



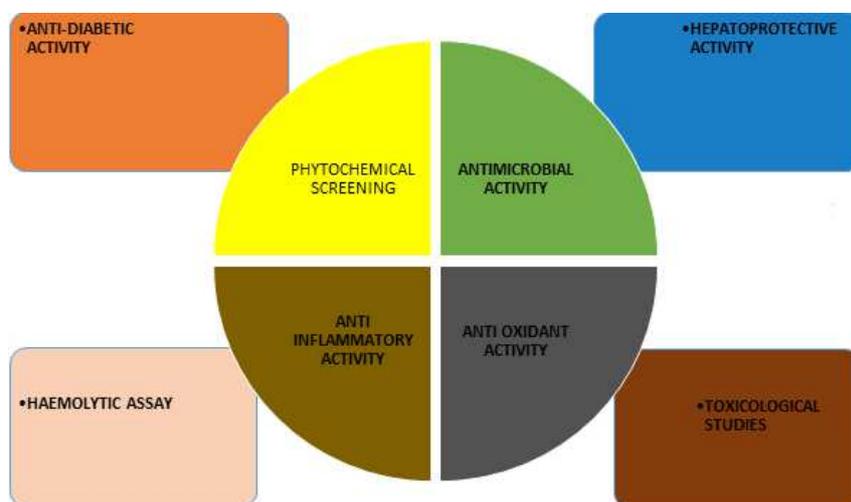
A perspective on bioactive compounds from *Solanum trilobatum*

Purushothaman Balakrishnan, Thameem Ansari Musafar Gani, Sreenath Subrahmanyam
and *Kumaran Shanmugam[†]

Department of Biotechnology, Periyar Maniyammai University, Vallam, Thanjavur, Tamil Nadu, India
[†]CoRx Lifesciences and Pharmaceutical Pvt. Ltd. Trichirapalli, Tamil Nadu, India

ABSTRACT

Solanum trilobatum is one of the medicinal plants commonly available in different parts of the world and this plant is used in Indian system of medicine to cure various diseases in human and animals. Phytochemical screening of this plant extract proved the presence of major bioactive drugs such as sobatum, solasodine, tomatidine, disogenin and solaine in various parts of the plant including leaf, stem, root, flowers and berries to treat various diseases like tuberculosis, respiratory problems and bronchial asthma. Bioactive compounds have been tested for anti-microbial, anti-inflammatory, antioxidant, cytotoxic, anti-diabetic and immunomodulatory activities. We have reviewed the selected bioactive compounds and phytochemicals from *Solanum trilobatum* in treating a tumor, cancer cells, and other diseases also involve in upsurge the immunity.



Keywords: *Solanum trilobatum*, Sobatum, Solasodine, Anti-cancer activity.

INTRODUCTION

Naturally arising nutritional and non-nutritional elements in numerous species of edible vegetation has its contribution in pharmacological action.[1] *Solanum trilobatum* has a typical botanical description.[2] It is habitually

used to treat several diseases, so far it has additional advantageous uses related to treating the diseases like bronchial asthma, [3] treatment for cancer, [4], [5] liver infection.[6] It is also used as a nanomedicine for antibacterial activity and human breast cancer (MCF 7). [7] In this plant, we can perform various tests by its extract obtained from its parts. The essential tests carried out in *Solanum trilobatum* are phytochemical screening, [8] antimicrobial activity, [9], [10], [11] anti-inflammatory activity, [12], [13] Hepatoprotective activity, [9] anti-cancer activity, [4], [5], [14] cytotoxic effect, [5] anti-inflammatory, [12] and Mosquitocidal property[15]. The phytochemical screening in the plant showed the presence of carbohydrates, saponins, phytosterols, and tannins in leaf part. While, stem passes carbohydrates, saponins, phytosterols, tannins, flavonoids and cardiac glycosides as its foremost phytochemical groups. [2] The compounds present in the plant are solasodine, linoleic acid, palmitic acid, oleic acid and stearic acid and partially purified fraction covers sobatum, β -sitosterol, disogenin and β -solamarine responsible for many biological properties.[16] In this plant, sobatum is the compound which inhibits the tumor growth.[5] Our group has carried out review on DNA methylation, [17] topographic imaging of antigen-antibodies,[18] AFM spectroscopy to measure intermolecular force between the drug and its enzyme, [19], [20] bioactive compounds from *Costus igneus* for controlling the diabetes and treating the urinary diseases.[21-25] Our group has extracted Allicin from Garlic [26] and Onion shoot and unknown proteins from Slaughterhouse animals used for treating the wounds.[27]

