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E: ISSN NO.: 2455-0817 *Remarking An Analisation*

Anti-microbial and Anti-oxidant Properties of *Solanum nigrum*: An Overview

Abstract

There has been long history of traditional medicine for serving living being all over the world.

In the recent past there has been an exponential growth in the field of herbal medicine in the developing as well as in developed countries owing to of their natural origin and minimum side effect. *Solanum nigrum* (makoi) plants belong to solanaceae family largely used in the Indian traditional medicare practices against various diseases. It is reported for various biological activities such as antibacterial, antifungal, anti-inflammatory, anticancer, anti-oxidant, antipyretic and cytotoxic activity. Chemical constituents commonly found in *S. nigrum* are glycoalkaloids, glycoproteins, polysaccharides, polyphenolic compounds such as gallic acid, catechin, protocatechuic acid, caffeic acid, epicatechin, rutin. Reddish brown coloured fruits are used for edible purpose. In present communication efforts have been made to overview the antimicrobial and antioxidant activities of the plant in view to arrange the scattered information to a single place which will ultimately be convenient to further studies.

Keywords: Anti-microbial Activity, Anti-oxidant Activity, Chemical Constituents, Medicinal Values, Pharmacological Activities, *Solanum nigrum.*

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Introduction

In recent years there has been a gradual revival of interest in the use of traditional herbal medicines all over the world as these are reported to safe and less or without any adverse effect in comparison to synthetic drugs (Shaikh et. al. 2016)**.** According to an estimate around 70,000 plant species, from lichens to tall trees have been used for medicinal purposes; among them higher plants play a significant role since ancient times (Farombi, 2003). Ayurveda, the most ancient and scientific treaties on medicines and diseases which dates back to 1500-800 BC has mentioned the role of plants in treating diseases (Manoharachary and Nagaraju, 2016). Today about 80 % population of the world rely on the use of traditional medicines for the treatment of several diseases because of its safe nature in comparison to synthetic drugs that are regarded unsafe to human and environment in long terms of use (WHO, 2002). There are about 45,000 plant species in India. The officially documented plants with medicinal potential are 3000 but traditional practitioners use more than 6000. India is the largest producer of medicinal herbs and is appropriately called as the Botanical Garden of the World (Ahmedullah and Nayar 1999; Bent and Ko 2004). In rural India, 70% of the population is dependent on the traditional system of medicine (Farombi, 2003). In fact, plants are reported to possess diverse range of bioactive phytochemicals which are responsible for biological activities such as antioxidant, antimicrobial, anticancer, antidiorrehal, anti-inflamatory and anti-HIV activities (Pandey et. al. 2010; Pandey et. al. 2012). It is estimated that approximately one quarter of prescribed drugs contain plant extracts or active ingredients obtained from plants (Shashank and Pandey 2014). Many medicinal products derived from plants are easily available in the market such as aspirin, atropine, artimesinin, colchicine, digoxin, ephedrine, morphine, physostigmine, pilocarpine, quinine, quinidine, reserpine, taxol, tubocurarine, vincristine and vinblastine (Sekar et. al. 2010).

Among different plants of medicinal values, *S. nigrum* commonly known as Black Nightshade or “Makoi” possess significant place in Ayurvedic medication and generally grows as weeds in moist habitats in

different types of soils. It is also cultivated in tropical and subtropical agro-climatic regions by sowing the seeds during April-May in well-fertilized nursery beds (Kiran et. al. 2009). There are two varieties of *S. nigrum*, one with black colour fruit and second with reddish brown colour fruit. In both varieties, black colour fruit are toxic (Chauhan et. al. 2012)). Leaves, whole plant and roots are important and used for health point of view. The curative properties of medicinal plants are perhaps due to the presence of various secondary metabolites such as alkaloids, flavonoids, glycosides, phenols, saponins, steroids etc. (Arora 2013). Traditionally known 'Gewai Saag' is the paste of stem and leaves of *S. nigrum* which is used in various body pain, joint pain and rheumatism in the tribals of Central Himalaya Region, Uttrakhand. In Korea, some communities use its leaf paste against numerous skin diseases. *S. nigrum* is also used in the Oriental Systems of Medicine for different purposes – as an anti-tumorigenic, antioxidant, anti-inflammatory, hepatoprotective, diuretic and antipyretic agent (Jain et. al. 2011). The members of this family are known for the presence of various natural products of medical significance. Different parts of this plant possess biological activities such as antitumor, anti-inflammatory, antioxidant, hepatoprotective, diuretic, antipyretic, antimicrobial, antiulcerogenic. Various compounds have been identified which are responsible for diverse activities (Zakaria et. al. 2006, Kumar et. al. 2016). *S. nigrum* is widely used in many traditional systems of medicine worldwide for disparate ailments but has not garnered attention for modern therapeutic use. It is essential to study medicinal plants which have folklore reputation in a more intensified way to promote the use of herbal medicine and to determine their potential as a source of new drugs**.**

