



**COMPREHENSIVE REVIEW ON ETHNOBOTANY, PHARMACOGNOSY,
PHYTOCHEMISTRY AND PHARMACOLOGICAL STUDIES ON SOLANUM
TRILOBATUM, LINN., (SOLANACEAE).**

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ABSTRACT

Solanum trilobatum Linn (Family: Solanaceae) is one of the important medicinal plant, more commonly available in Southern India. *Solanum trilobatum* is an extensively used Indian Traditional system of Medicine including Siddha to cure several ailments in humans. It was distributed throughout the southern parts of India. *S. trilobatum* is reported to cure numerous diseases viz., tuberculosis, respiratory problems and bronchial asthma. *S. trilobatum* was reported to possess hepatoprotective activity, antimicrobial activity, antioxidant activity, cytotoxic activity, haemolytic activity, protective effect, immunomodulatory activity and anti-inflammatory activities. Phytochemical screening exhibited the presence of various phytoconstituents like carbohydrates, saponins, phytosterols and tannins in leaf, whereas, stem possess carbohydrates, saponins, phytosterols, tannins, flavonoids and cardiac glycosides as major phytochemical constituents.

KEYWORDS: *Solanum trilobatum*, Ethnobotany, Phytochemistry, Pharmacology.

INTRODUCTION

Nature has a source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural sources, many based on their use in traditional medicine. Even now, approximately 80% of the third world population is almost entirely dependent on traditional medicines for maintaining general health and combating many diseases.^[1] Herbal medicine is the foundation for about 75–80% of the World population, mainly targeting primary health care for in the developing countries because of better cultural acceptability, compatibility with human body and lesser side effects. However, there is a drastic increase in the usage of herbal medicine was found in last few years from the developed countries.^[2] The World Health Organization (WHO) has also recommended the evaluation of plants for effectiveness against human diseases and for the development of safe modern drugs.^[3] *Solanum trilobatum* Linn (Family: Solanaceae), a thorny creeper with bluish white flower and grows as a climbing under shrub. It is one of the important medicinal plant, more commonly available in Southern India and has been used in herbal medicine to treat various diseases like respiratory problems, bronchial asthma and tuberculosis.^[4] This plant is well known in Ayurveda and Siddha system of medicine. In Sanskrit it is known as

‘Alarka’, in Telugu ‘Alarkapatramu’, in Tamil ‘Tuduvalai’ and in Malayalam ‘Tutuvalam’. The roots, berries and flowers are used for cough.^[5]

The interest in plant derived drugs is due to the fact that “green medicine” is safer and this rich mineral element cures several health problems. It is shown to exhibit various biological activities like antidiabetic, antibacterial due to the presence of tannins^[1] and saponins,^[6] antifungal, antimutagenic, antioxidant property that produce hypoglycemic effect, anti-tumors that protect from ROS (Reactive Oxygen Species) and suppress cell proliferation. The extract has an inhibitory effect on metal corrosions in alkaline solutions.^[7] It shows a significant decrease in lipid levels (anti-hyperlipidemic effect)^[8] and it possess hepato-protective activity against metal induced toxicities by regenerating the damaged liver cells.^[9] It is an effective reducing agent for the synthesis of nanoparticles. It possesses acaricidal and larvicidal activity of synthesized nanoparticles.^[10] It also acts as an immune stimulant that enhance the innate immune system and the production of cytokines.^[11] In regard to “Green Medicine”, the composition of constituents in the particular herbal drug is of prime importance. Usage of same vernacular name for two or more herbs poses a serious problem in

identification of specific herb. Standard and authenticity of herbal drug is established by its pharmacognosy.^[12]

Systematic position

Botany^[13]

Biological source: *Solanum trilobatum*, Linn.

Family: Solanaceae

Synonym (s): *Solanum acetosaefolium* Lamk.—
'*Solanum canararum* Miq.

Common Name: Climbing Brinjal, Purple-fruited pea Egg plant.

Solanum trilobatum Linn (Solanaceae), the nightshade, (order Solanales), with 102 genera and nearly 2,500 species. The genus *Solanum* was established by Carl Linnaeus in 1753. *Solanum trilobatum* (Solanaceae) is a thorny shrub widely distributed in Bengal, Uttar Pradesh, Southern India and Srilanka in moist place.

It is a prickly diffuse, bright green perennial herb, woody at the base, 2–3 m height, found throughout India, mostly in dry places as a weed along roadsides and waste lands.^[14, 15]

Taxonomic hierarchy

Kingdom: Plantae

Division: Tracheophytes

Sub-division: Spermatophytina

Class: Magnoliopsida

Clade: Eudicots

Clade: Asterids

Order: Solanales

Family: Solanaceae

Genus: *Solanum*

Species: *Solanum trilobatum*, Linn.

