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Review article

A comprehensive review of the anti-arthritic and anti-inflammatory potentials of the balloon vine plant (*Cardiospermum halicacabum* L.)

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Abstract: Arthritis is one of the many common rheumatic conditions that affect joints and connective tissues throughout the body all over the world. This condition is more prevalent in women than in men, and it's frequently associated with ageing. Treatment is often based on age, linked factors, risk factors, and symptoms. Medicinal herbs are used widely in indigenous medicine, particularly in underdeveloped nations, to cure arthritis. It is a climbing plant that belongs to the Sapindaceae (soapberry family) and has a wide range of therapeutic uses. Currently, herbal remedies and dietary supplements derived from the *Cardiospermum halicacabum* plant are utilized in Sri Lanka to treat arthritis. The researcher conducted this type of study to demonstrate *Cardiospermum halicacabum's* anti-inflammatory and anti-arthritic properties. Scientific studies relevant to comprehensive reviews, *in vitro* and *in vivo*, with clinical studies were used to conduct the current study. Based on scientific investigations, the present review confirmed that it has anti-inflammatory, anti-arthritic, and analgesic possessions. It also plays an imperative role in the treatment of arthritis and some inflammatory disorders. This review article will be very helpful to the established indication for the special anti-inflammatory and anti-arthritic properties of the balloon vine plant.

Keywords: Anti-arthritic - Anti-inflammatory - Balloon vine - *Cardiospermum halicacabum* - Review.

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INTRODUCTION

Cardiospermum halicacabum L., is a member of the Sapindaceae (Raza *et al*. 2013, Britannica 2015, Ferrara 2018) or soapberry family (Menzel 2003, Hudson *et al*. 2013). The Latin words "*cardiospermum*" and "*halicacabum*" refer to heart-shaped seeds and salt containers, respectively and the plant is referred to as "herzsamen" in German (Ferrara 2018). It's referred to as "love in a puff" or balloon vine in English (Thamizh Selvam *et al*. 2013, Zalke *et al*. 2013) and Welpenela in Sinhala (Dinithi *et al*. 2015). Its Sanskrit name are Indravalli, Sakralata, and in Tamil it has been mentioned as Mudakkathan (Mruthunjaya *et al*. 2015).

It is an herbaceous climbing plant that is occasionally perennial and might be annual and widely disseminated throughout tropical and subtropical areas of the world (Raza *et al*. 2013, Mohaddesi *et al*. 2016). This is particularly common in Sri Lanka, a low-income country (Dinithi *et al*. 2015). The whole plant of *C. halicacabum* is used to treat tumors, rheumatism, and fever (Das *et al*. 2023). Moreover, its various portions are utilized in many medical situations as a paste, powder, and decoction (DeFilipps *et al.* 2018). For several centuries, it has been primarily used to cure rheumatism. In addition to treating rheumatism, it is frequently used to treat limb stiffness and snakebite (Ferrara 2018, Vijayakumar & Kumar 2021).

This plant is often described as a 'natural cortisone' because of its wide range of active constituents and strong anti-inflammatory properties. Its earliest applications were in the treatment of rheumatic diseases (Ferrara 2018). Numerous scientific studies worldwide have investigated the pharmacological effects of *C. halicacabum*,

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highlighting its anti-inflammatory, analgesic, and antioxidant properties (Pillai & Vijayamma 1985, Kumaran & Joel Karunakaran 2006, Sheeba & Asha 2009, Huang *et al*. 2011, Merighi *et al*. 2021, Elangovan, *et al*. 2022). The findings further indicated that preparations of the plant are safe and well tolerated, even with long-term administration.

Currently, a broad variety of herbal products containing *C. halicacabum* are available, including gel, cream, medicinal drops, and pills (Dowlath *et al*. 2020). Extensive scientific studies and traditional literature consistently demonstrate that *C. halicacabum* possesses potent anti-arthritic properties. Although numerous studies including *in vitro*, *in vivo*, and clinical investigations have documented the anti-arthritic properties of *C. halicacabum*, a comprehensive critical evaluation of its anti-arthritic, anti-inflammatory, and analgesic activities is still lacking. This review was therefore undertaken to systematically synthesize the existing evidence and highlight the plant's therapeutic potential and clinical relevance.

MATERIALS AND METHODS

Based on the specific objectives, this 2023 review in Jaffna District, Sri Lanka, synthesized evidence from scientific databases, research articles, original papers, websites, and traditional textbooks. *In vitro* studies examining cellular or tissue-based assays, *in vivo* animal studies evaluating experimentally induced arthritis, inflammation, or pain, and clinical studies in humans involving *Cardiospermum halicacabum* were identified, screened, and critically analyzed to summarize the pharmacological evidence supporting its anti-arthritic, anti-inflammatory, and analgesic properties.

