COMPREHENSIVE REVIEW ON CARDIOSPERMUM HALICACABUM

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ABSTRACT
The plant Cardiospermum halicacabum commonly known as Balloon Vine, belongs to the Sapindaceae family. This plant grows extensively in India, Africa, and South America. Balloon Vine is a woody perennial vine distributed almost globally in the tropics. This plant also known as “khanputi” and Mudakathan in Tamil is used in Ayurveda for the treatment of Rheumatism, lumbago, earache and fever. The plant is commonly referred as "Heart pea", or "winter cherry", "balloon plant / love in a puff". It contains Tannins, Saponins, Flavanoids, Steroids, Terpenoids, Cardiac glycosides, Alkaloids, Anthraquinones. C.halicacabum possesses various medicinal activities such as anti-inflammatory, anticarcinogenic, antidiarrhoeal, antiparasitic, rubefacient, anticonvulsant. The present article summarises the history, chemical constituents and ethnomedicinal uses and pharmacological activities of C.halicacabum.

KEYWORDS: Cardiospermum halicacabum; Mudakathan; anti-inflammatory; anti-rheumatic.

INTRODUCTION
Cardiospermum halicacabum (Sapindacea), English name: Balloon vine, is an annual or sometimes perennial climber, commonly found as a weed throughout India.[1] eaves are deltoid, biternate, 3-8 cm long, leaflets deeply cut, acuminate, laterals oblong or ovate, terminal rhomboid - lanceolate; flowers white, in umbellate cymes, with a pair of peduncles
modified to tendrils. Depressed Capsules or fruits-pyrimorphic, covered with bladder like calyx, winged at the angles of alternate acute, seeds are globose, black, smooth, 4-6mm, white-heart shaped aril present. Widely distributed over America and Asia and mode of distribution is mainly through sea due to their floaty nature of capsules.[2]

HISTORY OF PLANT
The ornamental attraction of Cardiospermum species are their inflated balloon shaped fruits. Cardiospermum species have been extensively moved around the world for both their medicinal and ornamental values. The ornamental trade of C.halicacabum spans more than 100 years. The first records of C.halicacabum in South Africa dates back to 1917, 1919 in Namibia and 1930 in Botswana. Due to its disperse nature over long distances it occurs in North America, South and Central America, China and India.[3]

DESCRIPTION[4]

Climbing tendril - bearing herbs with wiry stems. Annual and perennial; branches slender, striate, pubescent or glabrous.

Leaves

Fig. 1: A. tendril of C.halicacabum with fruits.

Fig. 2: Leaves of Cardiospermum plant.
Alternate, Exstipulate, 2-ternate, leaflets coarsely crenate or serrate. Deltoid, petioles 2-3.8cm long; ultimate segments of the leaves lanceolate, glabrous or sparsely pubescent, inciso-serrate, very acute at the apex and narrowed at the base.

**Flowers**

![Fig. 3: Flowers of C.halicacabum.](image)

White, 3-4mm long, in few-flowered umbellate cymes; peduncles slender, stiff, axillary, 3.8-10cm long, provided beneath the cyme with 2 opposite usually circinate tendrils; pedicels very slender, 3-12mm long. Outer sepals rounded, obovate, usually with a few scattered hairs on the back just below the apical margin; inner sepals larger than the outer, rounded, membranous. Petals rounded at the apex. Style: very short.

**Capsules**

Short stalked, subglobose or more commonly depressed-pyridriform, trigonous, truncate at top, winged at the angles, bladdery, veined.

![Fig. 4: Capsules of C.halicacabum.](image)

**TAXONOMIC IDENTITY**

Kingdom: Plantae
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Sapindales
Family: Sapindaceae
Genus: Cardiospermum
Species: C.halicacabum

ETHNO MEDICINAL USES

Leaf - Rheumatism, Inflammation, Earache, Gas trouble, Chronic rheumatism, Joint pain, Asthma
Stem - Fever, Skin diseases, Chronic rheumatism
Root - Diuretic, Diaphoretic, Chronic rheumatism, Lumbago, arthritis, urinary stone
Seed - Fever
Whole plant - Snake bite, rheumatism, bone fractures, diuretic.
Fruit - Boils