Vernacular name (s)

Sanskrit: Alarka, Vallikantakaarika, Kantakaari-lata.

English: Climbing Brinjal.

Hindi: Kantakaari-lataa.

Malayalam: Padarchunda, Parachunda, Tootuvila.

Marathi: mothiringnee, thoodalam.

Tamil: Tuduvilai, Nittidam, Sandunayattan, Surai.

Telugu: Alarkapatramu, kondavuchinta, mullamustila.

Kannada: Kakamunji, Ambusondeballi.

Oriya: Bryhoti.

Distribution

Occurs in India, Ceylon and Malay Peninsula. It is very common in waste ground in the dry regions of Ceylon, Indo-Malesia; In India- Kerala, Idukki, Palakkad, Wayanad. Maharashtra: Ahmednagar, Kolhapur Karnataka: Chikmagalur, Dharwar, Mysore; Tamil Nadu: All districts.



Fig. 1. Occurrence of *Solanum trilobatum*, Linn.



Fig. 2. Habit of *Solanum trilobatum*, Linn.

The plant having much branched spiny scandent shrubs. Leaves are deltoid or triangular, irregularly lobed. Flowers are purplish-blue, in cymes. Berry are globose, red or scarlet.

A small sub-scandent undershrub with numerous hooked prickles, stems slender with long divaricate branches with a few stellate hairs on the young shoots, otherwise glabrous, provided with many flattened, hooked, decurved very sharp prickles; leaves simple, alternate, small, 1.8—3.7 cm long, rotund-ovate in outline; obtuse, irregularly 3 or 5-lobed, glabrous often with 2 or 3 small curved prickles on midrib, petioles as long as leaves and prickly; **flowers** regular, bisexual, rich violet-purple, large on long divaricate or reflexed glabrous pedicels, cymes extra-axillary, short racemose, 3—9-flowered, nearly sessile; sepals 5, fused into a small, slightly stellate-hairy calyx, segments lanceolate, acute; petals 5, fused into a rotate corolla, 3.1—3.7 cm diam., stellate pubescent outside, lobes very deep, oblong-oval, obtuse, usually reflexed; **stamens** 5, inserted in corolla throat, filaments very short, anther large, connivent (but not connate) into an exerted cone, opening by two apical pores; ovary superior, 2-locular, stylesimple, long, often slightly curved, stigma small; fruit a globose berry, 0.8 cm long, smooth and scarlet in colour. **Flowering** from December to February.^[14, 16]

Uses: The roots and leaves of this plant are given in the form of a decoction to consumptive patients. The berries and flowers are used for coughs. The leaves are a common pot herb given to children suffering from prolonged cough. The siddha system of medicine uses a ghee prepared from this plant for treatment of tuberculosis.^[15]

The root bark is laxative, useful in the treatment of ulcers on the neck, burking of thwart, inflammation of liver and chronic fever. Berries are bitter and pungent useful in the heart disease, piles and dysentery.^[16, 17] Roots, berries and flowers are used for cough.^[18] This herbal plant is used as medicine for asthma, vomiting of blood, reducing blood glucose level and bilious matter phlegmatic rheumatism and several kinds of leprosy it is also antibacterial, antifungal, antimutagenic, antioxidant and antitumourous.^[19]

Solanum trilobatum is reported to cure numerous diseases viz., respiratory problems and bronchial asthma. *Solanum trilobatum* was reported to harbour hepatoprotective activity, antimicrobial activity, larvicidal activity, antidiabetic activity, cytotoxic activity and anticancer activity. The leaves and stem of *Solanum trilobatum* are reported to possess antimutagenic, anti-inflammatory and anti-ulcerogenic properties. The leaf extracts are used to increase male fertility and to cure snake poison.^[20] It is used with ghee in siddha for treating tuberculosis, as decoction in case of acute and chronic bronchitis, root and berries for treating cough.^[21] The major alkaloids identified in the alcoholic extract

from leaves and stem part of *Solanum trilobatum* has been shown to possess antimutagenic and antimicrobial activity against bacteria and fungi. Biological screening of the alkaloid mixture of this plant revealed anticancer activity against certain type of cancer and its effectiveness as an adjuvant in cancer chemotherapy.^[20]

Medicinal properties

Plant pacifies vitiated pitta, kapha, cough, bronchitis, dyspnoea, anorexia, worm infestation, skin diseases, hemiplegia, edema, urinary calculi, amenorrhoea, and urinary tract disorders.