In this work, we have reviewed the research work on *Solanum trilobatum* drug, list of microorganisms studied minimum inhibition concentration, extraction techniques, anti-inflammatory, cytotoxic effect, Hemolytic assay, Hepatoprotective, and Mosquitocidal.

Origin of plant

Nature consumes a birthplace of medicinal agents for thousands of years and a notable number of modern drugs arises from the natural sources.[2] *Solanum trilobatum* L. is a flowering shrub of the family Solanaeace and originates in some of the warmer parts of the tropical and the subtropical areas.[28] It is an erect branching herb widely distributed throughout the Indo-Malaysian regions and southern India, although it has a traditional medicinal use in the areas where it is cultivated for treating various ailments.[29]

Botanical description:

Solanum trilobatum Linn has its place to the family Solanaeace, the nightshade plant originates below the order of Solanales, with 102 genera in addition nearly around 2500 species.[2] It is a thorny creeper with bluish white flower and grows as climbing under a shrub. It is touchy diffuse, bright green recurrent aromatic plant, wooded at the base, 2-3 m height, found all over Asian continent, mostly in dry places as a wild plant along waysides and harsh environment.[2] The plant having much branched sharp scandent bushes.[2] The leaves are deltoid, trilobal or wedge-shaped by means of irregularly lobed.[2] Flowers are purplish-blue, in cymes. Berry is globose, pink or crimson.[2]

Table 1 *Solanum trilobatum* botanical description

	Description	Reference
Botanical name	<i>Solanum trilobatum</i> .	[2]
Genus name	<i>Solanum</i> .	[2]
Species name	<i>Trilobatum</i> .	[2]
Family	<i>Solanaeace</i> .	[2]
Order	<i>Solanales</i> .	[2]
Common name	Climbing Brinjal, Purple-fruited pea Eggplant.	[2]

Table 2 List of vernacular names of *Solanum trilobatum*

S.no	Languages	Names	Reference
1	Tamil	Thoothuvalai, Nittidam, Sandunayattan, Surai.	[30], [2]
2	Marathi	Mothiringnee, thoodalam.	[2]
3	Malayalam	Tutavalam, putharichunda, Putricunta, Puttacunta, Tudavalam.	[2]
4	Telugu	Lavuste	[2]
5	Kannada	Kakamunji, Ambusondeballi.	[2]
6	Oriya	Bryhoti, Nab-hiankuri.	[2]
7	Sanskrit	Achuda, Agnidamini, Agnidamini, Alarka, Vallikantakarika.	[2]
8	English	Climbing Brinjal.	[2]
9	Vietnam	Quacuacaycabathuy.	[2]
10	Hindi	Kantakaari-lataa.	[2]

Biography and ecosystem

The plant is widely warmer parts of the Asian continent as inhabitant scrublands, mainly they distributed throughout the Indo-Malaysian regions and southern India, and although it has a traditional medicinal use in the areas where it is cultivated for treating various ailments.[29]

Phytochemicals studies:

Phytochemicals are non-nutritive plant chemicals that partake protective or ailment blocking properties.[16] Phytochemical screening of *Solanum trilobatum* was performed by using water, chloroform, methanol, ethanol and the further variety of organic solvents. [2] The screened extracts are attempted for Qualitative tests to prove the presence of alkaloids, flavonoids, carbohydrates, glycosides, saponins, tannins, terpenoids, proteins, anthraquinone and are proved by phytochemical analysis.[2] All the phytochemicals remained from the *Solanum trilobatum* was used for various activities. The plant also shows the presence of chemical components like sobatum, [29] β -solamarine,[29] solasodine,[12], [13] solaine,[2] glycol, and disogenin.[29],[2].

