

Exploring the Therapeutic Potential of *Cardiospermum halicacabum*: A Multifunctional Medicinal Climber

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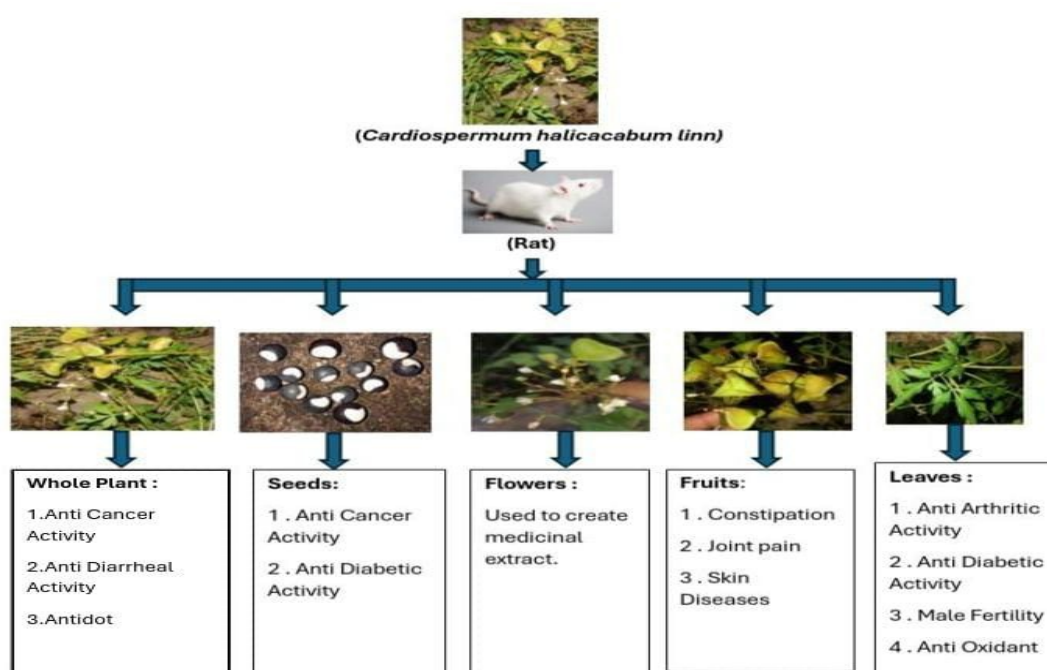
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ABSTRACT

Cardiospermum halicacabum Linn. Commonly known as Balloon Vine, is a medicinal climbing plant belonging to the family Sapindaceae. It has been traditionally used for its diverse pharmacological properties such as antidiabetic, antirheumatic, anti-inflammatory, antioxidant, anticancer, antifungal, and antimicrobial activities. The plant contains a rich profile of phytochemicals, including flavonoids (apigenin, luteolin), saponins, tannins, terpenoids, alkaloids, and glycosides. Experimental studies on different extracts like ethanolic, aqueous, and petroleum ether demonstrate significant therapeutic potential. The ethanolic extract of leaves shows strong anti-arthritic and antioxidant activity, while the seed extract exhibits potent cytotoxic effects against colon, skin, and breast cancer cell lines. Root extracts have displayed anticonvulsant activity with minimal toxicity, and the leaf extract improved sperm count and testosterone levels in male rats. These findings highlight the plant's potential as a multi-target natural remedy. Overall, *Cardiospermum halicacabum* represents a promising candidate for future drug development owing to its wide pharmacological spectrum and safety profile.

Key Words: Anti-arthritic, Anti-Inflammatory, Antidiabetic, Respiratory Problems, Skin Diseases, Snakebite

Graphical Abstract: Pharmacological profile of *Cardiospermum halicacabum* Linn



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INTRODUCTION

The *Cardiospermum halicacabum* are also known as Balloon vine. It is commonly found in distributed areas like roadside riverbanks and open fields. It is fast growing, climbing plant found across tropical and subtropical regions. It should be planted in well-drained soil in full sun area. For optimal growth requires 25 °c temperature and avoid over watering which can leads to root damage. In these the plant characterized by its distinctive, inflated, balloon like fruits that contains three small black seeds with a white heart shaped spot. The various parts of plant like Root, stem, leaves, and seeds are used for different diseases. The effectiveness of plant small scale

observation. It belongs to the family Sapindaceae.⁰¹ It is traditionally used for different diseases. It works on gram positive and gram-negative microbial activity 02 as well as fungal activity. In India, it is a popular leafy green vegetable. It is a crucial herb in conventional Ayurvedic medicine. The plant exhibits a broad spectrum of pharmacological activities including abdominal pain, nervous disorder, antirheumatic, anticancer, anticonvulsant, antiviral, anti-ulcer, anxiolytic, antipyretic, antimicrobial, hyperthermia, anti-inflammatory, anti-arthritic, analgesic antioxidant, anti-parasitic, antidiabetic, fertility issues, ear and eye issues, respiratory problems, nervous system, skin diseases, also used to treat snakebite.