Useful part: Whole plant^[22, 23]

Siddha properties^[24]

From ancient period this herb is used by roasting in oil or pure ghee and making a powder on it. Thuthuvalai kashayam or legiyam reduces the congestion of nose and chest. Consuming the juice of the plant with honey is used for respiratory problems like carcinoma, dyspnoea and anorexia. Most common recipes in siddha are Thuthuvalai candy, legiyam, rasam and chooranam.

Ayurvedic properties

Rasa: Tikta, Kashaya

Guna: Lakhu

Virya: Seeta

Phytochemistry

Phytochemical screening of various extracts such as chloroform, ethanol, water of *S. trilobatum* revealed the presence of secondary metabolites such as steroids, triterpenoids, sugars, reducing sugars, phenolic compounds, tannins, anthraquinone, amino acids, saponins.^[15]

The leaves of *Solanum trilobatum* revealed the presence of sugars, protein, alkaloids, flavonoids, saponins, tannins, cardiac glycosides, terpenoids and lipids.^[6, 25]

Phytochemical analysis of dried powder of *S. trilobatum* leaves showed the presence of carbohydrates, saponins, phytosterols and tannins, where as the stem portion possess carbohydrates, saponins, phytosterols, tannins, flavonoids and cardiac glycosides. Alkaloids such as soladunalinidine and tomatidine were isolated from the leaf and stem of *Solanum* species. *Solanum trilobatum* contains chemical compounds like sobatum(1), β -solamarine, solasodine(2), solaine(3), glycoalkaloid and diosgenin.^[26]

The phytochemical screening of the genus *Solanum* including *Solanum trilobatum* Linn. characterized by several secondary metabolites, including glycol alkaloids, steroidal- glycosides and saponins wherein, the most useful glycol alkaloids are solanidine, solasodine and solanine. Since, the toxic level of glycol alkaloids in human diet is still not confirmed.^[27]

Predominantly, the identified chemical ingredients have numerous pharmacological activities such as antiviral^[28], anti-cancer^[29-31] and anti-diabetic activity.^[32]

Pharmacological studies

The bioactivity of the herbs is based the following perspectives namely taste, potency, post digestive effect (PDE), individual action of the herbs and other characteristic properties.^[33] In fact, the taste of *Solanum trilobatum* Linn. is pungent and less bitter with hot potency that results in producing pungent flavour during post digestive period. It is indicated to tackle Aiyam (Phlegm), Vali (Air) and Azhal (Heat) humours. Moreover, its individual action includes stimulant, expectorant and tonic action.^[34]

According to the primal literature^[35], *Solanum trilobatum* Linn. is used as a rejuvenator and consumed as greens which are capable of alleviating phlegmatic diseases. The leaves are used to treat hypogeusia, flower is an aphrodisiac, fruit pacifies all the three humours. Of course, root and creeper relieve cough, wheezing and phlegmatic afflictions respectively. In addition, the specific action of leaves alleviates dullness of the ear and its related disorders especially due to phlegm, cough, pruritus, ascites, dysbiosis, vitiated humours in unison and pricking pain in the body and provides strength to the body.^[34]

In addition, the dried fruit is beneficial for vitiated phlegm, air and heat associated disorders as well as loss of appetite and hernia, whereas the ripe fruit useful for smoothening vitiated humours, loosen the increase of phlegm in the bronchial tubes and catarrh and also used in toxic conditions. Most importantly the leaves decoction is indicated for bronchial asthma. If *Solanum trilobatum* Linn. is consumed as rejuvenator in the form of green leaves, root, dried fruits and pickles with cow ghee, it alleviates vitiated heat disorders and especially cures eye related disorders.^[36]

Antimicrobial properties

Aqueous methanol and n-butanol extract of aerial parts of *Solanum trilobatum* produces good antimicrobial activity against Gram (+) and Gram (-) bacteria.^[37] In this study, the antimicrobial potential of ethanol, acetone and ethyl acetate extracts of leaves, fruits and flowers of *Solanum trilobatum* and pure saponin extracted from the leaves against bacterial strains like *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia*.^[38]

Antibacterial properties

In vitro studies of chloroform, methanol, petroleum ether and water leaf extracts were carried out on eight bacterial strains (*Staphylococcus aureus*, *Bacillus subtilis*, *Streptococcus pyrogens*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Escherichia coli*, *Proteus vulgaris*) showed good

inhibitory activity compared with standard antibiotics like streptomycin.^[39]

