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Study on the Antimicrobial Activity of Medicinal Plant Solanum Nigrum: A Syatematic Review

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Abstract – Black nightshade or the technical term- Solanum nigrum (SN), aka Makoi has a range of ayurvedic properties and known widely for the medicinal benefits. But, this does not affirm that it would garner attention of the therapeutic users. Given in the study, researchers perform characterization, synthesis, and the cream's antibacterial evaluation from Solanum nigrum extract. As seen in India, Solanum nigrum has been combined with different medicinal plants and seen to have a protective hepatic impact on the patients suffering from Liver cirrhosis. The impact can be attributed to the action antioxidant, diuretic, immuno modulating and the anti-inflammatory drug.

Keywords: Solanum Nigrum, Antibacterial

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I. INTRODUCTION

Use of different kinds of medical plants was known to the human race since history unknown and when no such term like “medicines” or “medical science” was even created. People knew the use of the plant family Solanaceae that belonged to the genus Solanum. It is a family of a large group of plants that comprises of about 1400 species. These plants are mainly available in the tropical and tropical regions. For instance, Solanum aviculare is mostly available in Europe, Australia, and New Zealand, S. dulcamara is mostly available in Europe, S. incanum is normally found in Africa, S. Khasianum is mostly available in Indian subcontinent, S. laciniatum normally available in Australian continent, S. Nigrum is a species mostly found in cosmopolitan regions. There are other species as well that are cultivated and some of which are popular agricultural products such as S. pseudocapsicum, S. tuberosum (potatoe) and S. melongena (eggplant, aubergine)[1]. Increasing the failure of synthetic drugs, side effects and development of antibiotic resistance by pathogenic microorganisms leads to development of the identification and screening of several medicinal plants for their potential antimicrobial activity [2]. Several medicinal plants have been tried against pathogenic microorganisms, hence to detect the plant medicinal properties an extensive study is required [3-4].

Respiratory Tract Infections (RTIs) accounts for almost 50 million deaths globally every year. RTIs include infections of different kinds such as laryngitis, sore throat, earaches, sinusitis, common cold, mastoiditis, and many more. RTIs can affect both upper and lower respiratory tract and mostly affects children and new borne. Pneumonia and Bronchitis are the most common infections that affect almost seven million people globally each year. Principal agents of pneumonia and bronchitis are respiratory pathogens like Pseudomonas Aeroginosa, and Klebsiellapneumoniae, and Staphylococcus Aureus. Solanum Nigrum that is commonly called “Black Night Shade” belongs to the Solanaceae family. In Tamil, it is famous as Manathakkali. It has a number of medicinal features such as antioxidant, anti-ulcerogenic, and antioxidant characteristics. It also shows cytotoxic and hepato-protective properties. It is a famous African pediatric plant that helps to cure dozens of ailments of infants such as feverish convulsions, hydrophobia, different kinds of eye diseases, and different kinds of chronic skin ailments. It is also known for its anticancer property. S. Nigrum has been traditionally used extensively to treat different ailments such as hepatitis, pain, fever, and inflammation. The plant has a number of traditional uses as medicine for various reasons. It has antioxidant, antitumorigenic, hepatoprotective, antipyretic, and anti-inflammatory properties. Diverse compounds in S.Nigrum have been identified that are responsible for a number of activities. Though it has so many applications in traditional systems of medicines, it has not been garnered for modern forms of medicines[1].

II. TRADITIONAL USES

The leaves and berries of the plant are used for diverse medicinal purposes. Other parts of the plant also have wide-ranging traditional uses. The

leaves of the plant are good for recovering from gouty and rheumatic joints and different types of skin diseases. Leaves are also used in the treatment of tuberculosis. Other than the above-mentioned medicinal benefits, leaves are found very effective in curing neurological disorders, nausea, and dropsy. The decoction of flowers and berries are cough and cold. These are also effective for bronchitis and pulmonary tuberculosis. Traditionally, the berry juice is used as a remedy of ophthalmopathy, hydrophobia, antidiarrhoeal. Seeds are useful in giddiness and dipsia. The extracts of berries are found to possess diuretic and cathartic features. They are good in skin rashes and inflammations. The roots of the plant are traditionally useful in ophthalmopathy, rhinopathy, osteopathy, and hepatitis. The entire plant can be used as digestive, diuretic, laxative, diaphoretic, sedative, antiseptic, anti-inflammatory, expectorant, cardiotonic, swelling resistor, cough, and cold resistor, and as a cure for asthma. The whole plant is also useful in leprosy, hemorrhoids, nephropathy, cardiopathy, ophthalmopathy, dropsy, and common weakness. A decoction of different parts of the pnat including roots and berries is useful in CNS and reflexes of the spinal cord [5-9].

