



**SOLENA AMPLEXICAULIS: A REVIEW**

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Article Received on 14/12/2017

Article Revised on 02/01/2018

Article Accepted on 23/01/2018

**ABSTRACT**

The plant species *Solena amplexicaulis* is commonly called creeping cucumber and belongs to the family Cucurbitaceae distributed very seldom in the dry deciduous forest and scrub jungles of throughout of India. Traditionally it is useful in the treatment of anorexia, asthma, arthritis, bronchitis, cardiac disorder, colic, constipation, dyspepsia, diabetes, dysuria, flatulence, gonorrhoea, haematuria, hepatosplenomegaly, jaundice etc. Various flavonoid, alkaloid, saponins, terpenoids, straight chain alcohol and steroid compounds were isolated from the different part of the *Solena*. A wide range of pharmacological action showed by *Solena* like anticancer, antioxidant, anti-inflammatory, antitumor, antimicrobial, diuretic, chemopreventive, Antifeedant, antioxidant, used as carcinogen, antimicrobial, antilipopolsaccharidal, and antitumor properties. Apart from the above activity, cell proliferation inhibitory and anti-angiogenesis activity in human umbilical vein endothelial cell line are also shown by the plant.

**KEYWORDS:** *Solena amplexicaulis*, therapeutic, cell proliferation, flavonoids, terpenoids.

**INTRODUCTION**

Herbal plants are the sources of various number phytochemicals which are utilized for human and animals. It is capable of synthesizing an overwhelming variety of low molecular weight organic compounds called secondary metabolites, usually with unique and complex structures. The medicinal actions of plants unique to particular plant species or groups are consistent with the concept that the combination of secondary products in a particular plant is taxonomically distinct.<sup>[1]</sup> It states that around 85–90% of the world's population consumes traditional herbal medicines.<sup>[2]</sup> In recent decades, studies on phytochemical constituents of medicinal plant and its pharmacological activities have received wide attention.<sup>[3,4]</sup> WHO has emphasized the need to ensure the quality of medicinal plant products using modern techniques with the application of suitable standards. Many modern methods are adapted for identification and quantification of active principle compounds in plant materials. Of them, gas chromatography-mass spectrometry (GC-MS) has become firmly established as a key technological platform for secondary metabolite profiling in both plant and nonplant species.<sup>[5,6]</sup> The plant species *Solena amplexicaulis* is commonly called creeping cucumber and belongs to the family Cucurbitaceae distributed very seldom in the dry deciduous forest and scrub jungles of throughout of India.<sup>[7]</sup>

The medicinal uses of this species are multifaceted. The

local healers of Tamil Nadu and Andhra Pradesh are prescribing this species for many ailments owing to its effective healing property.

A scandent dioecious perennial herb with several tuberous roots spindle-shaped, 1.5-2 cm in diameter and with slender branched furrowed stems bearing simple tendrils; Leaf-stalk slender, 4-10 mm, finely velvet-hairy at first, becoming hairless; leaf blade very variable, polymorphous, ovate, suborbicular, oblong or narrowly lanceolate, 3-5 angled or lobed, lobes are lathery, usually cordate at base, reticulately veined beneath, margins remotely denticulate, oblong-lance shaped, lance shaped, or triangular, 8-12 × 1-5 cm, below densely bristly or almost hairless, above densely bristly or scabrous, base heart-shaped, margin entire or toothed, tip blunt or tapering.<sup>[8-11]</sup>

Flowers are small and yellow in color. Male flowers are umbellate or subumbellate, flower-cluster-stalk is very short, apically with 10-20-flowered. Flower-stalks are 2-8 mm in length, calyx tube about 3-5 mm in length and about 3 mm in diameter. Flowers are yellow or yellow-white in colour, petals are triangular in shape, 1-1.5 mm in size, tip of petals are blunt or pointed, filaments are thread-like, about 3 mm in length. Female flowers are usually solitary, flower-stalk is about 2-10 mm in length, finely velvet-hairy, calyx and flower of female flower is same as male flowers. Ovary is ovoid in shape, 2.5-3.5 × 2-3 mm in diameter, stigmas are 3 in number. Fruit is

red-brown in colour, broadly ovoid, oblong, or nearly spherical in shape, 2-6 × 2-5 cm in size. Seeds gray-white or gray-brown in colour, nearly round or obovate in shape, 5-7 × 5-6.5 mm in size and smooth or slightly tuberculate. The flowering month for the plant is from May to August.<sup>[12]</sup>

