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“Comprehensive Overview On *Cardiospermum Halicacabum* Linn.”

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Abstract:

Medicinal plants serve as natural reservoirs of bioactive phytochemicals that can address various health conditions due to their significant physiological impacts on the human body. Its common name, Heart-seed, is derived from the Greek words "cardio," meaning heart, and "sperma," meaning seed. Once ripe, the black seeds display a white heart-shaped pattern. *Halicacabum* is a Latin term referring to a plant characterized by inflated fruits. *Cardiospermum halicacabum* is a deciduous climbing shrub that typically reaches about 3 meters in height and is frequently highly branched from its base. The stems scramble across the ground, climbing into nearby vegetation to support themselves. The plant is primarily harvested from the wild for local use as medicine, food, and a source of various commodities. India, renowned for its rich ethnic diversity and unique biodiversity, boasts a centuries-old tradition of using ethnobotanical knowledge to promote health and treat illnesses. *Cardiospermum halicacabum*, a climber in the Sapindaceae family known for its inflated fruits and seeds featuring a white heart-shaped pattern, is one of the medicinal herbs. The primary phytochemical constituents of this plant include alcohols, phenols, alkynes, flavonoids, alkanes, and aliphatic esters. Phytochemical analysis identified the presence of terpenoids, flavonoids, tannins, proteins, saponins, glycosides, carbohydrates, volatile esters, and fatty acids in the herb. *Cardiospermum halicacabum* has been shown to possess a wide range of biological activities, including antioxidant, antiviral, anti-ulcer, antidiabetic, anticonvulsant, antipyretic, anxiolytic, anticancer, antibacterial, antiarthritic, antifungal, antiparasitic, and fertility-promoting effects. This plant's decoction is employed to treat dysentery, diarrhea, colds, asthma, and pertussis. The plant has been traditionally used as a refrigerant, emetic, stomachic, diuretic, and laxative, as well as for wound healing and treating earaches. This review provides a comprehensive overview of the phytochemical constituents, pharmacological activities, microscopic and macroscopic characteristics, and traditional uses of *Cardiospermum halicacabum*.

Keywords: *Cardiospermum halicacabum*, ethnobotanical, wound healing, anti-inflammatory.

Introduction: Medicinal plants have long been utilized in traditional medicine to address various health conditions. Approximately 75% to 80% of the global population relies primarily on herbal medicines. The majority of these plants possess medicinal properties and were investigated for novel and effective compounds. The diverse phytochemicals found in plants play a crucial role in treating life-threatening diseases. The name *Cardiospermum* comes from the Latin words "cardio," meaning heart, and "sperma," meaning seed, referring to the heart-shaped pattern on the seed. The name *halicacabum* originates from the Latin term "halicacabus," which denotes a plant bearing inflated fruits. The balloon vine, *Cardiospermum halicacabum*, is a member of the Sapindaceae family. It is a climber widely distributed across tropical and subtropical regions. The balloon-vine is native to Bermuda, Florida, and Texas. This plant is native to the tropical forests of East Africa, with a distribution across Africa and Asia, including throughout India. It is a woody, branching perennial herbaceous climber that can grow up to 10 feet tall. Different parts of the plant are used to treat limb stiffness, snake bites, and rheumatism. In Ayurveda and folk medicine, this plant is employed to alleviate fever, lumbago, and earache. It is also employed as a stomachic and diuretic. It exhibits a range of pharmacological activities, including antioxidant, anti-diabetic, anti-viral, anti-convulsant, anti-diarrheal, anti-cancer, anti-bacterial, and anti-fungal properties. This herb is valuable for the production of commercial drugs due to its rich content of constituents such as beta-sitosterol, its D-glucoside, amino acids, oxalic acid, saponins, quebrachitol, oleic acid, eicosonic acid, erucic acid, octanoic acid, n-hexadecenoic acid, and triterpenoids. In Ayurvedic pharmacopoeia, the root of the medicinal plant *Cardiospermum halicacabum*, known as 'karnasphota', is officially recognized for its therapeutic applications in treating jvara, kusta, ksaya, and sandhivata.

Description:

Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta
Superdivision	Embryophyta
Division	Tracheophyta
Subdivision	Spermatophytina
Class	Magnoliopsida
Superorder	Rosanae
Order	Spindales
Family	Spindaceae
Genus	<i>Cardiospermum</i>
Species	<i>Helicacabum</i>

Table No.1

Morphology:

Cardiospermum halicacabum plant is an herbaceous vine featuring bi-ternate leaves. The leaflets are ovatelanceolate in shape, featuring a glabrous texture, smooth surface, and dentate margins. The leaf measures 3 to 5 cm in length and 1.5 to 2 cm in width. The plant's stem is green and measures 0.2 to 0.3 cm in width. The petiole measures approximately 1.5 to 2.5 cm in length. The flowers are tetramerous and irregular, featuring 2+2 sepals, 2+2 equal petals, and 8 unequal stamens. The ovary is tricarpeal, with each carpel containing a single ovule. It features a trifid stigma and globose fruits characterized by a winged, bloated capsule.