Table 3 List of phytochemical screening from *Solanum trilobatum*

Sl.No.	Extract materials	Confirmatory tests	Progress	Result	Reference
1	Test for alkaloids	Mayer	+	Yes	[9], [31]
2		Wagner's test	+	Yes	[9], [31]
3		Dragendroff's	+	Yes	[9], [31]
4	Test for flavonoids	Shinoda's test	+	Yes	[9], [31]
5		Alkaline reagent test	+	Yes	[9], [31]
6	Test for carbohydrates	Benedict's test	+	Yes	[9], [31]
7		Molisch's test	+	Yes	[9], [31]
8	Test for glycosides	Bontrager's test	+	Yes	[9], [31]
9		Keller-killani test	+	Yes	[9], [31]
10		Legal's test	+	Yes	[9], [31]
11	Test for proteins	Ninhydrin test	+	Yes	[9], [31]
12		Biuret test	+	Yes	[9], [31]
13	Xanthoproteic test	Xanthoproteic test	+	Yes	[9], [31]
14	Test for saponins	Froth test	+	Yes	[9], [31]
15		Lead acetate test	+	Yes	[9], [31]
16	Test for tannins	Ferric chloride test	+	Yes	[9], [31]
17		Lead acetate test	+	Yes	[9], [31]
18		10 % $K_2Cr_2O_7$	+	Yes	[9], [31]
19	Test for terpenoids	Salkowski test	+	Yes	[9], [31]
20	Test for anthraquinone	Ammonia test	+	Yes	[9], [31]
21	Test for phlobotannins	Test for phlobotannins	+	Yes	[9], [31]
22	Test for phytosterols	Libermann-Burchard test	+	Yes	[9], [31]
23	Test for polyphenols	Test for polyphenols	+	Yes	[9], [31]

Pharmacognostic characters**Table 4 List of drugs produced from *Solanum trilobatum***

S.no	Tested Compounds	Reference
1	Sobatum	[29]
2	Solasodine	[12] and [13]
3	Solaine	[2]
4	Tomatidine	[2]
5	Disogenin	[3]
6	β -Solamarine	[29]
7	Disogenin	[29]

Antimicrobial activity:

The extract of *Solanum trilobatum* leaves and stem using n-butanol have antimicrobial activity against *Klebsiella pneumoniae* and *Staphylococcus aureus*. [32]. Leaf extract of *Solanum trilobatum* has maximum inhibitory effect in *Vibrio cholera* and then *E.coli* by inhibition level.[9] leaves, flowers stem and fruits of *Solanum trilobatum* has an activity against gram positive and gram negative bacteria also they highlighted that the aqueous extract has maximum activity against *Klebsiella* and the *S.aureus* is highly inhibited by the methanol extract of the stem.[8] The MIC of *Solanum trilobatum* aqueous extract against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli* and

Klebsiella species found in between 0.06 to 0.5 mg/mm.[11] proved that dental pathogens such as *Staphylococcus aureus*, *Streptococcus mutans*, *Streptococcus salivarius*, *Streptococcus sanguinis* and *Lactobacillus acidophilus* were inhibited by acetone extract of seed.[33] They have marked as the maximum antibacterial activity of *Streptococcus salivarius* was highly inhibited.[33] Selected microorganisms were used for the antimicrobial activity by Authors that are shown in the table -3.[33] The authors also reviewed that the extract obtained in *Solanum trilobatum* using methanol increases the lifespan and growth rate and decrease the microbial content in *Penaeus monodon* post larvae, especially in vibrio species.[33]

Table 5 List of microorganisms inhibited by *Solanum trilobatum*

Sl.no	Microorganisms	ATCC number	Reference
1.	<i>Salmonella typhi</i>	ATCC 700931	[2]
2.	<i>Pseudomonas aeruginosa</i>	ATCC 27853	[2]
4.	<i>Staphylococcus aureus</i>	ATCC 29737, ATCC 700699	[10] and [2]
5.	<i>Escherichia coli</i>	ATCC 10412	[10]
6.	<i>Proteus vulgaris</i>	ATCC 13315	[8]
7.	<i>Vibrio parahaemolyticus</i>	ATCC 33934	[8]

