum Nigrum* (Figure 1)**

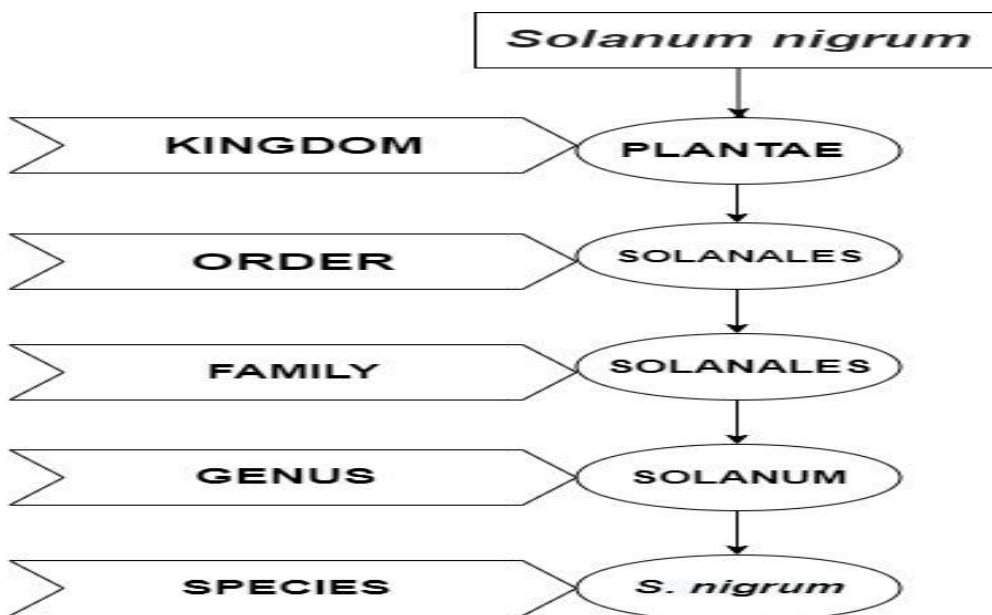


Figure 1: Shows the Taxonomy of Solanum Nigrum

Geographical Distribution

The global distribution of *S. nigrum* suggests that at least one component of the complex is present in every country, from Finland in the northern hemisphere to New Zealand in the southern hemisphere. Despite coming from Eurasia, it was brought by people to America, Australia, and South Africa. But there is where it was initially found; A number of other nations, including India, Afghanistan, Bangladesh, Bhutan, Indonesia, Iraq, Iran, Japan, Pakistan, Europe, North America, and South America also sell it (Mandal et al. 2023). Brazil, Peru, Colombia and several nations are all included. Many regions of India, including Uttar Pradesh, Uttarakhand, Himachal Pradesh, and Tamil Naidu.

Active compounds

Natural compounds with a wide range of structural patterns and advantageous qualities can be found in *S. nigrum*. These phytochemicals have led to the discovery of about 188 new compounds so far. The active ingredients include steroids, alkaloids, flavonoids, phenylpropanoids, organic acids, and glycosides (Figure 2).

Steroidal Saponins

Higher plants contain steroidal saponins, a type of secondary metabolite and therapeutic resource with potential pharmacological characteristics. Numerous investigations also indicate that steroidal saponins are the main pharmacologically active elements of *S. Nigrum* (Chen et al., 2022). The extraction and identification of 76 steroidal saponins to date. One of the nine steroidal saponins that were discovered was Solanigroside Y1, which was derived from the berries of *S. nigrum* and showed strong anti-inflammatory properties (Wang et al. 2017).

Alkaloids

The alkaloids found in *S. nigrum* that have been shown in studies consist mainly of steroidal alkaloids. The steroidal alkaloids found in *S. nigrum* serve as the foundation of its anticancer activity. Solamargine, the primary component of *S. nigrum* total alkaloids, has been shown in pharmacological trials to have high inhibitory effectiveness towards liver cancer, cervical cancer, lung cancer, laryngeal cancer, cholangiocarcinoma, and esophageal cancer.