There are so many synonyms provided by the different authors like 1. *Bryonia amplexicaulis* Lam., *Melothria amplexicaulis* (Lam.) Cogn., *Melothria heterophylla* (Lour.) Cogn., *Melothria angulata*, *Solena heterophylla* Lour., *Zehneria hastata* Miq, *Zehneria umbellata* Thw.<sup>[8-11,13-15]</sup> Geographical distribution of the plant is throughout India upto 2100 m in the hills<sup>[9,11]</sup> and in word distributed in Indo-China, China, Taiwan, Malaysia<sup>[10]</sup>, Bangladesh<sup>[16]</sup>, Sri-Lanka, Myanmar, Afghanistan and Australia.<sup>[17]</sup>

### TRADITION USE OF PLANT

The tuberous roots are sour, astringent, thermogenic, appetizer, carminative, digestive, purgative, stimulant, cardiotoxic, diuretic, expectorant and invigorating. They are useful in anorexia, asthma, arthritis, bronchitis, cardiac disorder, colic, constipation, dyspepsia, diabetes, dysuria, flatulence, gonorrhoea, haematuria, hepatosplenomegaly, jaundice, haemorrhoids, renal and vesical calculi, seminal debility, spermatorrhoea, snake bite and vomiting.<sup>[9-11,13,18-21]</sup> Rhizome part is used in fever, diarrhoea, promoting milk production.<sup>[16, 21]</sup> The leaves are useful in allergic and other types of inflammation.<sup>[9-11]</sup> Leaf extract is used for the treatment of inflammation related disorders<sup>[22-24]</sup> and also to cure jaundice.<sup>[25]</sup> Based on use value, information consensus factor and fidelity level, Venkatachalapathi *et al.*<sup>[26]</sup> reported that it is one among the five most important species in the treatment of inflammation and wound healing in Nilgiris of Western Ghats being prescribed by the Irula tribal community. In addition to this, it is known from the literature that the tubers are astringent, appetizer, carminative, cardiotoxic, digestive, diuretic, expectorant, invigorating, purgative, stimulant, sour and thermogenic.<sup>[27,28]</sup> Initial records also showed the several therapeutic properties as antimicrobial<sup>[29]</sup> and antioxidant activities<sup>[30,31]</sup> Terpenoids, the characteristic feature of the family, Cucurbitaceae<sup>[32]</sup> are attributed to various pharmacological claims including anti-inflammatory, anticancer, antimalarial, antiviral and antibacterial activities.<sup>[33,34]</sup> Seeds are used for their purgative action.<sup>[9]</sup> Ripe fruits are considered as stomachic and tonic.<sup>[13]</sup> *Solena amplexicaulis* (Lam.) Gandhi also has been used as a traditional medicine for the treatment of dysentery, multiple abscess, gastralgia, urethritis, and eczema in the minority area of China.<sup>[35]</sup>

### CHEMICAL CONSTITUENTS

Alkaloid, glycoside and steroid were reported in root.<sup>[36]</sup> Thirty-five compounds were determined in the methanolic extracts of leaf, stem, and tuber parts of the medicinal climber, *Solena amplexicaulis*, using GC-MS. Six compounds were detected in the methanolic leaf