Anti-cancer

Solanum trilobatum own an anti-tumor effect against chemically induced tumors in test animals.[5],[16],[34]. The different concentrations of *Solanum trilobatum* extract using ethanol has markable effect against Ehrlich ascites carcinoma (EAC) cell line, it was performed using Tryphan blue assay.[35] Table-3 saponins which are cytotoxic to human larynx carcinoma cells were extracted from *Solanum trilobatum*, the activity of the saponins depends upon the dosage.[4] saponins are steroids of *Solanum trilobatum* which has maximum inhibition on laryngeal cancer cells (HEP2) cell lines of saponins fractions was achieved at the concentration of 1000µg/ml.[4] The Di Ethyl Nitrosamine increase the activities of Aspartate Amino Transferase (AST), Alanine amino Transferase (ALT), Alkaline Phosphatase (ALP) and Lactate Dehydrogenase (LDH) the liver marker enzymes in the serum of the rat was lowered by *Solanum trilobatum* extracts indicates the inhibition of carcinogens.[4] The sobatum inhibits the ascites tumor growth which is induced by DLA and EA cells. The level of the life span in a test animal was increased in animal comparatively when administered through orally.[5]

Anti-oxidant:

The chloroform extract of *Solanum trilobatum* shows an Antioxidative effect in certain concentration by some level of extent in further increased concentration, when compared with anti-oxidative compounds such as ButylatedHydroxyToluene (BHT), Superoxides, and other compounds, the extract shows more effective anti-oxidant property than the compounds used to test. [36].

Anti-inflammatory:

The pharmacological investigations of compounds isolated from the *Solanum trilobatum* show an efficient Anti-inflammatory property in test animals by creating different models of inflammations such as acute and chronic by inducing edema.[37],[38] Solasodine is one of the steroidal glycoalkaloid compound present in the plant plays an important role to generate inflammation.[12] The extract obtained from ethanol and methanol at usage in different doses has proved the anti-inflammatory property in the test animals.[12],[37]

Hepatoprotective activity

The Hepatoprotective experimental toxicity was induced by known or unknown drug[9] and also using transition metals or heavy metals to induce hepatotoxicity in test animal[39] which influence the antioxidant enzymes and provides protection against free radical-induced hepatic damage, also authors showed that the *Solanum trilobatum* was extracted using chloroform and orally administrated to Swiss albino mice.[1] Finally, they found it furnished protection against toxicity induced by the mercury in a dose-dependent manner.[1] The extract obtained from the *Solanum trilobatum* also experimented that it reduces the lipid content by lowering the cholesterol level in test animals.[40]

Antidiabetic activity

The Diabetes mellitus persuaded in test animals which can be withheld by *Solanum trilobatum* and aqueous extract of the leaves benefits for hyperlipidemia due to diabetes.[40] The study of this aromatic plant in contradiction of diabetes to evaluate anti-hyperglycemic activity.[2]

Hemolytic Activity

Hemolytic activity was conceded out via blood agar plate method by adding human blood in the plate.[32] The herbal extracts were used to spot the hemolytic action by observing hemolysis zone formed in the plate.[32]

Immunomodulatory activity:

The immune system is get convoluted in the study of origination as well as pathophysiologic requests in lots of diseases.[41] The immunomodulatory response is instigated by some immuno-stimulants occurs naturally or artificially by way of in-vitro or in-vivo methods.[3],[42] The *Solanum trilobatum* consumes in stimulating the immune response conflicting the annexing pathogens was evinced in the all-inclusive physiological system.[3],[42]

Cytotoxicity:

The cytotoxic potential of different fractions of *Solanum trilobatum* exhibited that 50µg of petroleum ether extract exposed the comprehensive cell lyse in both L929 and Vero cells[5] and also the ethanolic extract of the plant has slightly toxic confirmed by examined different activities in test animals.[28]

Oviposition activity:

The extracts obtained from acetone, chloroform and petroleum ether from the *Solanum trilobatum* shows the oviposition activity against the vector *Culex quinquefasciatus*. [15] Among this petroleum ether shows the maximum effectiveness against the parasite ovicidal activity.[15] Its leaf extract possesses the oviposition and skin repellent activity against *A. stephensi* and they also prove it did not cause any discomfort or hypersensitivity to the users.[43]

CONCLUSION

We have reviewed origin of plant, botanical description, vernacular names, biography and ecosystem, phytochemicals studies, pharmacognostic characters, antimicrobial activity, anti-cancer, antioxidant, anti-inflammatory, hepatoprotective activity, antidiabetic activity, hemolytic Activity, immunomodulatory activity, cytotoxicity, oviposition activity of *Solanum trilobatum*. This review will be useful for the researchers who are interested to extract the bioactive compounds from this plant.