Phenylpropanoids

In some plants, phenylpropanoids (also known as cinnamic acids) are relatively simple secondary metabolites generated via the shikimic acid pathway via phenylalanine and tyrosine. It is a compound of three straight carbons connected to a benzene ring. Scopoletin which is one of the compounds isolated and identified is extensively distributed in *S. nigrum*, and recent research has revealed that it has anticancer, anti-inflammatory, hypoglycaemic, hypertensive, and anti-neurodegenerative properties (Chu et al., 2019).

Flavonoids

They are a type of low-molecular-weight phenolic chemical found across the plant kingdom. Flavonoids are a kind of secondary metabolite which accounts for more than half of plant phenolics and has a variety of pharmacological activity including antioxidant and anti-inflammatory properties. Two compounds were isolated and identified from *S. nigrum* in 2017, demonstrating that they have cholinesterase inhibitory action (Sabudak et al., 2017).

Benzoic acid

The most fundamental carboxylic acid derived from benzene is benzoic acid. Seven benzoic acids with phenolic hydroxyl substituents have been isolated from *S. nigrum*. The acids included salicylic acid, vanillic acid, 4-hydroxybenzoic acid, gallic acid, 2, 4-dihydroxybenzoic acid, protocatechuic acid, and 2, 5-dihydroxybenzoic acid. Most of these substances have anti-inflammatory, antioxidant, antibacterial, and antiviral characteristics that make them valuable as pharmaceutical intermediates in the treatment of disease (Gao et al., 2021).

Polysaccharides

They consist of multiple smaller monosaccharide and are made up of lengthy chains of carbohydrates. They are a fundamental part of life. Plant polysaccharides compromise various important biological activities such as antifatigue, antioxidative, antiradiative, blood sugar-lowering, antiviral, anticancer, and liver-protective properties. Polysaccharides extracted from *S. nigrum* have been reported to exhibit anticancer, immunomodulatory, and liver protective properties. And there are 12 kinds of polysaccharides that are purified till now from the plant (Yao et al., 2020).

Therapeutic Properties

Numerous investigations conducted over the last few decades have documented the pharmacological effects of *Solanum nigrum*. *S. nigrum* various active compounds have showed a wide range of pharmacological activities, including anti-tumor, anti-inflammatory, antibacterial, antifungal, anti-cancer, anti-oxidant, anti-diabetic, hepatoprotective, and anti-allergic effects. (Figure 3)