RESULTS AND DISCUSSION

Position in the taxonomic hierarchy

Tables 1 displays *Cardiospermum halicacabum*'s place in the taxonomic ladder and table 2 represents its common names along with synonyms (Amit & Satish 2018, Shakunthala *et al.* 2020, Afrid *et al.* 2021, Vedhachalam *et al*. 2022, Mruthunjaya *et al*. 2023).

Table 1. Classification taxonomy of *Cardiospermum halicacabum* L.

Classification	Taxonomy
Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta
Super division	Embryophyta
Division	Tracheophyta/ Magnoliophyta
Subdivision	Spermatophytina
Class	Magnoliopsida
Subclass	Rosidae
Superorder	Rosanae
Order	Sapaindales
Family	Sapindaceae
Sub-family	Sapindoideae
Genus	*Cardiospermum*
Species	*halicacabum* Linn.

Table 2. Common Names and Synonyms for *Cardiospermum halicacabum* L.

Common Names	Different Names
Sanskrit	Bunuchchhe, Indravalli, Jyotishmati, Indravalli, Sakralata
Tamil	Mudakkan, Mudukattan (that is disabling pain and remedy)
English name	Heart pea, Puff-ball, Heart seed vine, Love-in-a-puff, Balloon vine (that is, climbing balloon),
Sinhala	Welpenela
Hindi	Kanphata, Kanphuti, Kapalphodi
Kannada	Agniballi, Erumballi
Telugu	Buddakakara, Ekkudutige, Jyotishmatitige
Malayalam	Jyotishmati, Katabhi, Karuttakunn
Bengali	Lalaphatkari
Marathi	Kanphuti, Shibjal, Kakumardanika
Guajarati	Ghisdoda
Synonyms	*Cardiospermum corumdum* L.*; Cardiospermum glabrum; Cardiospermum inflatum*

Geographical distribution and botanical description

Various plant parts of *C. halicacabum* have been shown in figure 1. It is extensively dispersed in tropical and subtropical Asia, South America, Africa, Brazil, and is frequently seen in India (Amit & Satish 2018). This herbaceous plant features axillary tendrils and biternate leaves. The leaflets have smooth surfaces, glabrous textures, and dentate borders. They have an ovate-lanceolate form. This plant has a green stem that is between 0.2 and 0.3 cm wide. Tiny, unisexual, white, obliquely zygomorphic, and with a straight pedicel are the characteristics of tetramerous irregular flowers (Zalke *et al*. 2013). This plant is also known as balloon vine because of its membrane fruits, which are oblong, inflated, and triangular. The fruit keeps the sepals affixed to it. One ovule is present in each carpel of a tricarpellary ovary. Round fruits with wings and a swollen capsule with a trifid stigma. July through August is the blossoming season, and August through October is when seeds ripen. Within the base of every petal is a scale that has a yellowish edge and is white to cream in color. The plant can raise up to two meters high, with a stem that is about 3 mm thick and generates internodes that are 5 to 10 cm long (Amit & Satish 2018, Shakunthala *et al.* 2020, Afrid *et al.* 2021, Mruthunjaya *et al*. 2023).