Table -01: Different Names of *Cardiospermum halicacabum*

Synonyms	Balloon vine, heart pea, heart seed vine, love in a puff and winter cherry , puff ball
Scientific Synonyms:	<i>Cardiospermum corindum</i> , <i>Cardiospermum glabrum</i> , <i>Cardiospermum inflatum</i> , <i>Cardiospermum corycodes</i> , <i>Cardiospermum luridum</i>
Vernacular Name :	Marathi: Kanphuti, Kaanphodi, kapal-phodi Sanskrit : Indravali , Jyotishmati, Triputa Hindi : Kanphuta, Bari -chirmi, Chirputa Tamil : Mudakathan , Kottavan, Uzhinjai Malayalam : Ulinja, Katabhi, Palloolavum Kannada: Chitaki Hambu, Jotishmati, Telugu : Budda kakara Bengali : Lataphatki , Sibjhul



Figure 1: *Cardiospermum halicacabum* linn (01-Fruits, 02-whole plant, 03-Seeds, 04-Flowers, 05 Leaves)

Geographical Source: The tropics and subtropics of Africa, America, Asia and Central and South America

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Chemical Components: The carbohydrates, proteins, lipids, saponins, flavonoids and steroids. It is also rich in compounds like flavonoids like apigenin and luteolin and fatty acids like oleic acid and stearic acid. Other compounds include terpenoids includes photos and caryophyllene, tannins include a group of phenolic compounds, alkaloids, glycosides and volatile compound like alcohol, alkanes, alkynes and aliphatic esters. Leaves contains Oxalic acid and various amino acids.

Table -02: Taxonomical Information

Class	Name
Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Sapindales
Family	Sapindaceae
Genus	Cardiospermum
Species	Halicacabum

Pharmacological Activity

Anti-Arthritic Activity:

Parts Used: Leaf

Animal: Wistar Rat

The goal of the current study was to profile the phenolic components of the ethanol extract of *Cardiospermum halicacabum* leaves (EECH) using LC-MS/MS, as well as to examine the antioxidant qualities and anti-rheumatic effects of the extract in Wistar rats with CFA-induced arthritis.⁰⁴

Method: NO and superoxide anion scavenging tests were used to assess the extract's capacity to scavenge free radicals. CFA caused the albino Wistar rats to develop arthritis. Arthritic rats were given oral EECH at doses of 250 and 500 mg/kg per day for 20 days, 15 days following CFA induction. The reference standard was diclofenac sodium. To identify phenolic chemicals, EECH is subjected to LC-MS/MS analysis.⁰⁴

Anti-Cancer Activity:

Parts Used: Seeds

One of the biggest public health issues of modern lifestyle is the rise in cancer and related chronic illnesses. Natural medicines have great demand despite the various approaches utilized to treat these disorders because of their considerable impact as therapeutic agents and immunological enhancers, as well as fact that they have less adverse effects than other treatment options. Therefore, based on conventional claims, this study was conducted to assess the cytotoxic impact of *Cardiospermum halicacabum* Linn seeds.⁰⁵

Method: Several extracts from *Cardiospermum halicacabum* Linn seeds were obtained using a Soxhlet extractor. The cytotoxic effect of the different extracts on HT-29, HCT-15 colon carcinoma, SK-MEL-2 skin carcinoma, and MCF-7 breast carcinoma was assessed using the Sulforhodamine B colorimetric (SRB) assay. The outcomes were contrasted with the standard medication, doxorubicin.⁰⁵

Anti-Bacterial Activity:

Parts Used: Leaves and stem

A variety of pharmacognostic and fluorescence analyses, phytochemical screening, and antimicrobial screening against specific Gram positive and Gram-negative bacteria were performed on the crude extracts from the leaves and stem of *Cardiospermum halicacabum* in various solvents. Acetone, alcohol, benzene, chloroform, and leaf and stem aqueous extracts were utilized for antibacterial activity and phytochemical screening.⁰⁶