**Fig No.1****Microscopy:****Leaf Microscopy:**

Leaf microscopy reveals a prominent midrib extending both adaxially and abaxially, accompanied by a thin dorsiventral lamina. The adaxial part of the midrib is thick and pyramid-shaped, whereas the abaxial part is semicircular with a wavy outline. The midrib is approximately 350 μ m thick. The lamina has a thickness of approximately 60 to 70 μ m. The adaxial epidermis is narrow and cylindrical, while the abaxial epidermal cells are thin and elliptical.

Stem Microscopy:

Microscopic sectional views of stem reveal a pentagonal stem featuring continuous epidermal layers composed of spindle-shaped cells with a prominent cuticle. The appearance of darkly stained cells. The parenchyma tissues are broader, and the cells within the ridges are enlarged. The stem is encircled by multiple layers of small cells forming thick sclerenchyma tissue. The vascular cylinder consists of a wider phloem cylinder that encloses an inner xylem cylinder. These fibers are characterized by thick, lignified walls and a wide lumen.

Phytochemical Constituents:

FT-IR spectral analysis of the ethanolic leaf extract of *Cardiospermum halicacabum* revealed the presence of alcohols, phenols, alkynes, flavonoids, alkanes, and aliphatic esters. GC-MS analysis of twenty-four compounds identified cyclohexane-1, caryophyllene, neophytadiene, 4,5-triol-3-one-1-carboxylic acid, phytol, and benzene acetic acid as the major constituents. The plant also contains various other chemical constituents, including 1-hydrotetradecane, 11-trimethyl-8-methylene, N-methyl tomatidine, 3-methylbutanamide, phenylethyl alcohol, hexadecane, nonadecane, heptadecane, benzene acetic acid, 14-methyl-8-hexadecyne, 5-dinitrobenzene, hexadecenoic acid, and octadecanoic acid.

Pharmacological Activities:

Anti-oxidant activity: Reactive oxygen species are linked to chronic diseases such as cancer, plaque buildup, arthritic conditions, and other age-related issues. The anti-oxidant activity of *Cardiospermum halicacabum* has been studied using its methanol extract in various in vitro methods like superoxide nitric oxide radical scavenging, beta-carotene-linoleate model system, reducing power, 1,1-diphenyl-2-picrylhydrazyl (DPPH), and iron ion chelating activity. The methanolic extract showed strong inhibition in the beta-carotene-linoleate model system and moderate, concentration-dependent inhibition in DPPH radical scavenging. It also has reducing power, nitric oxide scavenging activity, superoxide scavenging capacity, and the ability to chelate ferrous ions, all contributing to its anti-oxidant properties. The anti-oxidant property of *Cardiospermum halicacabum* methanolic extract was confirmed in these models. Another study used the plant's chloroform and ethanolic extracts. The anti-oxidant activity was tested using models like nitric oxide scavenging, DPPH, hydrogen peroxide scavenging, reducing power assay, ABTS, and superoxide scavenging. Compared to the ethanol extract, the chloroform extract showed stronger anti-oxidant properties.

Anti-fungal activity: Dermatophytosis is a fungal infection affecting the skin, nails, and hair, and it is a significant public health concern due to its increasing frequency and severity. The fungi *Trichophyton mentagrophytes* and *Trichophyton rubrum* are the main causes of this infection. *Cardiospermum halicacabum* extract was evaluated for its antifungal activity against *T. rubrum*, suggesting that interactions with Hsp90 (a protein involved in fungal survival) may play a key role. Various concentrations of *C. halicacabum* (from 500 to 31.25 µg) were tested in vitro against *T. rubrum*. Computational analysis showed that several active compounds in *C. halicacabum* interact with Hsp90. The highest concentrations (250 and 500 µg) showed distinct antifungal effects. Rutin and luteolin, two compounds found in *C. halicacabum*, were identified as the most effective Hsp90 inhibitors. When tested individually, rutin and luteolin had some anti-fungal activity, but less than when used in the full plant extract. This study indicates that *C. halicacabum* has a strong fungistatic effect against *T. rubrum*, supporting its potential as a treatment for fungal infections. Another study using the ethanolic extract of *C. halicacabum* showed anti-fungal activity against *Candida albicans*, with a minimum inhibitory concentration of 190 µg extract/ml.

Anti-inflammatory activity: Inflammation occurs when the body is exposed to infectious agents like microbes, viruses, or fungi, or due to tissue damage, cell death, or other conditions like cancer or ischemia. It plays a role in both the body's innate and adaptive immune responses. The anti-inflammatory effects of *Cardiospermum halicacabum* were studied using its ethanolic and aqueous extracts. The ethanolic extract was tested in mice with carrageenan-induced paw oedema. The extract helped reduce paw oedema caused by carrageenan. It also increased the activity of enzymes like glutathione peroxidase (GPx), superoxide dismutase (SOD), and catalase (CAT) in the liver. These findings suggest that the ethanolic extract could be a potential anti-inflammatory agent.