Figure 1: Leafs and fruits of Solanum nigrum (Mohammad et al, 2017) [10]

III. PROFILE OF SOLANUM NIGRUM

Biological source

It contains full grown berries of Solanum Nigrum in dried form.

Geographical Source

It is a part of Medical Botany, National Institute of Siddha, located in Chennai, Tami Nadu, and India.

Family

It belongs to the family Solanaceae

Common name

Black nightshade, Makoi

Synonyms

It is known in different names in different places:

- In Australia it is famous as Blackberry nightshade and Black nightshade.
- In Europe it is known as Annual nightshade, Black nightshade, Common nightshade, and Garden nightshade.
- In New Zealand it is known as Black nightshade
- In South Africa it is known as Nightshade

In different language and different locations in India it is called in different names:

- Sanskrit: Dhvansamaci
- Urdu: Mako
- Bengali: Gudakamai
- Hindi: Makoya, Kakamachi, Kali makoy
- Kannada: Ganikesopu
- Malayalam: Manatakkali
- Marathi: Kamoni
- Punjabi: Mako, Peelak, Mamoli

TAXONOMY

Following is the complete taxonomy of the plant Solanum Nigrum:

- Kingdom: Plantae – Plants
- Subkingdom: Tracheobionta - Vascular plants
- Superdivision: Spermatophyta - Seed plants
- Division: Magnoliophyta - Flowering plants
- Class: Magnoliopsida – Dicotyledons
- Subclass: Asteridae Order: Solanales
- Genus: Solanum – nightshade
- Species: SolanumNigrum L. - black nightshade
- Authority - Linn.

IV. MACROSCOPY

The bark of the plant is thin and flexible. It uppermost skin of the root is peeled off that

exposes the pale yellow part of the wood. The flowers that come out possess five petals. The petals are more or less regular in shape. The flowers are normally bell-shaped but it can be star-shaped, tubular, or flat. Members of this family of plants are normally climbers or they may be scrambling plants. The steams are hairy and full of leaves. The leaves are whole or dissected but stipules are absent. In the stems, they are oriented alternatively. The morphological study makes it clear that the roots possess numerous small branches and the roots look small brown externally. Mature fruits are more or less 6mm in diameter and usually obtuse. Fruits are thin, papery, pulpy, and seeds lie freely in the pulp of the fruit [11].

V. MICROSCOPY

Leaves have clear petiole and midrib with visible covering. These are uni seriatetrichomes with 3-5 cells with pointed tips. Leaves are arc-shaped collateral with a vascular bundle like arrangement. Leaf lamina shows anisocytic stomata present on both surfaces but concentration was high in the lower surface. Vein islets number is 7-10 and palisade ratio is 2-4 [12].

VI. CHEMICAL CONSTITUENTS

Unripe green fruits that contain glycoalkaloids is damaging to human health. It is also damaging to livestock. It includes solanine, α, and β-solamargine, solasodinsolanidine, solamargine, solasonine (0.09-0.65%). The last two can also be traced in leaves. As a plant matures the level of solanine increases[13]. Phytochemical investigation of whole plant reported that which contain alkaloids, flavonoids, tannins, saponins, glycosides, proteins, carbohydrates, coumarins & phytosterols. It has been found that *Solanum nigrum* contains the substances, such as total alkaloid (14), steroid alkaloid (15), steroidal saponins (16) and glycoprotein (17). Recently phytochemical analysis of *Solanum nigrum* has resulted in the isolation of two novel disaccharides. Their structures were determined as ethyl b - D - thevetopyranosyl-(1-4)- b- D -oleandropyranoside and ethyl b- D -thevetopyranosyl-(1-4)- a - D-oleandropyranoside, respectively, by chemical and spectroscopic methods (18). *Solanum nigrum* seeds have high lipid content. Their protein content and minerals elements (Mg being prominent) are considerable and *Solanum nigrum* oil is an important source of linoleic acid (19).