Tannin isolated from methanolic extract of leaf of *Solanum trilobatum* produces good antibacterial activity by agar disc diffusion method. Minimum inhibitory concentration of the tannins ranged between 1.0 and 2.0 mg/ml while the minimum bactericidal concentration ranged between 1.5 and 2.0 mg/ml.^[6] The green synthesis of silver nanoparticles (AgNPs) by using the leaf extracts of medicinally valuable plant *Solanum trilobatum*. Antibacterial activity of synthesized silver nanoparticles was done by agar well diffusion method against different pathogenic bacteria.^[40]

Haemolytic activity

In this study, the leaves and stem extracts of *Solanum trilobatum* were prepared in different polarity solvents (n-butanol, chloroform and methanol) and the dried plant extracts were used for the estimation of antimicrobial and hemolytic activity.^[20]

Antioxidant properties

A chloroform extract of *Solanum trilobatum* was analysed and compared with reference antioxidants for its *in-vitro* anti-oxidative properties such as scavenging of α , α - diphenyl picryl hydrazyl (DPPH) and superoxide radicals, protection to deoxy ribose degradation, reducing power, as well as inhibition of lipid peroxidation. The chloroform extract was found four times effective than catechin. This was able to prevent the formation of OH- induced malondialdehyde (MDA) in rat liver homogenate.^[41] The methanolic extract of *Solanum trilobatum* (ST) is cytotoxic and exerts an inhibitory effect on tumor growth and in the present study, its role on the antioxidant status of N-diethyl nitrosamine (DEN) induced and phenobarbital (PB) promoted hepato carcinogenesis.^[19]

Immunomodulatory activity

Aqueous extract of leaves of *Solanum trilobatum* Linn (Solanaceae) was pharmacologically validated for its immunomodulatory properties in experimental animals. Oral administration of extract at dose of 100, 200 & 400 mg/kg significantly increased in percentage neutrophil adhesion ($P < 0.001$). The delayed type hypersensitivity also showed a dose dependent activity ($P < 0.001$). Further, a dose related increase in haem agglutination antibody titer was observed with different doses as compared to control group. Carbon clearance test was conducted to establish phagocytic activity of reticulo endothelial system after treatment with aqueous extract. Phagocytic index was significantly increased after the administration of *Solanum trilobatum* compared to control group ($P < 0.001$). These findings suggested that the immunostimulatory activity of *Solanum trilobatum* influences by potentiating humoral as well as cellular immunity.^[42]

Anti-inflammatory activity

Methanol extracts of *Solanum trilobatum* leaf were investigated for anti-inflammatory activity with acute and chronic models. In the doses of 100, 200 and 300 mg/kg exhibited significant ($P < 0.05$) anti-inflammatory activity in all the models tested. The methanol extracts of *Solanum trilobatum* Linn at 300 mg/kg showed maximum inhibition of 54.44% in carrageenan-induced rat paw oedema while the standard drug indomethacin was 57.08% after 3 hrs of carrageenan injection. On the other hand at 100, 200 and 300 mg/kg inhibited with dextran, histamine and serotonin-induced rat paw oedema significantly and dose dependently compared with control group. In the chronic inflammatory model, at a dose of 200 and 300 mg/kg inhibited the granuloma weight by 22.65%, whereas the indomethacin inhibited 28.37%.^[18, 43]

Antidiabetic activity

The study was conducted to evaluate the antihyperglycemic activity of the ethanolic extracts of *Solanum trilobatum* (STEt) leaves on blood glucose of albino rats. Diabetic rats had much reduced body weight than normal rats. Administration of the extracts at the dose of 400 mg/kg body wt./day resulted in a marked decrease in the levels of fasting blood glucose with a concomitant increase in body weight. *Solanum trilobatum* extract at 400 mg/kg was found to be comparable to glibenclamide. STZ-diabetic rats treated with STEt (400 mg/kg) significantly reversed all these changes to near normal. These results suggest that STEt induce antihyperglycemic as well as antihyperlipidemic activities in STZ-diabetic rats.^[47]

Hepatoprotective properties

Hepatoprotective effect of an aqueous leaf extract of *Solanum trilobatum* extract was examined against lead acetate Swiss albino mice. The oral administration of the above extract for 30 days against lead acetate affected mice significantly increased the levels of antioxidants (SOD, CAT, GPx) and decreased the level of lipid peroxidation (LPO). The results of the present study, for the first time, provide clear evidence of defense provided by *Solanum trilobatum* extracts against lead acetate induced toxicity in brains of albino mice.