Wide range of secondary metabolites have been found in the leaf and stem, according to phytochemical investigations. All five of the leaf solvent extracts that were tested contained phenol, tannins, and saponins in the highest concentrations, followed by steroids, sugars, flavonoids, and terpenoids (acetone and benzoene). Similarly, the main components of all the solvent extracts of the stem that were tested were phenol, tannin, and amino acids.⁰⁶



Anti-Fungal Activity:

Because of its high prevalence and related morbidity, dermatophytosis—a superficial fungal infection restricted to the stratum corneum of the epidermis or to the hair and nails—represents a significant public health issue. The most common pathogens are dermatophyte fungus, particularly two species: *Trichophyton rubrum* and *Trichophyton mentagrophytes*. Dermatophytoses are currently treated with topical antifungal medications, primarily azoles or allylamines, while systemic treatment may be necessary in certain situations, such as when nail and hair involvement is present.⁰⁷

Method: We examined in vitro how various *Cardiospermum halicacabum* concentrations (ranging from 500 to 31.25 µg) affected a clinical isolate of *T. rubrum*. Additionally, the interaction between various active chemicals of *Cardiospermum halicacabum* and the fungal Hsp90 was examined using a computational evaluation.⁰⁷

Anti-Diabetic Activity:

Parts Used: Leaf

Animal Used: Wistar Rat

To examine the protective effect of leaf extract from *Cardiospermum halicacabum* (*C. halicacabum*) on the metabolism of glycoproteins in rats with diabetes induced by streptozotocin (STZ).⁰⁸

Method: Male albino Wistar rats were given intraperitoneal STZ to develop diabetes. Normal and STZ-diabetic rats were given the *Cardiospermum halicacabum* leaf extract (CHE) orally for 45 days. Hexose, hexosamine, fucose, and sialic acid glycoproteins in plasma and tissue were examined in relation to *Cardiospermum halicacabum* leaf extract (CHE).⁰⁸

Anti-Inflammatory and Anti-Oxidant Activity:

Parts used: Leaf and stem

Chinese medicine has long made use of *Cardiospermum halicacabum* (CH). Its fingerprint chromatogram, anti-inflammatory, antioxidant, and mechanism still need to be investigated, though. Thus,

the purpose of this study was to examine the anti-inflammatory and antioxidant properties of CH extracts and their reference compounds both in vivo and ex vivo.⁰⁹

Method: The ethanolic extract of CH (ECH) fingerprint chromatogram was developed in HPLC analysis. The antioxidant and LPS-induced NO production effects of ACH (aqueous extract of CH) and ECH extracts were evaluated in RAW264.7 cells. ECH's in vivo anti-inflammatory properties were assessed in mice with paw edema brought on by λ -carrageenan (Carr). Through analyses of the liver's glutathione peroxidase (GPx), catalase (CAT), and superoxide dismutase (SOD) activities as well as the edema paw's levels of MDA and nitrite oxide (NO), we look into the anti-inflammatory mechanism of ECH. TNF- α and serum NO levels were also assessed.⁰⁹

Anti-Diarrheal Activity:

Parts Used: Whole Plant

Animal Used: Rat

Cardiospermum halicacabum Linn whole plant extracts' used to antidiarrheal properties in rats.¹⁰

Method: Aqueous (AqCH) and petroleum ether (PeCH) extracts of the entire *Cardiospermum halicacabum* (Linn) plant were made by the maceration process, followed by extraction in a soxhlet apparatus. In albino mice, LD50 tests were performed for each of the three extracts up to the 2000 mg/kg dose limit. To investigate the antidiarrheal activity in various experimental models, including castor oil-induced diarrhea, prostaglandin E2 (PGE2)-induced enteropooling, and the charcoal meal test in rats, one-fifth of the maximum dose of LD50 of each extract was chosen.¹⁰

Male Fertility:

Parts Used: Leaf

The sperm counts and sperm motility in both the caput and cauda regions significantly increased after 30 days of treatment with 100 mg/kg and 200 mg/kg body weight of *Cardiospermum halicacabum* aqueous



leaf extract (ALE). Furthermore, at all administered dosages, a notable rise in serum testosterone levels was visible. There were no appreciable variations in the weight of the sex organs, though. In addition, aqueous leaf extract reduced the overall number of resorption sites in the pregnant females while increasing the number of implantations, viable fetuses, and females impregnated. ALE demonstrated a hepatoprotective effect, but the serum total cholesterol level stayed constant and there were no reports of renotoxicity. It was determined that *Cardiospermum halicacabum* aqueous leaf extract improved sperm concentration, motility, and testosterone, which improved fertility.¹¹