extract of *S. amplexicaulis*. Among them, the most prevailing major compounds were phytol, a diterpene, carane, a terpene, and 1-octanamine, an aliphatic amine. The methanolic stem extract of *S. amplexicaulis* showed the presence of fifteen different organic compounds. The major phytochemical compounds among them were 4-(4-ethoxyphenyl) but-3-en-2-one, an aliphatic acid, trehalose, sucrose hexadecanoic acid, methyl ester, a linoleic acid ester and 9-octadecenoic acid (Z)-, methyl ester, another linoleic acid ester. Fourteen compounds were identified in the methanolic tuber extract. In this account, 9,17-octadecadienal (Z)-, an unsaturated aldehyde, n-hexadecanoic acid, a palmitic acid, phthalic acid, di(2-propylpentyl) ester, a dicarboxylic acid ester and 9,12-octadecadienoic acid (Z,Z)-, a linolenic acid were the major identified phytochemicals on the basis of quantity.<sup>[37]</sup> Karmakar *et al* were detected thirty two compounds in volatiles from the leaves of *Solena amplexicaulis* by GC-MS and GC-FID analysis. Methyl jasmonate was the major compound which isolated from the plant This volatile constituents could be used in development of baited traps in pest management strategies [38, 39]. Krishnamoorthy was isolated forskolin, (3R,4aR,5S,6S,6aS,10S,10aR,10bS)-6,10,10b-Trihydroxy-3,4a,7,7,10a-pentamethyl-1-oxo-3-vinyldodecahydro-1H-benzo[f]chromen-5-yl acetate) from the methanol leaf extract of *S. amplexicaulis* by column chromatography. By quantitative estimations it was found that the dry powdered leaf sample of *S. amplexicaulis* contained appreciable amount of alkaloid content (9.92 mg/g dry powder). Similarly, the crude methanol and water extracts also displayed considerable amount of phytochemical constituents *viz.*, phenolics, tannins, flavonoids, ascorbic acid and saponins.<sup>[40]</sup>

Karthika *et al* were isolated 6 alkaloids, 6 flavonoids, 2 glycosides, 9 saponins and 3 terpenoids and studied from the methanol extract of the stem of *S. Amplexicaulis* by TLC and HPTLC technique.<sup>[41]</sup> Kabir *et al* also found flavonoid, alkaloid, saponin and steroid compounds in plant extract. The total phenol of *Solena amplexicaulis* of ethanol extract were 12.36 mg/g Gallic acid equivalent and total flavonoid content was 18.9 mg/g Quercetin equivalent. Total ascorbic acid content was found to be 0.357 mg AA/g.<sup>[42]</sup> Twenty-one long-chain alcohols were identified by Chatterjee *et al* between C10 and C30 alcohols from the chloroform extract of leaves of *Solena*. 1-Heptadecanol (780.44 ± 42.59) was the predominant alcohol followed by 1-pentadecanol (737.45 ± 76.73), 1-nonadecanol (559.33 ± 43.47), 1-tridecanol (448.93 ± 40.79), 1-Heneicosanol (338.69 ± 36.77), 1-Tricosanol (245.07 ± 29.86) and 1-Pentacosanol (94.57 ± 8.170). 1-Triacontanol was least abundant representing 3.28 ± 0.55 lg. The remaining individual alcohols displayed difference in the pattern with other alcohols in the leaf extracts.<sup>[43]</sup>

### THERAPEUTIC USES

Some researchers isolated different constituents from the methanolic extract of leaf, stem, and tuber parts of the of