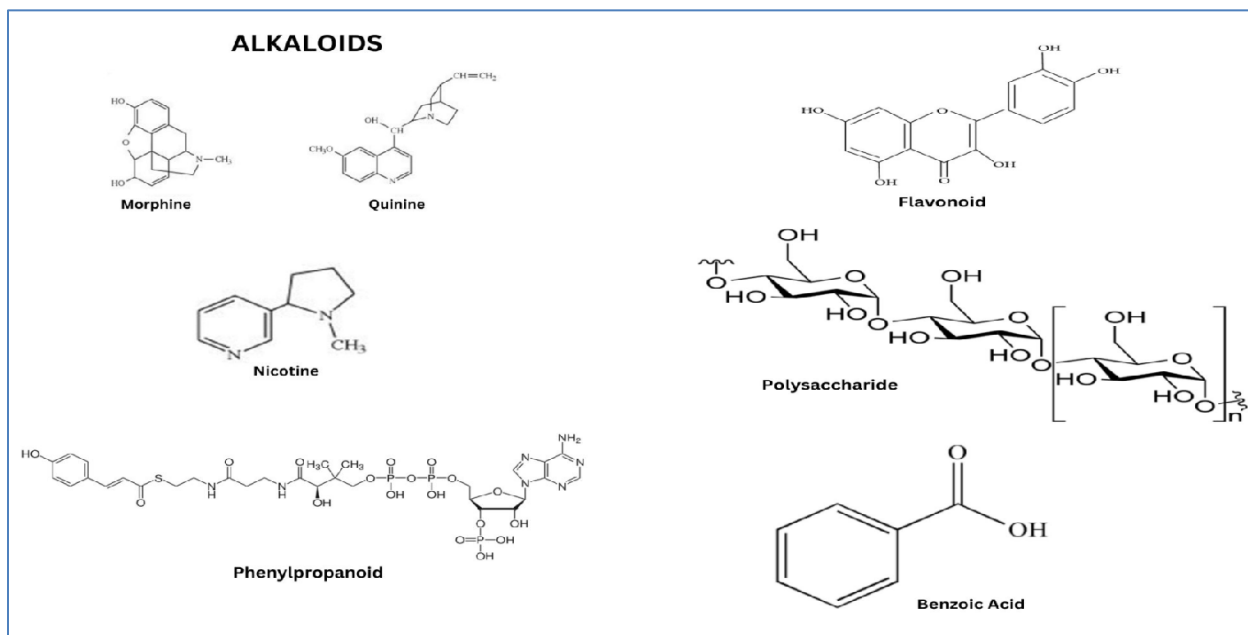


Figure 2: Structures of different chemical compounds *Solanum nigrum* possesses.

ANTI INFLAMMATORY ACTIVITY

Solanum nigrum Linn. plays a significant function in the treatment of inflammation since pain and inflammatory illnesses are now widespread among people. Inflammation is the result of leukocytes releasing complex mediators such as prostaglandins, leukotrienes, and others. Inflammation is reduced with the *S. nigrum* plant. Experimental animals were administered the plant's berries' methanolic extract at a dose of 375 mg/kg body weight, and it was discovered to have potent anti-inflammatory qualities. This method shows that the plant's anti-inflammatory effect is improved when extracted with methanol in a rat model of induced edoema.

ANTI MICROBIAL ACTIVITY

The antibacterial potential of *Solanum nigrum* leaf extracts in both water and methanol was studied, and phytochemical screening was carried out to identify the active ingredients, Against *E. coli*, *S. aureus*, *Enterobacter aerogenes*, and *Pseudomonas aeruginosa*, methanol and water extracts were tested. The methanol extract displayed the highest activity when compared to the aqueous extract. *Solanum nigrum* L. leaf extracts in methanol and aqueous form were used in antibacterial research. Methanol extracts of all plant samples were found to exhibit significant activity against the two tested bacteria, *Xanthomonas campestris* (a plant pathogen) and *Aeromonas hydrophila* (an animal pathogen), in antibacterial screening using the disc diffusion method. The examined microorganisms were suppressed by *S. nigrum* methanol extracts in a certain zone.

ANTIFUNGAL ACTIVITY

The antifungal activity of the plant extract is examined using the agar diffusion method and the fungal strains *Penicillium notatum*, *Aspergillus niger*, and *Fusarium oxisporium*. When compared to the other leaf and root extracts, the ethanolic seed extract exhibits the maximum activity (approximately 6.0-16.8mm) against all of the examined fungal strains. *Penicillium notatum* resistance of ethyl acetate root extracts is much lower (4-4.5mm) as compared to other strains.

ANTI CANCER ACTIVITY

In many cancerous cell lines, both crude extracts and purified components of *S. nigrum* have anti proliferative action. Crude extract is typically made from dehydrated berries, but it can also be made from the entire plant. Both antiproliferative effects of the crude organic extract and separated chemicals have been investigated on cancer cell lines from the liver (HepG2), colon (HT29 and HCT-116), breast (MCF-7) and cervical (U14 and HeLa). The antitumor action of *Solanum nigrum* and its fruits on the HeLa cell line. The methanol-based extract of the berries of *Solanum nigrum*, was examined for its inhibitory impact on the human HeLa cell line. The cell line's % survival was determined using the Trypan blue- dyed exclusions technique. The SRB and MTT assays were used to assess the cytotoxicity of *S. nigrum* on HeLa cells.