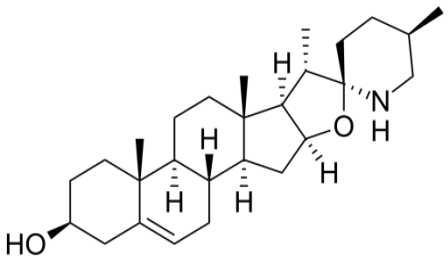
Aim of the Study

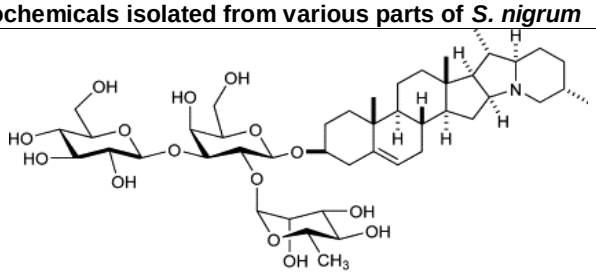
In present communication, efforts have been made to overview the phytochemical properties of *S. nigrum* with the aim to highlight the significance of the plant for human being and also provide new area of research to develop the compounds synthetically.

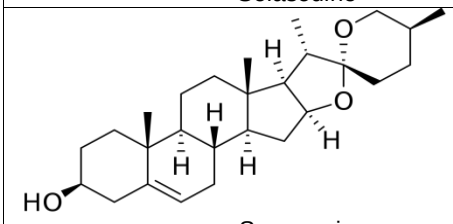
Active Constituents

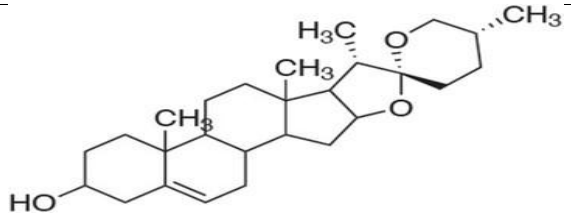
S. nigrum is considered as a pool of various active compounds those are responsible for its diverse activities, namely glycoalkaloids, glycoproteins and polysachharides. Phytochemical studies revealed that the glycoalkaloids are the major components of *S. nigrum.* Important glycoalkaloids are solanine, solasonine, solamargine, diosgenin, gitogenin, solavilline and solasdamine (Figure 1) belong to the tropane group of compounds (Jain et. al. 2011; Juneja et. al. 2007). Tannins, polyphenolic compounds such as gallic acid, catechin, protocatechuic acid (PCA), caffeic acid, epicatechin, rutin (Figure 1), and naringenin are some other active constituents (Sikdar and Dutta 2008, *Kumar and Pandey 2014*). Among many bioactive compounds, solanine has been extensively studied which accounts 90-95 % of total alkaloid (Khan et. al. 2016). Due to a high content of solanine, *S. nigrum* is considered to be toxic too. Solanine is found nearly in every part of *S. nigrum,* whereas the highest content is in unripe berries. However, berries become non-toxic after ripening. As the plant matures, the solanine content of leaves goes on increasing. The extract of fruit of *S. nigrum* is considered as the most active and useful part and reported to have antiulcer, antioxidant, anti-inflammatory, antituberculosis, antidiuretic, antitumor and neuropharmacological properties (Khan et. al. 2016). Although *S. nigrum* is considered as a rich source of one of the most popular plant poison due to abundance of solanine mostly in unripe fruit, it has been claimed to be a reservoir of phytochemicals with pharmacological prospects (Lee and Lim 2006, Atanu et. al. 2011). It is one of the plant's major natural defenses as it is toxic even in small quantities. These glycoalkaloids demonstrate noticeable antitumor effects on various tumor cell lines (Ji et. al. 2008). Glycoproteins obtained from all the part of plants (Lee and KT 2003). These glycoproteins consist of carbohydrate (69.74%) and protein (30.26%, mainly hydrophobic amino acids such as glycine and proline). These glycoproteins exhibit antitumor effects on HCT-116 cells, as well as diuretic and antipyretic effects. Polysaccharides isolated from aqueous extracts of *S. nigrum* have been shown to possess antiproliferative activity that can be attributed to their immunomodulatory ability (Jain et. al. 2011).