Nervous Disorder:

Parts Used: Leaves

The ancient Indian medical system known as Ayurveda makes use of medicinal plants because of their neuroprotective properties. According to Ayurveda, the leaves of *Cardiospermum halicacabum* have important neuroprotective qualities. The buildup of tau, acetylcholinesterase, and amyloid- β tangles that disrupt neural transmission and reduce cognitive function is a hallmark of Alzheimer's disease.¹²

Method: In order to optimize and integrate the effects of process variables, specifically powder weight, solvent volume, and extraction time, on the microwave-assisted extraction (MAE) of *Cardiospermum halicacabum* leaves, this study used the Box-Behnken design within the response surface methodology (RSM). These factors, in addition to microwave usage, had a significant impact on the extraction yield, according to the optimization process. Gas chromatography-mass spectrometry

(GC-MS) analysis was used to analyze the ethanolic extract. Computer-based simulations, such as docking, absorption, distribution, metabolism, excretion, and toxicity (ADMET) studies, drug-likeness assessment, molecular dynamics, LigPlot analysis, and density functional theory (DFT) analysis, were used to further analyze the phytoconstituents that were found.¹²

Anti-Convulsant Activity:

Parts Used: Root

The current study's objective was to assess the anticonvulsant properties of *Cardiospermum halicacabum* L., Sapindaceae (ARECH) alcoholic root extract on a variety of epilepsy-modeling mice. Prior to evaluation, male Swiss albino mice were given oral doses of 30, 100, and 300 mg/kg of the plant's root extract. After two days of administration, the levels of monoamines in the brain were measured. At doses of 100 and 300 mg/kg, ARECH markedly postponed the onset of tonus and clonus in convulsions caused by picrotoxin, isoniazid, and pentylenetetrazol.¹³

In the maximal electroshock model, tonic hind limb extension was also reduced at doses of 100 and 300 mg/kg in comparison to vehicle control. Even at the highest dose given, 900 mg/kg, no discernible motor toxicity was seen. GABAergic activity in C+ (in the cerebellum) and C- (apart from the cerebellum) was significantly elevated, according to HPLC analysis of brain monoamines. According to these findings, ARECH has a low profile of motor toxicity and strong anticonvulsant action. An increase in GABAergic activity could be the cause of this activity.¹³

Table -03: Summery of Pharmacological Activities of *Cardiospermum halicacabum* with Corresponding Doses, Diseases, and Experimental Models

S. No.	Activity / Disease	Parts Used	Animal Used / Model	Dose / Concentration	Remarks / Findings
1	Anti-Arthritic Activity	Leaf	Wistar Rat (CFA-induced arthritis)	250 and 500 mg/kg (oral, 20 days)	Ethanolic extract (EECH) reduced arthritic symptoms; antioxidant and phenolic profile analyzed by LC-MS/MS.
2	Anti-Cancer Activity	Seeds	In vitro (HT-29, HCT-15, SK-)	Various extracts tested;	Soxhlet extracts showed cytotoxicity compared with