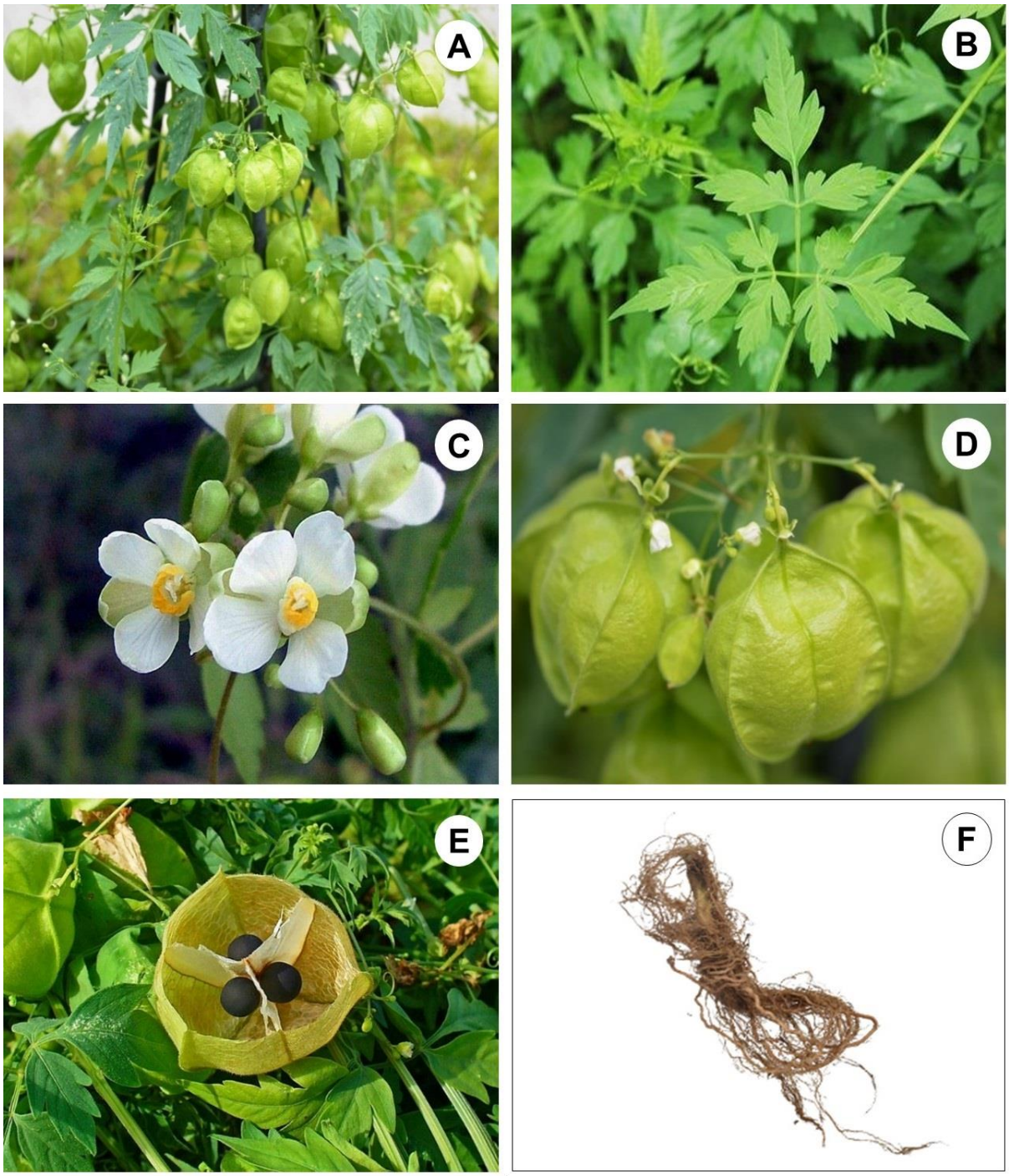

Figure 1. Different parts of *Cardiospermum halicacabum* L.: **A**, whole plant; **B**, leaves; **C**, flowers; **D**, Fruits; **E**, Seeds; **F**, Root.

Reviews of the literature

Several reviews summarized that *C. halicacabum* demonstrated an assortment of pharmacologic activities, such as anti-inflammatory and anti-arthritic or antirheumatic properties, due to its bioactive properties (Raza *et al*. 2013, Savitha *et al*. 2017, Ferrara 2018, Amit & Satish 2018, Shaily & Sarmad 2018, Patel & Dixena 2019, Vedhachalam *et al*. 2022, Elangovan *et al*. 2022, Mruthunjaya *et al*. 2023, Das *et al*. 2023).

The review study by Amit & Satish (2018) highlighted how the anti-inflammatory properties of extracts from the *C. halicacabum* may be the primary cause of the reduction of symptoms associated with rheumatism, wounds, and swellings, based on their use in traditional medicine and the entire plant is rich in reducing sugars, triterpenes, flavonoids, proanthocyanidin, apigenins, phytosterol, tannins, and saponins (Savitha *et al*. 2017, Amit & Satish 2018). According to Afrid *et al.* (2021), *C. halicacabum* has anti-inflammatory and anti-arthritic properties.

In-vitro Investigations

Medicinal plants are natural bases of bioactive phytochemical elements that have the ability to combat a wide range of disorders due to their biological effects on human anatomy. Therefore, to determine the potential of these local sources of therapeutic goods, medicinal plants must be evaluated for their phytochemistry (Ferrara 2018). Qualitative examination revealed the presence of saponin, glycosides, polysaccharides, phytosterols, flavonoids, and phenolic compounds in the aerial parts of *C. halicacabum* extract (Zalke *et al*. 2013, Dowlath *et al*. 2020). This claim was further supported by several studies (Zalke *et al*. 2013, Mruthunjaya *et al*. 2015, Savitha *et al*. 2017, Amit & Satish 2018, Elangovan *et al*. 2022).