ANTIOXIDANT ACTIVITY

The antioxidant capacity of a methanol extract of a plant called *Solanum nigrum* berries was assessed using a tissue- based physiological antioxidant profile. According to the molecular

antioxidant profile of cardiac tissue, the extract revealed considerable (p0.001) antioxidant potential. The activity took place in a dose-independent way. The methanolic solution of *S. nigrum* berries exhibited anti-oxidant action. *Solanum nigrum*, an insufficiently utilized and unique element of the plant, provides a significant number of antioxidants that help to combat the detrimental effects of radicals that are free.

ANTI DIABETIC ACTIVITY

Water and hydro-alcoholic extraction of various sections of the *Solanum nigrum* plant, namely the leafy part, berries, and stem, were tested for hypoglycemia actions in Sprague Dawley rats. To assess oral glucose tolerance with conventional Metformin, several dosages of the extract (200, 400mg/kg body weight) were used. The results demonstrated that water-based extracts of leaves and berries have a dependence on dosage hypoglycemic effect, followed by hydroalcoholic extracts.

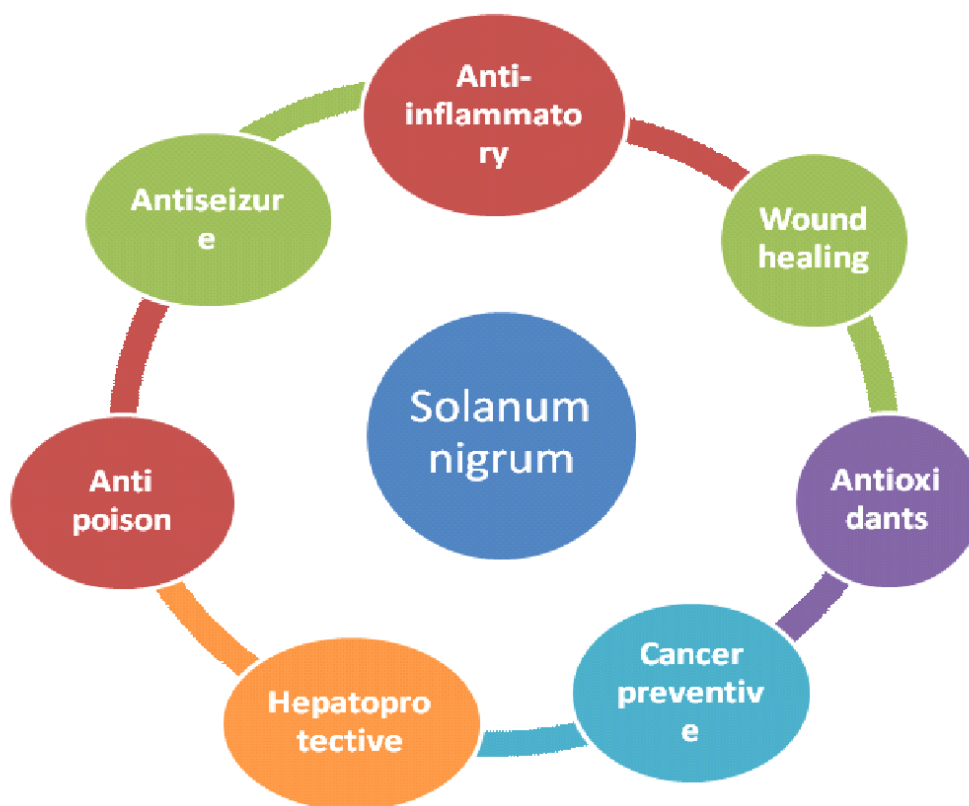


Figure 3: Flow chart of therapeutic properties of *Solanum nigrum*

Food Fortification : *Solanum nigrum* is one of the most useful medicinal plants because its leaves and berries are used to make food products such as pasta, soup, chakli, namkeen and shows the lot of medicinal effects for treating diseases like pneumonia, sore teeth, stomach aches, tonsillitis, ringworms, pain, inflammation, and fever, as well as acting as a hepaprotective, diuretic, and antipyretic (Figure 4). The study was done by Anita et al. (2022) to discover salmon protein by using the *S. nigrum* extract. The protein and fat level were greatly raised and the carbohydrate content was dramatically lowered when salmon protein was added. The snacks with 30% salmon protein powder received the top rating across the board. *S. nigrum* had total phenolic content of 380 mg GAE/100 and a DPPH-radical scavenging (% inhibition) of 79.0, respectively.