			MEL-2, MCF-7 cell lines)	dose not specified	doxorubicin using SRB assay.
3	Anti-Bacterial Activity	Leaves and Stem	In vitro (bacterial strains: Gram + and Gram –)	Not specified	Acetone, alcohol, benzene, chloroform, and aqueous extracts active against bacteria; phenols, tannins, saponins major constituents.
4	Anti-Fungal Activity	Not specified (whole extract used)	In vitro (T. rubrum, T. mentagrophytes)	31.25–500 µg	Effective against dermatophyte fungi; in silico studies on fungal Hsp90 interactions.
5	Anti-Diabetic Activity	Leaf	Wistar Rat (STZ-induced diabetes)	Dose not specified; oral for 45 days	Leaf extract (CHE) improved glycoprotein metabolism in diabetic rats.
6	Anti-Inflammatory & Anti-Oxidant Activity	Leaf and Stem	Mice (Carrageenan-induced paw edema); RAW264.7 cells (in vitro)	Dose not specified	Ethanollic (ECH) and aqueous (ACH) extracts reduced edema, NO levels, and improved antioxidant enzyme activity.
7	Anti-Diarrheal Activity	Whole Plant	Rat (Castor oil-, PGE ₂ -, charcoal-induced models)	1/5 of LD ₅₀ (≤2000 mg/kg tested for LD ₅₀)	AqCH and PeCH extracts showed significant antidiarrheal activity.
8	Male Fertility Enhancement	Leaf	Male Rat (fertility test)	100 and 200 mg/kg (30 days)	Aqueous extract (ALE) increased sperm count, motility, testosterone; no toxicity observed.
10	Neuroprotective /Nervous Disorder (Alzheimer's)	Leaf	In silico (computational & extraction optimization study)	Not specified	Ethanollic extract analyzed via GC-MS, docking, ADMET, DFT studies; active neuroprotective compounds identified.
11	Anti-Convulsant Activity	Root	Male Swiss Albino Mice (epilepsy models: PTZ, picrotoxin, isoniazid, MES)	30, 100, 300 mg/kg (oral); safe up to 900 mg/kg	Alcoholic extract (ARECH) delayed seizure onset, enhanced GABAergic activity, no motor toxicity.

RESULT AND DISCUSSION:

The present study compiled and evaluated the pharmacological potential of *Cardiospermum halicacabum* Linn. A medicinal plant traditionally used in various systems of medicine. Experimental evidence from in vivo, in vitro, and in silico studies demonstrated that different parts of the plant exhibit multiple therapeutic activities.

The cumulative data strongly support the traditional therapeutic claims of *Cardiospermum halicacabum* and reveal its versatile pharmacological potential. The plant's wide biological spectrum stems from its rich phytochemical diversity, notably flavonoids, saponins, and tannins, which exhibit well-documented antioxidant, anti-inflammatory, and cytoprotective mechanisms.



Phytochemical analyses confirmed the presence of major secondary metabolites such as flavonoids, phenols, tannins, terpenoids, and saponins, which contribute to the plant's pharmacological properties. Experimental findings indicate that ethanolic leaf extracts significantly reduced inflammation and oxidative stress in arthritic rats. Seed extracts showed notable cytotoxicity comparable to doxorubicin in cancer cell lines, suggesting strong anticancer potential. Root extracts prolonged the onset of convulsions in mice, indicating anticonvulsant activity mediated through GABAergic mechanisms. Antifungal and antibacterial screenings revealed inhibitory activity against *Trichophyton rubrum* and several pathogenic bacteria. Additionally, the aqueous leaf extract enhanced sperm motility and testosterone levels without affecting organ weight or causing toxicity. Overall, *Cardiospermum halicacabum* demonstrated broad-spectrum therapeutic potential, validating its traditional medicinal uses.

Precautions:

1. Generally considered safe in traditional dosages.
2. Excessive use may cause mild gastrointestinal irritation in sensitive individuals.
3. Should not be used as a replacement for prescribed anti-inflammatory drugs without medical supervision.

CONCLUSION:

Cardiospermum halicacabum is a pharmacologically rich medicinal plant exhibiting multiple biological activities including anti-inflammatory, antidiabetic, antioxidant, anticancer, antifungal, and fertility-enhancing effects. The presence of bioactive phytochemicals like flavonoids and saponins supports its therapeutic relevance. Experimental evidence suggests that extracts from different parts of the plant act through various mechanisms, such as free radical scavenging, enzyme modulation, and receptor interactions. Hence, *Cardiospermum halicacabum* may serve as an effective natural source for developing new plant-based therapeutic agents. Further studies on isolation, standardization, and clinical validation are recommended to fully explore its medicinal potential.

FUTURE SCOPE

While the pharmacological evidence strongly supports the medicinal importance of *Cardiospermum halicacabum*, further research is needed to translate these findings into clinical applications. Future studies should focus on:

1. Isolation and structural characterization of individual active compounds responsible for specific therapeutic effects.
2. Elucidation of molecular mechanisms through biochemical, genomic, and proteomic approaches.
3. Toxicological and pharmacokinetic evaluations to determine safe dosage levels and bioavailability.
4. Formulation development for standardized extracts or phyto-pharmaceutical products.
5. Clinical trials to confirm safety, efficacy, and therapeutic outcomes in humans.
6. By integrating traditional knowledge with modern pharmacological and clinical research, *Cardiospermum halicacabum* could emerge as an important botanical resource for the discovery and development of novel, safe, and effective natural drugs

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