According to a study, in chronic inflammatory models, a crude ethanolic extract of *C. halicacabum* (an extract containing the flavonol glycoside rutin) reduced inflammation (Babu & Krishnakumari 2005). Treatment for rheumatoid arthritis can be justified by the ethanolic fraction of *C. halicacabum* leaf extract, which has anti-inflammatory activities (Venkatesh Babu & Krishnakumari 2006). The processes behind the ethanolic extract of the entire *C. halicacabum* plant's anti-inflammatory and analgesic properties were discovered by another investigation (Sheeba & Asha 2009). According to a phytochemical analysis, it is helpful to quantify some pharmacognostic factors from *C. halicacabum* to establish standards for crude medications (Zalke *et al*. 2013). The protein denaturation was reduced in a dose-dependent manner by the ethanolic extract of *C. halicacabum* (Padmini *et al*. 2016). Additionally, another study lays the groundwork for investigations into *C. halicacabum*'s efficacy against a target related to rheumatoid arthritis (Swaminathan & Saleena 2017).

A further investigation verified that the green synthesis of copper nanoparticles mediated by *C. halicacabum* exhibited noteworthy anti-inflammatory properties (Chandran *et al.* 2020). Only 42.40% of the ten distinct concentrations of *C. halicacabum*'s aqueous extracts shown anti-inflammatory efficacy *in vitro*, according to a study (Kousalya *et al.* 2020). An additional investigation revealed that the combination of *C. halicacabum* and *Moringa oleifera*, in an ethanolic extract form, had stronger *in vitro* anti-inflammatory and anti-arthritic belongings than diclofenac sodium (Balamurugan & Muruganandam 2021). According to a different study, there is a possibility to use *Cardiospermum halicacabum* as an anti-inflammatory agent because of the statistically significant ($p<0.05$) positive correlation between the concentration and percentage inhibition of protein denaturation in both the cold ethanol and aqueous extracts of the plant (Pabasara *et al.* 2021).

In-vivo Researches

By using the cotton pellet implantation and granuloma pouch procedures, the alcohol extract of *C. halicacabum* demonstrated a strong anti-inflammatory activity in rats when given orally (Gopalakrishnan *et al.* 1976). Significant anti-inflammatory effects were demonstrated by the aqueous extract (decoction) of the entire *C. halicacabum* plant in both acute (10 g kg^{-1}) and chronic (10 and 20 g kg^{-1}) animal models produced by xylol and croton oil (Pillai & Vijayamma 1985). Using rat paw oedema generated by carrageenan, the ethanol extract of *C. halicacabum* aerial parts demonstrated its anti-inflammatory properties in male albino rats (Sadigue *et al.* 1987). Comparing the usual indomethacin-10 mg kg^{-1} to the oral administration of *C. halicacabum* leaf ethanolic extract, Albino rats treated with Freund's complete adjuvant-induced arthritis showed a substantial reduction in arthritis at doses of 125 mg kg^{-1} and 250 mg kg^{-1} (Kumar *et al.* 2008). Compared to other extracts, the methanolic extract of the stem of *C. halicacabum* exhibited a greater degree of substantial anti-inflammatory activity (400 mg kg^{-1}) in carrageenan induced rats (Arjumand *et al.* 2009). Ethanolic Extract of *C. halicacabum* was shown to have anti-inflammatory properties in mouse paw oedema caused by λ-carrageenan and may also function as a naturally occurring anti-inflammatory agent (Huang *et al.* 2011). In Wistar rats with CFA-induced arthritis, Jeyadevi *et al.* (2013) discovered that the ethanolic leaf extract of *C. halicacabum* exhibited whole

cartilage regeneration. In complete Freund's adjuvant-induced arthritis and carrageenan-induced inflammation, a combination of methanol leaf extracts of *C. halicacabum* and *Vitex negundo* L. demonstrated a better reduction of inflammation than the control (Aiyalu *et al.* 2014). On Freund's Adjuvant Arthritis Model in Wistar rats, the combination Bi-Herbal Ethanolic extract consisting of equal amounts of leaves from *Calotropis gigantea* (L.) Dryand. and *Cardiospermum halicacabum* exhibits strong anti-arthritic and anti-inflammatory properties (Narayani *et al.* 2014). In Wistar rats using Freund's adjuvant arthritis model, paw volume and oedema significantly decreased when exposed to a bi-herbal ethanolic extract containing equal amounts of leaves from *Pisonia grandis* R.Br. and *Cardiospermum halicacabum* (Padmini *et al*. 2016).