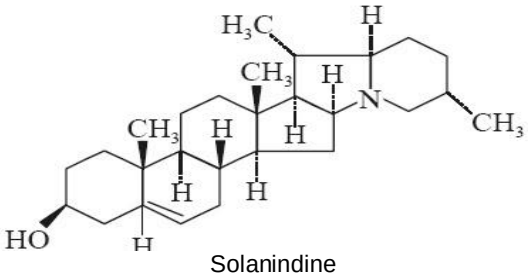
Figure-1: Molecular structure of some phytochemicals isolated from various parts of *S. nigrum*

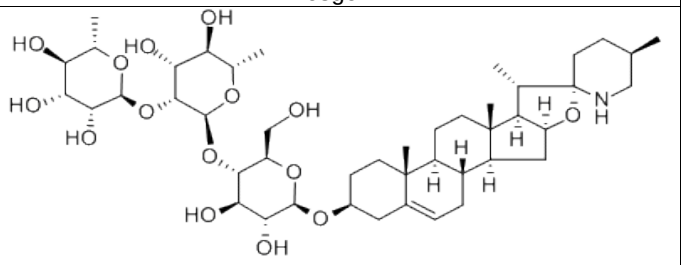

Solasodine

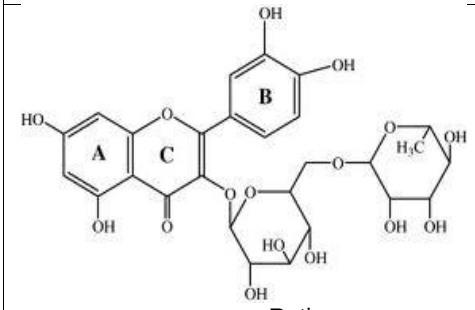

Solanine

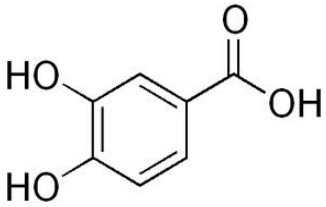

Sapogenin

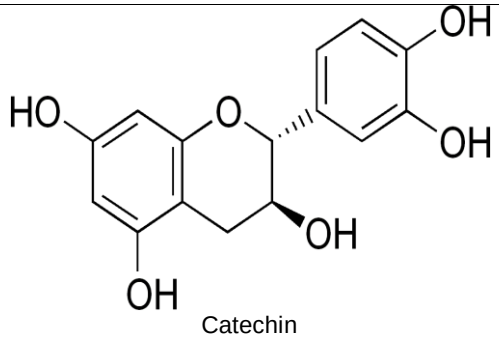

Diosgenin

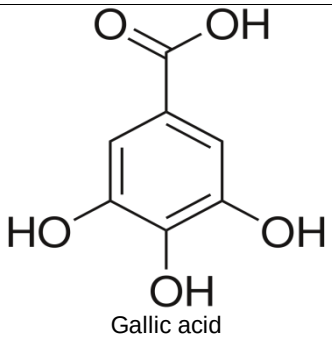

Solanindine


Solamargine


Rutin


Protocatechuic acid


Catechin


Gallic acid

(***Source:*** *Chauhan et. al. 2012, Kumar and Pandey 2014)*

Antimicrobial

The medicinal plants are known as antimicrobial agent that kills or inhibit the growth of microorganisms. Several workers have reported antimicrobial activities of different extracts of various plants against different species of bacteria like *Micrococcus varians*, *M. luteus*, *Staphylococcus aureus, Salmonella typhi*, *E. coli*, *K. pneumoniae*, *V. cholera* and some species of fungi like *Aspergillus niger*, *A. flavus*, *A. fumigates.* Yogananth et. al. (2012) claimed that three different extracts of stem and leaf of *S. nigrum (viz. ethanol, hexane and chloroform) have antimicrobial activity against* eight bacterial cultures like *Enterococcus faecalis, E. coli, K. pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa, Shigella flexneri, Salmonella typhi,*

Staphylococcus aureus and *V. cholerae*. They also reported that methanolic extracts of dried root tissues of *S. nigrum* contained antifungal properties which act against *A. brassicicola*. Prakash and Jain (2011) tested the aqueous and crude extracts of *S. nigrum* against few fungal strains viz. *A. niger*, *A. flavus, C. albicans.* They observed that extracts prepared using crude solvents exhibited higher antifungal activity as compared to their corresponding aqueous extracts. In a study, Kumar et. al. (2016) evaluated the antibacterial activities of various extracts of leaves, fruits and stems of *S. nigrum* against six pathogenic bacteria and reported that various extracts of different parts of *S. nigrum* significantly inhibited the growth of all six selected pathogenic bacteria in different way. Among different extract of leaves, water extract showed the best inhibition zone against *P. aeruginosa, E. coli* followed by extracts of ethanol and water respectively which indicated that *S. nigrum* has potent