PHYTOCONSTITUENTS

Phytochemical studies indicated that leaves and stem of plant contains a broad spectrum of secondary metabolites in acetone, alcohol, benzene, chloroform and aqueous extracts the following: steroids, phenols, tannins, saponins, sugars, flavanoids, terpenoids.[6]

Leaves - β sitosterol, and its D-glucoside, an alkaloid, oxalic acid and amino acids. The presence of a saponin and Quebrachitol is reported in this plant.[2]

Seed oil - 11-eicosenoic acid-Major fatty acid (42%).
Gas chromatography- mass spectrometry analysis of this plant extract revealed presence of many active compounds in C. Halicacabum such as 1,2,4-trioxolane-2-octanic acid, 5-octyl-methyl ester, ethanol, 2-(9-octadecenylxyl), 1,2,4-Trioxolane-2-octanic acid, 5 octyl methyl ester, ricinoleic acid, {1,1- bicyclopropyl1}-2-octanic acid, methyl ester, 7-methyl-7tetradecan-1-ol acetate, oleic acid, 9-octadecenoic acid, 1,2,3-propanetriyl ester. Apigenin-7-0-glucoronide, arachidic acid, chryserior-7-glucoronide, linoleic acid, luteolin-7-0-glucuronide and stearic acid.[7]

Chemical constituents like cyclohexane-1,4,5-triol-3-one-1-carboxylic acid, benzene acetic acid, caryophyllene, phytol and neophytadine using GC-MS. FT-IR confirmed the presence
of alcohols, phenols, alkanes, alkynes, aliphatic ester, flavanoids in Ethanolic extract of *C. halicacabum*.[8]

A collective separation and identification was performed in *C. halicacabum* plant extracts and compounds identified as follows: pentadecanoic acid, apigenin, protocatechuc acid, protocatechualdehyde, hentriacontanol, calycosin, rutin, quercetin.[9]

Ethanolic extract of *C. halicacabum* highlighted the presence of several compounds including phenolic acids, flavanoids, glycosidic compounds, tannins and sterols including β-sitosterina, campestrina, stigmaterin. Chemical analysis of mucilage obtained by watery extract consists of carbohydrates and nitrogenated substances.[10]

Total phenolic content was identified using Folin-ciocalteu method and the estimated content was found to be 192.7mg equivalents of chlorogenic acid /g of plant extract. HPCL-DAD fingerprint profile of the Methanolic fractions revealed the presence of major constituents like Quercetin, apigenin, apigenin-7-O-glucoside, rutin, luteolin, caffeic acid. HPLC was performed and identified 4 compounds namely rutin, apigenin, apigenin-7-o-glucoside, luteolin. N-hexane fractions was estimated to have β-amyrin, stigmasterol, β-sitosterol.[11]

**Isolation of mucilage**

Mucilage of *C. halicacabum* was isolated from aerial parts of the plants and characterized for Rheological studies, physical characterization, solubility etc., The mucilage being non-toxic, chemically inert, biocompatible can be used as an excipient in pharmaceutical formulations.[33]

**PHARMACOLOGICAL ACTIVITIES**

**Anti-Inflammatory:** Plant exhibit anti-inflammatory effects in *in vivo* animal studies. In the anti-inflammatory test, Ethanolic extract of *C. halicacabum* inhibited the development of paw edema induced by Carr and increased release of CAT, SOD in liver cells. There is also decrease in NO level and serum TNF-α levels after Carr injection.[12] Ethanolic extract of *C. halicacabum* possess worthy anti-inflammatory activity against mouse macrophage cell lines RAW264.[13]

Crude *C. halicacabum* extract administered at a dose of 350mg/kg significantly inhibited the paw swelling in rats after Carrageenan injection.[14]
**Anti-diabetic:** Treatment with *C. halicacabum* extract (CHE) significantly decreased plasma glucose and HbAlc, and increased the levels of insulin and Hb. The 200mg dose of the extract produced a better effect than 50mg or 100mg dosed.\[15\]

Oral administration of kaempferol showed significant inflection in carbohydrate metabolic enzyme levels, improvement in Hb and insulin level reduction in HbAlc level.\[16\] Anti-diabetic effect of *C. halicacabum* ethanolic extract against streptozotocin-induced diabetic rats showed good activity. The flavonoids with antidiabetic principles increase the activity of glucokinase and decrease the activity of glucose-6-phosphotase, fructose-6-phosphotase in liver.\[17\]