Protective action of *Solanum trilobatum* extract (STE) was evaluated by us in an animal model of hepatotoxicity induced by carbontetrachloride (CCl₄) Group I was normal control group; Group II, the hepatotoxic group was given CCl₄; Groups III-V received different doses of plant extract with CCl₄. Liver marker enzymes were assayed in serum and antioxidant status was assessed in liver tissue. Lipid peroxidation (LP) was increased significant in liver tissue in the CCl₄ treated rats (group II) while the activities of glutathione peroxidase (GPx), catalase (CAT) and superoxide dismutase (SOD) were decreased. STE treatment led to the recovery of these levels to near normal.^[45]

Protective effect

Protective effect of an aqueous leaf extract of *S. trilobatum* extract was examined against lead acetate Swiss albino mice. The oral administration of the above extract for 30 days against lead acetate affected mice significantly increased the levels of antioxidants (SOD, CAT, GPx) and decreased the level of lipid peroxidation (LPO). The results of the present study, for the first time, provide clear evidence of defence provided by *S. trilobatum* extracts against lead acetate induced toxicity in brains of albino mice.^[26]

Oviposition Deterrent and Skin repellent activity

The leaf extract of *S. trilobatum* (Solanaceae) was tested under laboratory conditions for oviposition deterrent and skin repellent activities against the adult mosquito *Anopheles stephensi*. Concentrations of 0.01, 0.025, 0.05, 0.075 and 0.1% reduced egg laying by gravid females from 18 to 99% compared to ethanol-treated controls. In skin repellent tests, concentrations of 0.001, 0.005, 0.01, 0.015, and 0.02% provided 70 to 120 minutes protection against mosquito bites, whereas the ethanol control provided only 2.2 minutes of protection. Both oviposition deterrent and skin repellent activity were dose dependent. The results suggest that the leaf extract of *S. trilobatum* is an effective oviposition deterrent and skin repellent against *A. stephensi*.^[46]

Mosquitocidal properties

The larvicidal and pupicidal activities of methanol extract of *Solanum trilobatum* leaf extracts against *Aedes aegypti*, *Culex quinquefasciatus* and *Anopheles stephensi*. The larvicidal and pupicidal was determined at five different concentrations of 50, 100, 150, 200 and 250 ppm.^[37] Acetone extract of *Solanum trilobatum* leaves was evaluated for its ovidical activity on the mosquito species *Culex quinquefasciatus* and *Culex tritaeniorhynchus*, by exposing eggs ranging in age from 0 to 18 h to concentrations of 50–200 ppm of the extract, and assessing their percent hatchability. A 100-ppm dose of the extract killed all of the eggs from both species aged between 0 and 6. The 50- and 75-ppm concentrations were also highly effective against young eggs; the effect declined in older eggs.^[47]

Antinociceptive properties

Solasodine a steroidal glycoalkaloid, is considered as a potential alternative to diosgenin for the synthesis of various steroidal drugs. It can be isolated from the roots of *Solanum trilobatum* Linn. Anti-nociceptive was activity conducted by several experimental murine models, viz. the writhing, formalin, and hot plate tests, used at doses of 2, 4, and 8mg/kg, this steroidal alkaloid caused a significant and dose dependent decrease in the nociception induced by an intra peritoneal injection of acetic acid ($p < 0.001$). It also led to a significant reduction of the painful sensation caused by formalin in both phases of the formalin test ($p < 0.001$). Furthermore, the alkaloid produced a significant increase in the reaction time in the hot plate test ($p < 0.001$).^[48]

Anti-dandruff properties

Solanum trilobatum Linn extract were prepared by both conventional and homogenization method. Silver nanoparticles were produced under sunlight, microwave and room temperature. The best results were obtained with sunlight irradiation, exhibiting 15–20 nm silver nanoparticles having cubic and hexagonal shape. In this study we report antibacterial activity against various Gram negative (*Klebsiella pneumoniae*, *Vibrio cholerae* and *Salmonella typhi*) and Gram positive (*Staphylococcus aureus*, *Bacillus cereus* and *Micrococcus luteus*) bacterial strains. Screening was also performed for any antifungal properties of the nanoparticles against human pathogenic fungal strains (*Candida albicans* and *Candida parapsilosis*). These nanoparticles when mixed with shampoo enhance the antidandruff effect against dandruff causing fungal pathogens (*Pityrosporum ovale* and *Pityrosporum folliculitis*).^[49]

CONCLUSION

In traditional medicine, the plant derived compounds are attracting much of attention. Scientists aim at exploiting these plants for application in pharmaceuticals and food industries.

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