*Solena amplexicaulis* are having anticancer, antioxidant, anti-inflammatory, antitumor, antimicrobial, diuretic, chemopreventive, Antifeedant, antioxidant, used as carcinogen, antimicrobial, antilipopolsaccharidal, and antitumor properties.<sup>[44-51]</sup> K. Krisnamoorthy et al demonstrate the biphasic nature of carrageenan-induced paw edema and significant activity of crude extract from *S. amplexicaulis* in the late phase of inflammation. This activity is due to the ability of extracts to inhibit the release and/or activity of the late mediators involved in carrageenan induced paw edema. Result of the study showed dose-dependent inhibition of edematous volume by the methanol leaf extract. This study clearly demonstrated that the oral administration of crude extract and the isolated compound, forskolin markedly dropped the Carrageenan-induced oxidative stress by significantly boosting the antioxidant enzyme status.<sup>[52]</sup> Parameshwar et al said that methanolic extract of *Solena amplexicaulis* could effectively controlled the AST, ALT, ALP and TB levels and increased the protein levels in the hepatoprotective studies. The histopathological studies also substantiate the activity of the drug. Therefore the study scientifically supports the traditional use of this drug for the treatment of liver disorders.<sup>[53]</sup> Hepatoprotective activity of methanolic extract of the fruits of *Solena amplexicaulis* were also evaluated by Hanwathe et al by CCl<sub>4</sub> intoxication in rats. The extracted treated group remarkably controlled aspartate amino transferase, serum alanine amino transferase, alkaline phosphatase and total bilirubin levels in serum. The histological examination of the rat leaver showed decreased necrotic zone and hepatocellular degeneration when compared to liver exposed to CCl<sub>4</sub>.<sup>[54]</sup> Anti-inflammatory activity of Ether extract of *S. amplexicaulis* was studied by Devi et al. The extract was administered at 100 or 200 mg/kg body weight per oral and the standard indomethacin at 20 mg/kg body weight per oral. The ether extract and indomethacin exhibited significant activity compared with the carrageenan control.<sup>[55]</sup> Arun et al studied anti-inflammatory activity of aqueous extract of leaves of *Solena amplexicaulis*, which was based on plethysmographic measurement of edema produced by sub planar injection of fresh egg white in the hind paw of rat. Percentage inhibition of edema at known intervals in treated animals were used for the purpose of calculating percent inhibition of edema of control. The study revealed that the test extracted compound showed better anti-inflammatory activity. The maximum activity was observed during 45 min. and 60 min. The anti-inflammatory activity may be due to the inhibition of release of histamine, serotonin and kinins.<sup>[56]</sup> Razia et al 2016, reviewed the different plants belongs to cucurbitaceae family showed antidiabetic activity by increase in serum insulin.<sup>[57]</sup> Dhanasekaran et al studied that ethanolic crude extracts of *Solena* showed larvicidal, ovicidal, and repellent potential against the medically important mosquito vectors, *Anopheles stephensi*, *Aedes aegypti* and *Culex tritaeniorhynchus*. Similarly, *S. amplexicaulis* showed the LC<sub>50</sub> value of 109.37 ppm against the larvae of *Cx.*

*Tritaeniorhynchus*. The selected plant extract offers 100% protection against *An. stephensi*, *Ae. aegypti* and *Cx. tritaeniorhynchus* adult female mosquitoes in terms of repellency up to 120 minutes of exposure periods.<sup>[58]</sup> Cell proliferation inhibitory and anti-angiogenesis activity in human umbilical vein endothelial cell line (HUVEC) studied by Yuan et al. They concluded that *Solena* could inhibit the growth of HepG2 cells in a dose- and time-dependent manner. FCM analysis showed that SACE could induce G2/M phase arrest, cell apoptosis, the mitochondrial membrane potential loss and increase the production of intracellular ROS of HepG2 cells. After treatment with SACE, topical morphological changes of apoptotic body formation, increase of apoptosis-related protein expressions, such as Bax, cytochrome c, caspase-3, PARP-1, and decrease of Bcl-2, procaspase-9 protein expressions were observed at the same time. Moreover, SACE caused the significant inhibition of endothelial cell migration and tube formation in HUVEC cells. Therefore, SACE could be a potent candidate for the prevention and treatment of liver cancer.<sup>[59]</sup> Krishna et al concluded that the hexane, benzene, chloroform, methanol and water extracts of the tuber part of *S. amplexicaulis* have inhibitory effects at varying degrees against the growth of bacteria (*Streptococcus faecalis*, *S. pyogenes*, *Bacillus subtilis*, *B. thuringiensis*, *Staphylococcus aureus* and *Enterococcus faecalis* and Gram negative strains viz., *Klebsiella pneumoniae*, *Salmonella paratyphi*, *S. paratyphi A*, *S. paratyphi B*, *Escherichia coli*, *Proteus vulgaris*, *P. mirabilis*, *Serratia marcescens* and *Pseudomonas aeruginosa*) and fungi (*Aspergillus fumigatus*, *A. niger*, *Candida albicans*, *Paecilomyces lilacinus*, *Trichoderma viride*, *Verticillium lecanii*, *Mucor* sp., *Fusarium* sp. and *Penicillium* sp.) tested.<sup>[60]</sup> Karthika et al 2012, examined Aqueous and alcoholic solvent extracts (hexane, benzene, chloroform and methanol) of leaf and stem parts of the *Solena amplexicaulis* against 15 In vitro antibacterial activity against 15 bacterial species which include the Gram positive strains viz., *Streptococcus faecalis*, *S. pyogenes*, *Bacillus subtilis*, *B. thuringiensis*, *Staphylococcus aureus* and *Enterococcus faecalis* and Gram negative strains viz., *Klebsiella pneumoniae*, *Salmonella paratyphi*, *S. paratyphi A*, *S. paratyphi B*, *Escherichia coli*, *Proteus vulgaris*, *P. mirabilis*, *Serratia marcescens* and *Pseudomonas aeruginosa*. The result showed the good antibacterial activity.<sup>[61]</sup> Long-chain alcohols as detected by GC-FID of 100 g *S. amplexicaulis* leaves compared with complete synthetic blend of 21 compounds and a synthetic blend of 6 compounds (1-tridecanol, 1-pentadecanol, 1-heptadecanol, 1-nonadecanol, 1-eicosanol and 1-tricosanol). Soumendranath et al the plant extract showe antibacterial activity at very low concentration whereas single pure synthetic compounds were found to be effective against bacterial pathogen at higher doses. This observation implicates that the synthetic compounds in the blend acted synergistically and thus produced higher inhibition zone against the bacterium.<sup>[62]</sup> Karthika et al tested antifungal properties of leaf and stem parts of