activity against all the tested microorganisms. In another study, water and methanol extracts of leaves of *S. nigrum* was tested against various strains of bacteria and observed that the methanol extract produced the highest activity when compared to aqueous extract. On the basis of the above results, they proposed that the methanol could be used for extracting antimicrobial compounds from leaves (Kavishankar et. al. 2011). In another study, the methanol and aqueous extracts of leaves of *S. nigrum* were used for the study of antibacterial activities in which antibacterial screening was performed by disc diffusion method against two gram negative bacteria namely *Xanthomonas campestris* (plant pathogen) and *Aeromonas hydrophila* (animal pathogen). Methanol extracts of all the plant samples showed significant activity against the two tested bacteria. The methanol extracts of *S. nigrum* exhibited clear zone of inhibition against the tested micro organisms (Britto et. al. (2011). It was also observed that when these extracts were tested against various fungi viz., *Saccharomyces cereviciae, Aspergillus parasiticus, Trichophyton rubrum, Macrophomina, Fusarium solani* and *Candida albicans*, moderate as well as significant activity against different fungal strains were observed (Sridhar et. al. 2011). In the further fractionation of ethanol root extracts by using ethyl acetate, n-butanol and water, the n-butanol fraction showed the strongest antifungal activity by its suppression of conidial germination of *A. brassicicola* (Chuahan et. al. 2012). Among many principles identified, saponins were the most active principles conferring antimicrobial effects (Hameed et. al. 2017). In another study, ethanol, methanol and ethylacetate extracts of *S. nigrum* leaf, seed and root were assayed for antifungal activities against some fungal strains such as *Penicillium notatum, Aspergillus niger, Fuserium oxisporium* and *Trichoderma viridae* and the zone of inhibitions was also compared with the standard antibiotics. Seed extracts showed antifungal activity against all the tested fungal strains compared to leaf and root extracts. Among all, ethyl acetate extract showed high antifungal activity on all the tested fungal strains and relatively lowest MIC value were obtained with ethanol seed extracts (Sridhar et. al. 2011).