**Anti-Arthritic**

A topical herbal gel formulated from *C. halicacabum* and Vitex negundo which shown promising results for the treatment of arthritis.\[18\] LC/MS analysis indicated the presence of anti-inflammatory compounds luteolin-7-O-glucuronide, apigenin-7-O-glucoronide and chrysoeriol.\[19\] The anti-arthritic effects of combined Bi-Herbal ethanolic (BHE) extract is compared with individual ethanolic extracts of *Calotropis gigantea* (ECG) and *C. halicacabum*. The BHE has got a significant reduction of these paw volume and oedema when compared to its individual extract ECG and ECH. The anti-arthritic effects of these plants extracts due to inhibition of protein plants extracts due to inhibiting the proteinase enzymes or stabilizing the membrane from the free radical attack which are generated due to immunological and inflammatory reactions observed in most of arthritic condition.\[20\]

Ethanolic fraction of *C. halicacabum* (EFC) inhibited TNF-α production in a concentration dependent way which was measured with cytotoxicity assay using 1929 tumourogenic murine cell lines. The concentration required to inhibit the production of NO by 50% (IC50 value) was found to be 90 µg/m1.\[21\]

**Antimicrobial activity**

Antimicrobial activity Maluventhan Viji et al.,\[22\] reported antibacterial activity of different extract and were subjected to pharmacognostic and fluorescence analysis, phytochemical and antimicrobial screening against selected Gram positive and Gram-negative bacteria. Acetone and chloroform extracts of leaf had higher inhibitory action against *Salmonella typhi* and *Streptococcus subtilis* respectively. Acetone extracts of stem showed maximum inhibitory
action against S. typhi and benzene extracts of stem had moderate inhibitory action against *Escherichia coli*.

**Anti-anxiety effect**
Nandha kumar et al.,\(^\text{[23]}\) investigated anti-anxiety effects of alcoholic and aqueous root extracts of *C.halicacabum* in mice. Mice were treated with the alcoholic or aqueous extract (100 or 300 mg/kg p.o.) 1 hour before subjecting the animals to various anxiety models. Anti-anxiety activity was checked using elevated plus maze, light-dark model and open field test. In Elevated Plus Maze, treatment with alcoholic and aqueous extracts increased the time spent in open arm and total locomotion time. In light dark model treatment with these extracts showed increase in time spent in light compartment and in Open field test treatment with these extracts increased the time spent in central compartment. These results shows that alcoholic and aqueous extracts of *C.halicacabum* has anti-anxiety activity.

**Neuroprotective effect**
Mona R Kukkar.,\(^\text{[24]}\) investigated the neuroprotective effect of Methanolic extract of *C.halicacabum* against scopolamine (0.5 mg/kg, i.p.) induced neurotoxicity in brain of albino mice. The work was undertaken to evaluate the effect of Methanolic extract of *C.halicacabum*on cognitive functions and anti-cholinesterase activity. Three doses (50, 100 and 200 mg/kg) was injected daily for eight successive days to albino mice of either sex. Scopolamine (0.5 mg/kg, i.p.) was used to induce amnesia in mice. Elevated plus maze and passive avoidance paradigm were used to evaluate learning and memory parameters using Piracetam (200 mg/kg, i.p.) as a standard nootropic agent. The effect of extract on whole brain acetylcholinesterase activity was also evaluated. *C.halicacabum* significantly improved learning and memory and reversed the amnesia induced by scopolamine. It also significantly decreased whole brain acetyl cholinesterase activity.

**Anti-diarrhoeal activity**
The anti-diarrhoeal activity of leaf extracts of *C.halicacabum* and *Dodoneaviscosa* in different experimental models of diarrhoea was reported by Prakash et al.,\(^\text{[25]}\) The anti-diarrhoeal activity was evaluated by castor oil induced diarrhoea. Gastro intestinal motility test and Prostaglandin-E\(_2\) induced enter pooling in experimental animals. The alcoholic and aqueous extracts of *C.halicacabum* and *Dodoneaviscosa* have showed the dose dependantantidiarrhoeal activity in the three experimental models by decreasing the frequency of faeces as well as total weight of wet defecation, decreased the propulsion of
charcoal meal through the gastrointestinal tract and also decrease in the water quantity in the intestine of the animals. The study reported that *C. halicacabum* and *Dodonea viscosa* has a therapeutic effect to formulate a phytomedicine to treat diarrhoea.