A. Traditional applications

- Leaves are very useful in reducing gout and pains or inflammation due to rheumatic joints. Leaves are also useful in skin diseases, nausea, nervous disorder, and tuberculosis.
- Solanum Nigrum is most popular for its anti-cancerous features.
- The juice and decoction of berries are good for couch and cold, skin diseases, and inflammation.
- Berries are good anti-inflammatory and antipyretic agents.
- The dried fruits provide ethanol that has a high hepatoprotective effect against CC14 induced oxidative harm to the liver.

VII. PHARMACOLOGICAL SCREENING OF SOLANUM NIGRUM

Analysis of the plant extract was accomplished to find out the key ingredients. Harbone investigated the phytochemistry of ethanolic extract of the berry of Solanum Nigrum. It was found that carbohydrate was present in it along with flavonoids, saponins, tannins, alkaloids, phenols, and steroids.

Solanum Nigrum consists of several steroidal glycosides, steroidal alkaloids, steroidal oligoglycosides, including solamargine, solasonine, clavioline, solasodine, and solanine, flavonoids, steroidal saponins, and glycoprotein. It also contains a number of polyphenolic compounds such as gallic acid, protocatechuic acid, catechin, caffeic acid, epicatechin, rutin, and naringenin. These compounds possess strong antioxidant and anticancer agents.

Besides, traces of proteins, carbohydrates, m coumarins, phytosterols crude polysaccharides, polyphenols, gentisic acid, luteolin, apigenin, kaempferol, anthocyanidin have also been reported. The steroidal alkaloids and glycoproteins as present in the plant and as revealed on research show anti-tumor activity [13].

VIII. PHARMACOLOGICAL ACTIVITIES

A. Anti-Tumor effect

Dilip and Saroja (2012) examined the polysaccharide fraction from Solanum Nigrum; SN-ppF3 was inspected to find its immune-modulator actions [20]. The results that came out of the research suggested that tumor control mechanism as detected in SN-ppF3-treated mice were most likely due to enhanced host immune response. SNL-P1a had noteworthy expansion inhibition effect on U14 cervical cancer and defensive effect on thymus tissue of the tested mice bearing tumor.

B. Anti-Cancer Activity

Chinthana (2012) evaluated the control of EMT in case of MCF-7 breast cancer treated with AESN.

The result showed that AESN could suppress EMT in case of MCF-7 breast cancer cells [21]. Here, mediation was done by attenuation of mitochondrial function. The current study gives new information on the application of Solanum Nigrum for colon cancer treatment. The information so obtained makes it clear that further study is required in this area.

Hanifa (2011) investigated the anticancer activity of the fruits. They followed the HeLa cell line. In this investigation, the researchers tested the fruits of Solanum Nigrum (methanol extract of the fruits) for their inhibitory outcomes on HeLa Cell Line. The percentage feasibility of the cell line was approved by using Trypan blue dye prohibiting process. The cytotoxicity was evaluated by the SRB assay and MTT assay. Solanum Nigrum methanolic extract has important cytotoxicity effect on HeLa Cell Line in a concentration range between 10 mg/ml to 0.0196 mg/ml by using SRB assay [22].

C. Anti-fungal effect

The author investigated the anti-fungal effect of Solanum Nigrum L. The results showed that the production of solamargine by a cultivable fungal endophyte at a significant yield is a new observation. Further experiments such as media optimization, OSMAC (One Strain Many Compounds) or epigenetic modifiers could be applied to enhance the fungal solamargine production [23].

D. Hepatoprotective activity

Author investigated the hepatoprotective activity of Ethanol extract of Solanum Nigrum against CCl4-induced hepatic damage in rats. The ethanol extract showed remarkable hepatoprotective activity. The activity was evaluated using biochemical parameters such as serum aspartate amino transferase (AST), alanine amino transferase (ALT), alkaline phosphatase (ALP) and total bilirubin. The histopathological changes of the liver sample in treated animals were compared with respect to control.