Anti-malarial activity: *Cardiospermum halicacabum*, traditionally used for treating malaria, was tested for its anti-malarial effects in both in vitro and in vivo studies. The aqueous extract was found to be toxic to mice, with no survivors after four days of oral administration. There was no evidence of protection against *Plasmodium berghei* malaria. This study highlights the possible differences between in vitro and in vivo results and the importance of considering in vitro findings when evaluating plant-derived extracts.

Anti-arthritic activity: Rheumatoid arthritis is an inflammatory condition that leads to the destruction of joint and surrounding tissues, causing significant worldwide health issues. The anti-arthritic effects of the ethanolic extract from

Cardiospermum halicacabum leaves were tested. Rats were given the extract orally at doses of 125 mg/kg and 250 mg/kg, following induction of arthritis using Freund's complete adjuvant (FCA). Various haematological indicators like haemoglobin (Hb), white blood cell count (WBC), red blood cell (RBC) count, and erythrocyte sedimentation rate (ESR) were used to assess the treatment effects. The extract showed a dose-dependent reduction in FCA-induced arthritis, with more significant effects observed at 250 mg/kg compared to the standard drug Indomethacin (10 mg/kg). Extract treatment also improved body weight in arthritic animals. The results suggest that the ethanolic extract of Cardiospermum halicacabum has anti-arthritic properties.

Nutritional value:

Cardiospermum halicacabum, also known as balloon vine, is a nutrient-rich leafy green vegetable.

Per 100 grams of fresh leaves, it contains:

- Energy: 455.6 kcal
- Carbohydrates: 96.5 g
- Protein: 5.67 g
- Fat: 0.58 g
- Fiber: 6.83 g
- Calcium: 608.4 mg
- Iron: 12.3 mg

It is also rich in phytochemicals like flavonoids, alkaloids, saponins, and terpenoids, which contribute to its medicinal benefits.

Traditional Uses:

1. Leaves (Most Versatile Part)

- Joint Pain: Crushed leaves are used as a poultice or cooked in castor oil and then wrapped around joints to help with rheumatism and arthritis.
- Skin Health: A paste made from fresh leaves is applied to treat eczema, itchy skin, and to reduce swelling from insect bites.
- Respiratory & Fever: A tea made from the leaves is consumed to treat coughs, asthma, and to induce sweating to reduce fever.
- Earaches: The juice from the leaves is warmed slightly and used as ear drops for pain relief.
- Culinary: In Tamil Nadu, where it is known as Mudakathan Keerai, the leaves are added to dosa batter or made into soup to prevent joint stiffness.

2. Roots

- Neurological Issues: Root extracts are used in Ayurvedic medicine for treating epilepsy, nervous disorders, and anxiety.
- Digestion: The roots act as a mild laxative and are used to treat long-term constipation.
- Women's Health: A root decoction is traditionally used to regulate menstrual cycles and treat amenorrhea. It is also sometimes used after childbirth to help the uterus return to its normal size.



3. Seeds

- Male Fertility: In traditional Siddha medicine, the seeds are believed to increase sperm count and motility.
- Tonic: Ground seeds are mixed with milk and taken as a general health tonic.
- Laundry: Due to their high saponin content, the seeds were historically crushed and used as a natural soap for washing delicate fabrics.

4. Stem & Whole Plant

- Diuretic: The whole plant is boiled to make a drink that helps flush the urinary tract and treat dropsy (edema).
- Hair Care: The plant is infused into hair oils to treat dandruff and prevent hair loss.
- Crafts: The flexible, climbing stems are sometimes used in rural areas to make small baskets or mats.

Adverse Drug Reaction: There are not many reports of adverse reactions from this plant. Skin issues like itching, rash, and irritation are treated with a formulation containing *Cardiospermum halicacabum* (10%). However, it is advisable to avoid using this cream during pregnancy.

Conclusion: *Cardiospermum halicacabum* has considerable therapeutic value and is used to treat both minor ailments and chronic conditions. It is an uncultivated crop usually eaten as a leafy vegetable in India. It has a wide range of phytochemical compounds that contribute to its therapeutic effects. Scientific studies have shown that this plant has several pharmacological activities in vitro. Additionally, the plant *C. halicacabum* has been suggested as a lead compound for developing a cost-effective and non-toxic medication. Although some studies have connected its activities with the active components present, more data is required to extract, identify, and evaluate the nature of bioactive compounds and their underlying mechanisms to create industrial pharmaceuticals. Various studies have revealed the antioxidant, antiviral, anti-inflammatory, antifilarial, antimalarial, antibacterial, anxiolytic, antiarthritic, antiparasitic, anticancer, antidiarrheal, antifungal, antipyretic, antisickling, adulticidal, and fertility properties of the plant.

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