*Solena amplexicaulis* against *Aspergillus fumigatus*, *A. niger*, *Candida albicans*, *Paecilomyces lilacinus*, *Trichoderma viride*, *Verticillium lecanii*, *Mucor sp.*, *Fusarium sp.* and *Penicillium sp.* The study revealed that generally the inhibitory activity is pathogen specific and depends on the solvent, concentration of the crude drug, temperature, plant parts used for the extraction of secondary metabolites and rate of diffusion. The antifungal activity was higher in the methanol extracts against all the tested fungi. It may further indicate that the antimicrobial principles/chemical constituents which are either polar or non polar can be effectively extracted only through the organic solvent medium. Many early studies also reported the effective inhibitory activity of alcoholic solvents against the growth of the pathogenic fungi. The hexane and water showed very less inhibitory effect which might be attributed to the extracting capacity of solvent and the concentration of the active ingredients in the extracts and also most of the active ingredients are dissolved better in alcoholic solvents than in water.<sup>[63]</sup> Kabir *et al.* studied the antioxidant, antimicrobial, toxicity and analgesic properties of ethanol extract of *Solena amplexicaulis* root. The extract exhibited excellent antioxidant activity in DPPH radical scavenging activity. The extract also showed potent activity in brine shrimp lethality bioassay. The LC<sub>50</sub> value was found to 44.677 µg/ml. The extract showed better anti-bacterial activity against gram-negative bacteria. In antifungal assay, the maximum 79.31% of anti-mycotic activity was observed against *Aspergillus ochraceus* while minimum 44.2% against *Rhizopus oryzae*. MIC value ranged between 1500–3000 µg/ml. The extract was found moderately toxic with a 24-hr LD<sub>50</sub> value of 81.47 mg/kg in Swiss albino mice. The degree of inhibition by the ethanolic extract of the root was found less than that of standard analgesic drug diclofenac sodium. The extract also showed moderate anti-inflammatory and antinociceptive activity and anti-diabetic property. Reducing power of the extract was comparable with standard ascorbic acid. Moderate *in vitro* thrombolytic activity, lipid peroxidation inhibition property, metal chelating ability and stress-protective activity was also observed.<sup>[64]</sup>

## CONCLUSION

Medicinal plant is the most exclusive source of life saving drugs for majority of the world's population. They continue to be an important therapeutic aid for alleviating the ailments of human kinds. The search for defense mechanism, longevity and remedies to relieve pain and discomfort drove early man to explore these immediate natural surroundings. It led to the use of plants, animal products and minerals etc., and the development of a variety of therapeutic agents. Today, there is a renewed interest in traditional medicine and an increasing demand for more drugs from plant sources because green medicine is safe and more dependable than costly synthetic drug, many of which have adverse side effects. *Solena amplexicaulis* was investigated at regular interval for their phytochemical components and

their therapeutic effect. The plant contains enormous phytochemical constituents of various medicinal applications. A very less information available of the use of plant as hypolipidemic and anti diabetic. Hence an initiative could be taken for evaluation of these activities which would help the need of the present pharmaceutical world.

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