**Anti fungal activity**

Roberta Gaziano et al.,[26] reported *in silico* and *in vitro* the antifungal activity of an extract of *C. halicacabum* against *T. rubrum* shows a potential interaction with Hsp90(chaperone protein), in both pathogenicity and drug susceptibility of *T. Rubrum*. Antifungal activity of the total plant extract of *C. halicacabum* at the highest concentrations (500 and 250 µg) is evaluated. The luteolin and rutin molecules have been identified in silico as the potential inhibitors of Hsp90.

**Anti Cancer activity**

Sivakumari et al.,[27] reported the anti-cancer activity of the three leaf extracts of *C. halicacabum* against MCF-7 cell line. GC-MS study of the leaf extract having anticancer activity. The anticancer activity was investigated by MTT assay method and GC-MS spectral analysis was done for the extract has antiproliferative activity. Methanol extract gave IC50 value of 24.90 µg/ml, whereas aqueous and chloroform extracts shows IC50 value of 43.51 µg/ml and 40.34 µg/ml respectively for potential in vitro anticancer activity. The GC-MS spectra of methanol extract showed 14 peaks. The study indicates the anti-cancer potential of *C. halicacabum* leaves.

**Anti convulsant effect**

Daniel Dhayabaran et al.,[28] investigated the anticonvulsant effects of alcoholic root extract of *C. halicacabum* on the various murine models of epilepsy. The root extract of the plant was given to male swiss albino mice at doses of 30, 100 and 300 mg/kg. The brain monoamine levels were evaluated after two days administration. At doses of 100 and 300 mg/kg significantly delayed the onset of clonus and tonus in pentylenetetrazol, isoniazid and picrotoxin-induced convulsions. Tonic hind limb extension was reduced at doses of 100 and 300 mg/kg as compared to vehicle control in maximal electroshock model. Brain monoamine analysis by HPLC showed a potential inhibition of nerve cells activity. in cerebellum. These results shows that alcoholic root extract of *C. halicacabum* possesses a potential anticonvulsant activity.
Antiparasitic activity

Antiparasitic activity of aqueous and alcohol extracts of *C. halicacabum* plant, were tested *in vitro* for its anti parasitic effect against third-stage larvae of *Strongyloides stercoralis*. The larvae (1,000 larvae/ml), cultured in phosphate buffer saline solution, pH 7.4, were treated against aqueous and alcohol extracts (2,000 µg ml⁻¹) of *Cardiospermum halicacabum* at 37°C with 5% CO₂. Ivermectin (250 µg/ml) and piperazine (2,000 µg/ml) were the standard drugs. The viability of Strongyloides larvae based on its motility was monitored each day for 7 days. Strongyloides larvae were died, after exposure to aqueous and alcohol extracts of *C. halicacabum* within 3 days and 2 days, respectively, while Ivermectin took from 3 to 6 days, and piperazine more than 7 days, to attain the equal rate of inanition.[29]

Diuretic Activity

Velmurugan et al.,[30] reported Diuretic Activity of aqueous and ethanolic leaves extract of *C. halicacabum*, medicinal plant, in experimental Wister rats. The aqueous and ethanolic leaves extract *C. halicacabum* Linn was given to rats at the dose 200 mg/kg and standard furosemide (10 mg/kg) also given. Excessive amount of urination in aqueous extract is observed when compared to ethanolic extract.

Anti Ulcer Activity

Sheeba et al.,[31] reported Anti ulcer activity of ethanol extract of *C. halicacabum*, in a concentration (200-600mg/kg) of extract inhibits gastric ulcers induced by oral administration of absolute ethanol. Extract of *C. halicacabum* increases gastric glutathione and decreases alkaline phosphatase activity. The extract shows anti ulcer activity in vitro hydroxyl radical scavenging and inhibition of lipid peroxidation activities.

Clonal propagation: A simple and effective protocol for invitro cloning of mature plants of *C. halicacabum* using nodal shoot segments has been successfully developed using Murashige and skoog medium (MS) + 2.0mg1-1 Indole-3 Butyric acid.[33]

REFERENCES