REFERENCES

- [1] Ekambaram, M., Ramalingam, K.R., Balasubramaniam, A., **2012**. *J. Drug Delivery & Therapeutics*, 2(6), 68-70.
- [2] Sahu, J., Rathi, B., Koul, S., Kosha, R.L., **2013**. *J. natural remedies*. 13 (2), 76-80.
- [3] Govindan, S., Viswanathan, S., Vijayasekaran, V., Alagappan, R., **1999**. *J.Ethanopharmacol*, 66, 205-210.
- [4] Kanchana, A., BalaKrishnan, M., **2011**. The anti-cancer effect of saponins isolated from *Solanum trilobatum* leaf extract and induction of apoptosis in human larynx cancer cell lines. *Int. j. pharmacy and pharmaceu. sci*.
- [5] Swapna Latha, P., Kannabiran, K., **2006**. *African J. Biotech.*, 5 (23), 2402-2404.
- [6] M. Shahjahan, K. E. Sabitha, M. Jainu, and C. S. S. Devi., **2004**. *Indian J. Medical Res.*, vol. 120, no. 3, pp. 194–198,
- [7] Ramar, M., Manikandan, B., Marimuthu, P.N., Raman, T., Mahalingam, A., Subramanian, P., Karthick, S., Munusamy, A., **2014**. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy* vol.140, 5 April 2015, 223-228.
- [8] Mohanan, P.V., Devi, K.S., **1996**. *Cancer Letters* 110 (1996) 71-76.
- [9] Pratheeba, M., Rajalakshmi, G., Ramesh. B., **2013**. Hepatoprotective and Antibacterial activity of leaf extract of *Solanum trilobatum*. *Int. J. Pharmaceu. Res. and Bio-Sci*.
- [10] Doss, A., Rangasamy dhanabalan, **2008**. *Ethnobotanical Leaflets*, 12, 638-642.
- [11] Sugnamam. Sai Durga Prasad., Kunjam. Mallikarjuna., and Ranjala. Venumadhav., **2015**. *Asian J. Plant Sci. Res.*, 5(2):34-37.
- [12] Pandurangan, A., Khosa, R.L., Hemalatha, S. **2009**. *J. Pharmaceu. Sci. Res.* 1(1), 16-21.
- [13] Emmanuel, S., Ignacimuthu, S., Perumalsamy, R., Amalraj, T., **2006**. *Fitoterapia* 77, 611-612.
- [14] Venugopal, R., Mahesh, V., Ekambaram, G., Aadithya, A., Sakthisekaran, D., **2014**. *Biomedicine and preventive nutrition* 4(2014) 535-541.
- [15] Sakthivadivel, M., Gunasekaran, P., Sivakumar, M., Samraj, A., Arivoli, S., Tennyson, S., **2014**. *J. Entomology and Zoology Studies*, 2(6), 102-106.
- [16] Madhuri. S., Govind. P., Verma Karuna.S., **2011**. *Int. res. j. pharmacy*, 2(8), 38-42.