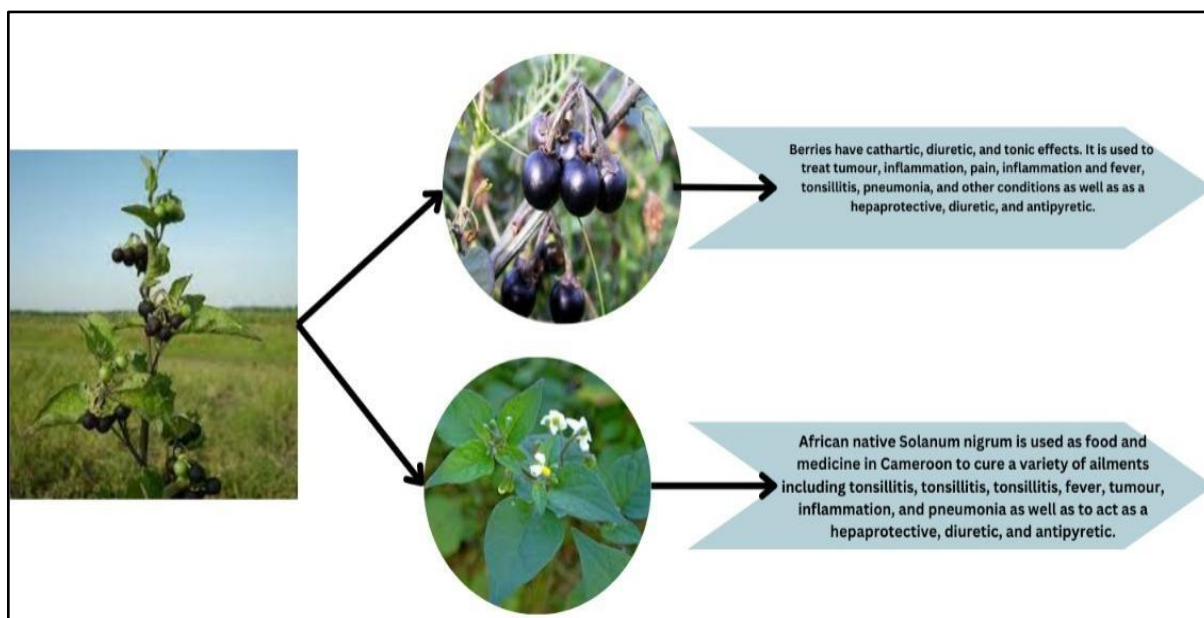


Figure 4: Shows the Medicinal effect of leaves and berries of *Solanum Nigrum*.

CONCLUSION

Solanum nigrum, also known as black nightshade, is a widely distributed plant around the globe with medical benefits as well as nutritional contents. It has been noted that *Solanum nigrum* is considered a weed in some agricultural situations as a result, it becomes crucial to teach farmers and gardeners to properly manage its growth and tell the positive aspects of the plant. While it has been used in traditional medicine and it is clear that many of the plant part such berries, leaf, whole

plant too is used in many folk remedies has shown promising results in some research trials, but it is important to conclude that more scientific research should be conducted on this plant in order to get the true potential of the plant and in many advance researches. Its nutritional values can be affected by factors like location and growth conditions. More research is needed to completely comprehend and measure its nutritional value and to validate these claims and identify the particular mechanisms of action of the plant. Overall, the research is important for preserving traditional food culture, promoting healthy and sustainable food choices, supporting local farmers, advancing research, and promoting sustainable agriculture.

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