E. Anti-oxygenic Activity

Author examined the anti-oxygenic activity of Solanum Nigrum L. The researchers evaluated leaves and its various solvent extracts with the help of sunflower oil model [24]. Leaf powder and its methanol/water (80:20) soluble fraction showed strong anti-oxygenic activity in refined sunflower oil. On the other hand, ethyl acetate part showed insignificant anti-oxygenic action, whereas the water-soluble part was mostly devoid of any action in cultured sunflower oil. Thermal constancy of altered extracts of Solanum Nigrum L. leaves at 80℃ in refined sunflower oil also pointed out the well-built effectiveness of methanol/water (80:20) extract to inhibit thermal oxidation. Solanum nigrum L. contain high levels of magnesium (239.0 mg/100g) and phosphorous (80.3mg/100g). Fatty acid analysis of the lipid extracted from Solanum nigrum L. leaves indicated the presence of linoleic (59.1%) as a major fatty acid. The result of this study confirmed the presence of anti-oxygenic compounds in leaves; in particular, its methanol/water (80:20) extracts showed great potential as a natural antioxidant to inhibit lipid peroxidation in foods.

F. Anti-larvicidal effect

According to the author conducted the investigation on the bio-control potentiality of active ingredients isolated from ethyl acetate extract of aged leaves of Solanum Nigrum L. The research findings made it clear that is apparent dose-dependent mortality [25]. It was found in the experiment that the rate of mortality (Y) was positively correlated with the concentrations of the compound (X). The regression coefficient value was close to 1.

G. Anti-Stress effect

As author investigated the prophylactic or curative efficacy of basic extract and the active constituents of Solanum Nigrum leave [25]. The research result suggested that the human brain is vulnerable to stress-related pro-oxidant insult as it contains fat at a very high level. Thus, as a safe herbal prescription of Solanum Nigrum leaves extract or its one-off ingredients can be applied as a nutritional supplement for arresting the free radicals developed in the brain due to physical or psychological stress or any related neurological disorder.

H. Anti-oxidative effect

The relationship between the plant growth and on effects of endophytic bacterium inoculation the beneficial effect was more obvious at relatively low Cd concentration (10 μM). Based on the modification of nutrient inclusion and activated oxygen metabolism in infected plants, the probable mechanism of the endophytic bacterium in Cd phytotoxicity reduction was concluded as an uptake augmentation of crucial mineral nutrition and development in the activities of anti-oxidative enzymes of the infected plants.

I. Anti-allergic effect

The author researched the usefulness of plant berries in the treatment of asthma. The petroleum ether extract of Solanum Nigrum berries is found to be very useful in arresting a number of symptoms of asthma.

J. Estrogenic activity

Author has done extensive research on the estrogenic potential of Solanum Nigrum fruits [1]. In their research work, they followed both in vivo and

in vitro investigation in the mouse. Their research depicted that Solanum Glycosides act almost like a hormone.

K. Hepatoprotective activity

According to Viswanath Jannu (2012), herbal-based treatment for the liver disorder has been there in this country for centuries. Some Indian pharmaceuticals have made them popular worldwide.

1. Herbal drugs need standardization.
2. There is a serious lack of the identification process of active ingredients and principles.
3. There is a serious lack of Randomized Clinical Trials (RCTs).
4. There is a serious need for toxicological evaluation.

L. Anti-convulsant activity

According to the authora research on Sn depression action of Central nervous system that has been affirmed by the measurement of effect of the Sn intra peritoneal injection on varied parameters of neuro pharmacology. Contractions isotonic of the toad rectus abdominis that is isolated [1].

Actions that are inotropic and Negative chronoscopic on isolated toad heart. Contraction isotonic of the guinea pigs isolated ileum. Rat's isotonic contraction of their isolated jejunum. Lowering of the blood pressure in cat's arteries. Effects of secretion on the gland sub maxillary of rat'.

M. Anti-diabetic activity

Both hydro's alcoholic and aqueous of Solanum nigrum plant, parts viz. Fruits, leaf, and stem to promote the hypoglycemic activity in the rats namely Sprague Dawley [23]. So it is concluded that the plant part of Solanum nigrum are rich in anti- diabetic properties.