- [17] Basheer. N. B., Rajasree .S., Laxmi. A., Harshiny. M., Kaliaperumal. R., Kumaran. S., **2013**. *J. Mol. Diag.* 15, 17 — 26.
- [18] Sankar Ganesh. P., Kanivalan. K., Rajendran. K., Kumaran. S., **2013**. *Int. J. Pharm. Bio. Sci.* 4, 255 — 262.
- [19] Vijayasathy. M., Rajendran. K., Kumaran. S., **2013**. *Quant. Matt.* 2, 238 — 240.
- [20] Manoharan. S. B., Marimuthu. V., Kalailingam. P., N. Basheer. B., Perumal. A., Kaliaperumal. R., Kumaran. S., **2013**. *J. Exp. Nanosci.* 8, 596.
- [21] Manjula. K., Pazhanichamy. K., Kumaran. S., Eevera. T., Rajendran. K., **2013**. *J. Liq. Chrom. Rela. Technol* 36, 192-212.
- [22] Manjula. K., Rajendran. K., Eevera. T., Kumaran. S., **2012**. *Scandinavian J. Urol. Nephrol.* 46, 290 — 297.
- [23] Manjula. K., Rajendran. K., Eevera. T., Kumaran. S., **2012**. *Urol. Res. (Urolithiasis)* 40, 499 — 510.
- [24] Manjula. K., Pazhanichamy. K., Kumaran. S., Eevera. T., Dale Keefe. C., Rajendran. K., **2012**. *Int. J. Phar. & Pharmce.* 4, 261 — 270.
- [25] Kalailingama. P., Sekara. A. D., Clement Samuela. J. S., Gandhirajana., Govindaraju. Y., Kumaran. S., Tamilmani. E., *J. Health. Sci.* 57, 37 — 46, **2011**.
- [26] Senthilkumar Rathnasamy, Rufus Auxilia.L, Purushothaman Balakrishnan, **2014**. *Asian j. chem.* 26 (12), 3733-3735.
- [27] Sundaramoorthy M, Prabakaran C, Purushothaman Balakrishnan, Saravanan T.S. *Indo-American journal of Pharmaceutical research* **2014** 4(01), 1021-1028.
- [28] Thongprodichote. S., Hanchanga. W., Wongkrajang. Y., Temsiririrkkul. R., Atisuk., **2014**. *Mahidol University J. Pharmaceu. Sci.*, 41 (4), 39-46.
- [29] Desingu. K., Devarajan, N. **2013**. *J. Natural Product and Plant Resources*, 3 (6), 24-28.
- [30] John de Britto, A., Herin Sheeba Gracelin, D., Benjamin Jeya Rathna kumar, P., **2011**. *Int. J. Appl. Biol. and Pharmaceu. Tech.*, 2 (3), 457-461.
- [31] Prashant. T., Kumar. B., Kaur. M., Kaur. G., Kaur. H., (**2011**). *Int. Pharmaceu. Sci.*, 1(1), 98-106.
- [32] Kumar, S.S.R., Priya, C.L., Rao, K.VB., **2011**. *Pharmacologyonline* 3, 1336-1341.
- [33] Citarasu, T., Venkatramalingam, K., Babu, M.M., sekar, R.R.J., Petermarian, M., **2003**. *Aquaculture Int.*, 11, 583-595.
- [34] Jahan, M.S., Vani, G., Shyamaladevi, C.S. **2007**. *Hepatology res.*, 37, 35-49.
- [35] Xavier, A.P., Santharam, L., Panigrahi, S., Muthuraman, M.S., Premiah, B., **2013**, *Int. J. Pharm tech Res.*, 5(3), 1119-1125.
- [36] Sini, H., Devi, K.S., **2004**. *Pharmaceu. Biol.*, 42(6), 462-466.
- [37] Pandurangan, A., Kosha, R.L., Hemalatha, S. **2011**. *Natural Product Research: Formerly Natural Product Letters*, 25(12), 1132-1141.
- [38] Pandurangan, A., Khosa, R.L., Hemalatha **2008**. *Oriental Pharmacy and Experimental Medicine* 8(4), 416-422.
- [39] Manivannan, E., Kothai, R., Arul, B., **2012**. Hepatoprotective activity of Solanum trilobatum Linn against CCL₄ induced hepatotoxicity in rats. *Int. J. Advances in Pharmacy, Biology & Chemistry*, 1(1).
- [40] Ganesan, K., Ramasamy, M., Gani, S.B., **2013**, *Asian J. Biomed & Pharmaceu. Sci.*, 3(22), **2013**, 51-57.
- [41] Livingston Raja. N.R., Vinotha Pooshan. G., Venkatachalam. V.V., Vijayakumar. M., **2009**. *Pharmacologyonline* 3, 758-765.
- [42] Divyagnaneswari. M., Christyapita. D., Michael. R.D., **2008**. *Diseases in Asian Aquaculture* 221-234.
- [43] Rajkumar, S., Jebanesan, J., **2005**. *J. Insect Sci.*, 5-15.