Antioxidant Activity

The substances which possess the ability to protect the body from damages caused by free radicals induced oxidative stress is known as anti-oxidants. Free radicals (super oxide, hydroxyl radicals and nitric oxide) and other reactive species (hydrogen peroxide, hypochloric acid and proxynitrite) produced during aerobic metabolism in the body and become the cause of oxidative damage of amino acids, lipids, proteins and DNA. 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 (Jain et. al. 2011). Various research findings have demonstrated that changes in oxygen utilization in the body and increased formation of reactive oxygen species (ROS) contribute to many chronic diseases such as atherosclerosis, arthritis, Alzheimer's, Parkinson's, diabetes, sclerosis, gastritis, aging, liver diseases, cancer, AIDS etc. (Monika et. al. 2016). Although an organism is naturally equipped with antioxidant protection systems to cope with the harmful effects of ROS, the endogenous antioxidant defence system is not totally adequate to counteract the oxidative stress. Therefore, protection against oxidative stress depends partly on the adequacy of dietary antioxidants. Antioxidants, both exogenous and endogenous help to neutralize the effect of free radicals in different ways such as prevention of the free radical formation, by scavenging free radical, preventing the radical chain reaction of oxidation, inhibit the oxidation process and increase shelf life by retarding the process of lipid per-oxidation. Antioxidants may also be synthetic and natural. Butylated hydroxyanisol (BHA), butylated hydroxytoluene (BHT), tertbutylhydroquinone (TBHQ), 2-tert-butyl-4-methylphenol (TBMP) and propyl gallate (PG) are the examples of some of the synthetic antioxidants used in food industry. Among them some synthetic antioxidants have been reported dangerous for human health [Monika et. al. 2016]. In nature there are a wide variety of naturally occurring antioxidants such as SOD, CAT, GPx are the well known enzyme present in plasma acting as antioxidants by transferring reactive oxygen species and reactive nitrogen species into stable compounds. Evidence suggests that phytochemicals from fruits and vegetables, including leafy vegetables, are capable of providing protection against free radicals. This antioxidant activity might be due to the presence of various phytochemicals isolated from plants such as vitamins A, C and E, polyphenols, flavonoids, tannins, lignins, phytoestrogens, saponin, betacarotene, anthocyanins and lycopene possesses antioxidant property (Monika et. al. 2016, Bubolsa et.al. 2013). Free radical scavenging activity of plant is estimated using a very quick and efficient method DPPH (1, 1 - Diphenyl- 2 -picryhydrazyl) and claimed that leaf extract have better antioxidant activity than stem bark and root extract (Chaudhary et. al. 2017). The methanol extracts of 10 plant species showed effective free radical scavenging in the DPPH assay. The ethanol extracts of *S. nigrum* fruits and *Acacia*

asak barks exhibited the highest antioxidant activity (Al-Fatimi et. al. 2007).

The anti-oxidant activity of methanolic extract of berries of the plant *S. nigrum* was evaluated by tissue biochemical anti-oxidant profile. The extract exhibited significant ($p<0.001$) antioxidant potential as evident from the cardiac tissue biochemical antioxidant profile. The activity occurred in a dose-independent manner. The ethanolic extract of the dried fruit of *S. nigrum* was assessed for antioxidant activity using DPPH (1, 1- diphenyl-2-picryl hydrazyl) and found that the extract showed free radical scavenging properties (Chauhan et. al. 2012). In another study, methanolic extracts of *S. nigrum* have shown to have 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 and found that methanol extracts of *S. nigrum* inhibited the DPPH by 92 percent; whereas, the aqueous extracts showed considerably less effective radical scavenger activities. A quantitative correlation between the antioxidant activity and the content of polyphenols was also observed which signifies that the phenolic compounds present in the plant contribute to the radical scavenging activity. It has also been demonstrated that the purified glycoproteins of *S. nigrum* 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 and found to be active in a dose dependent manner (Jain et.al. 2011)

Conclusion and Prospectives

Curing of different diseases through holistic management became more significant nowadays. Numerous materials of natural origin have already been reported for biological activities. *Solanum nigrum* is abundantly available throughout the world which is largely reported for antimicrobial and antioxidantal properties at different places. *S. nigrum* possess many phytochemicals which have been shown as a promising alternative to the synthetic drugs. In present communication, an attempt has been made to compile scattered material at one place to provide viable utility and search for more effective compounds. Molecular structures of different biologically active compound isolated from *S. nigrum* also depicted in view to search more effective bioactive compounds through the derivatization.

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