N. Protective effect

As per researcher performed an experiment on the Solanum nigrum extract's protective effect against the Swiss albino mice lead acetate. The present study results laid clear evidence of Solanum Nigrum extract's defense against the toxicity induced by lead acetate in albino mice brains.

Immuno-stimulant activity

The researcher did an investigation to find that the potential plants of immunostimulant are the alternative which was effective in preventing varied fish diseases. Extracts of plants have immense potential in terms of an immunostimulant against different microorganisms and so they are used to treat diseases caused by infectious microorganisms.

O. Anti-microbial activity

According to author performed an investigation on methanol anti-bacterial activity and Solanum nigrum leaves water extracts were assessed along with phytochemical screening done to seek compounds doing the above activities. Based on the obtained results, it is concluded that the compound of methanol can extract compounds having antimicrobial properties from leaves.

The researcher used the Solanum Nigrum L. leaves aqueous and methanol extracts to investigate the presence of antibacterial activities. While the antibacterial screening was being done by the method of disc diffusion with two gram of Xanthomonas Campestris, a negative bacteria (plant pathogen) and an animal pathogen : Aero monas hydrophila, it was seen that plants extract's for methanol revealed considerable activities against the bacteria tested. S. Nigrum methanol extracts showed clear inhibition zone against the microorganism tested.

Venkatesan and Karrunakaran (2010) said that the compound of Solanum nigrum has been subjected to screening activities that are preliminary phytochemical against one gram E.Coli, a negative organism (NCIM: 2065) along with Staphylococcus's one gram, a positive organism (NCIM: 2079). These two were then compared with Penicillin, the drug of control at varied concentrations (0.5, 1.0, 1.5, 2.0, and 2.5) mg/ml by the method of disc diffusion. Considering Escherichia coli, a maximum inhibition zone were exhibited by Solanum nigrum around 30.1mm whereas Penicillin, the control drug has less activity in comparison to plant extracts of Solanum nigrum.

Researcher took six extracts of solvent from Solanum Nigrum's seed, leaf, and roots and then assayed them to check their vitro antibacterial activity in opposition to the bacteria of pathogens as Bacillus Megaterium, Bacillus subtilis, klebsiella pneumonia E.coli, Staphylococcus aureus, Pseudomonas Putrids, Proteous vulgaris, and the inhibition zone then compared with several antibiotics. Crude extract's phytochemical screening revealed the prevalence of compounds secondary like flavonoids, alkaloids, tannins, steroids, and phenols. Varied extracts of organic solvent (methanol, ethanol, diethyl ether, ethyl acetate, hexane, and chloroform) of seeds released strong activities of antibacterial properties against varied pathogenic bacteria in comparison to the root solvent and leaf extract's. The extracts of ethyl acetate seed of Solanum nigrum showed positive activities against the different organism such as Pseudomonas, Klebsiella, Proteous

vulgaris, (20.5 – 21.0mm of inhibition zone). Of the varied extracts types tested, the seed extract of ethyl acetate showed the least possible value of MIC (1.50-4.50 µg/m) in opposition to the bacterial isolates. Further, low values of MIC recorded against Porteus vulgaris, pseudomonas putrida, and klebsiella pneumonia.

According to the author dried fruits ethanolic extract if Solanum nigrum has been assessed to test the antimicrobial activity. Extracts of ethanol show a considerable antibacterial activity in opposition to the gram negative and gram-positive bacteria.

Parameswari et al (2012) S. Nigrum antibacterial activity has been tested against E. coli, Bacillus subtilis, pseudomonas aeruginosa, and Klebsiella pneumonia. Plant extracts of Solanum nigrum in composition of, 10ìg, 50ìg and 100ìg has been with respect to CLSI standards. The inhibition zones were first recorded and then analyzed against streptomycin, a standard control. The extracts of methanol have revealed the largest antibacterial activity when compared to the extracts of ethanolic. In both of the extracts, the whole extract of plant showed significant activities they are anti-bacterial than berries and stem. The outcome suggests that the S. Nigrum total extract can be used to prepare herbal drugs.

P. Anti-ulcer activity

As per author study he conducted experiment on the extract of method of S.Nigrum having effect of anti-ulcer on ulceration induced by aspirin in rats owing to their antioxidant status investigated [26]. Results show that the berries of Solanum nigrum exert its effect that is primarily gastro protective by the action of a free radical scavenger. It is seem that berries of Solanum nigrum might have potential therapeutic effect while treating gastric diseases.

Q. Cardio-protective activity

According to the researcher performed an investigation on the methanolic extract's cardio-protective activity of Solanum nigrum berries plants using global in the injury of vitro ischemia-reperfusion in doses of around 2.5 and also 5.0 mg/kg for a period of 6 days every week for the next 30 days. S. Nigrum berries methanolic extract is seen to be stuffed with cardio-protective activity [26]. Methanolic extract's cardio-protective activity of the plant Solanum nigrum berries has been done using the global in injury of vitro ischemia-reperfusion at varied doses. Outcomes suggest that the extract showed relevant activities that were cardio protective ($p<0.001$) against global injury of in-vitro ischemia-reperfusion. The occurence of the activity was in a manner dose-independent. The berries methanolic extract of Solanum nigrum plants has cardio-protective property.

R. Analgesic activity

Researcher did an investigation on the S. Nigrum ethanolic extracts to seek if it has analgesic activity and evaluated for the peripheral and the central pharmacological actions done by using the hot plate of Eddy' and inducee writhing acetic acid respectively.

As per author S.Nigrum Ethanolic extracts for the analgesic activity has been evaluated. Extract's analgesic activity has been evaluated for the peripheral and the central pharmacological actions done by using the hot plate of Eddy' and inducee writhing acetic acid respectively. The S.Nigrum dried fruit's ethanolic extract has been tested for various analgesic activities [23].

S. Anti-diarrhoreal activity

Author conducted an experiment on S. Nigrum dried fruit ethanolic extract has been tested to possess anti-diarrhoeal activity [26]. A considerable activities was possessed by the fruit extract ($P<0.01$ and $P<0.001$) against diarrhoea inducing castor oil in mice where the defecation frequency was lowered and the latent period leveraged at a dosage of 250mg/kg and 500mg/kg of the weight of body .

T. Cytzotoxic activity

Researcher performed an investigation to test S. Nigrum dried fruit ethanolic extract's cytotoxic activity. In the test of the brine shrimp lethality, cytotoxicity was revealed by the compound having LC50= 63.10µg/ml and LC90= 160µg/ml.

U. Anti-inflammatory activity

Arunachala et al (2009) S.Nigrum L methanolic extract has been investigated to test the animal model's anti-inflammatory activity. Extracts of methanol taken at dose per body weight) 100 mg/kg b.w and 200 mg/kg) revealed inflammatory activities of dose based on the egg white and carrageenan induced edema in rats. Indomethacin (10 mg/kg) along with Cyproheptadine (8 mg/kg) account for standard drugs. S. Nigrum extracts of ethanol has anti-inflammatory property and tests using the edema of rat by Carrageenan. Concentration of 100, 250 & 500 mg/kg given orally to conduct the test. Activities anti-inflammatory at concentration of 500 mg/kg ($P<0.01$) in comparison to Diclofenac sodium (50 mg/kg), the standard drugs. Lina et al (2008) performed an investigation on S. Nigrum L methanolic extract to test for presence of anti-inflammatory activity based on the animal models [26]. It was seen that the extract of methanol can lower the, edema in hind paw of rats.

V. Anti-seizure activity

Lina et al (2008) conducted an investigation on S. Nigrum leaves aqueous extract to test for the ppresenxe of anti-seizure property in rats, mice and chicks by the extract's intraperitoneal administration [26]. Amphetamine was seen to potentiate the extracta anti-seizure property.

IX. CONCLUSION

The above study reveals that the Solanum nigrum has the property of anti-microbial against bacteria linked to infection of respiratory tract. The plant is user to treat the same and given orally but it is important to conduct further studies for active principle isolation from drug development crude extract. Also, traditional remedy to treat fever, hepatitis, ulcer, and other cancerous immunological applications. One can also use the paper to treat cytotoxicity and hepatotoxicity in a way enhancing kidney and liver functions. It further reveals anti-microbial, analgesic, anti-diabetic, anti-inflammatory, brain functioning and immunostimulant, property. The plant can actively aid better pharmaceutical and medical practices.

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