On rats with Freund's full adjuvant-induced arthritis, a topical herbal gel comprising *C. halicacabum* and *Vitex negundo* leaf extracts demonstrated a strong anti-arthritic activity (Aiyalu *et al.* 2016). Rats with paw oedema caused by carrageenan showed a significant ($P<0.001$) reduction in paw thickness when treated with 500 mg kg^{-1} of both *Cardiospermum halicacabum* and *C. canescens* Wall. extracts (Sreedevi & Venkateswara 2017). Another study demonstrated that when rats with adjuvant-induced arthritis were treated with *C. halicacabum* ointment, the anti-arthritic effect was significantly greater in a dose-dependent way than with the conventional medication diclofenac (Ashwini *et al.* 2017). Because of the presence of phenolic antioxidants, which were verified to block xanthine oxidase by the *in vivo Bombyx mori* L. model, the aqueous leaf *Cardiospermum halicacabum* extract demonstrated a greater reduction of uric acid (Preethi *et al.* 2018). Another study confirmed that in carrageenan-induced rats, the methanolic extract of *C. halicacabum* leaves has anti-inflammatory efficacy that is comparable to standard medication (Ibuprofen) (Mahmood *et al.* 2023).

Clinical trials involving Humans

According to Rajasekaran *et al.* (2016) a topical herbal gel created from *C. halicacabum* and *Vitex negundo* has demonstrated encouraging outcomes for the management of arthritis. According to a case study, *Cardiospermum halicacabum* juice can treat both acute and chronic Rheumatoid arthritis symptoms by acting as an antioxidant, anti-inflammatory, and anti-arthritic (Arthia *et al.* 2019).

Several studies have been showed to investigate the effectiveness of extracts from therapeutic plants and their bioactive components in the management and avoidance of arthritis (Maroon *et al*. 2010, Ghasemian *et al*. 2016, Gessner *et al.* 2017, Gandhi *et al.* 2022). Yatoo *et al*. reported that important pharmacological effects, such as anti-inflammatory activity, are produced by a diversity of strong phytochemicals or the robust action of particular bioactive components contained in medicinal plant extracts (Yatoo *et al.* 2018). There have been reports of the use of phytoconstituents from medicinal plants to treat inflammatory illnesses. These phytochemicals include flavonoids, terpenoids, polyphenols, saponins, tannins, alkaloids, anthraquinones, chemical components of essential oils, and some of their metal/metal oxide nanoparticles (Gonfa *et al.* 2023). The anti-arthritic and anti-inflammatory properties of *C. halicacabum* can thus be supported by the aforementioned conclusions, which were determined by reviews, *in vitro* and *in vivo* research, as well as studies connected to clinical trials.

CONCLUSION

There are important characteristics of *Cardiospermum halicacabum* that contribute to its use in medicine. The potential of *C. halicacabum* has been extensively researched, and contemporary science now acknowledges the plant kingdom as a source of novel biodynamic elements. Based on scientific investigations, the present review confirmed that it has anti-inflammatory, anti-arthritic, and analgesic properties. It also plays a noteworthy role in the treatment of arthritis and some inflammatory disorders. This review article will be very helpful to the established indication for the special anti-inflammatory and anti-arthritic properties of the balloon vine plant.

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REFERENCES

Afrid S, Sagheer Ahmed S, Rupesh Kumar M & Zuber M (2021) Botanical Description, Phytochemistry, Traditional Uses and Pharmacology of *Cardiospermum halicacabum*: An Updated Review. *Journal of Global Ecology and Environment* 13(3): 1–9.

Aiyalu R, Govindarjan A & Ramasamy A (2016) Formulation and evaluation of topical herbal gel for the

treatment of arthritis in animal model, *Brazilian Journal of Pharmaceutical Sciences* 52(3): 493–507.

Aiyalu R, Subramaniam I, Govindarajan A & Ramasamy A (2014) Evaluation of Synergistic Effect of Methanol Leaf Extract of *Cardiospermum halicacabum* and *Vitex negundo* on Inflammation and Arthritis. *Journal of Herbs, Spices and Medicinal Plants* 20(4): 372–385.

Amit S. Sharma & Satish A Bhalerao (2018) Review of Ethnobotanical, Phytochemical and Pharmacological Profile of *Cardiospermum halicacabum* Linn. *International Journal of Pharmaceutics & Drug Analysis* 6(3): 371–376.

Arjumand Ara, Srinivas Reddy K & Reddy CS (2009) Analgesic, Anti-Pyretic and Anti-Inflammatory Activity of Various Extracts of Stem of *Cardiospermum halicacabum*, *Journal of Chemical and Pharmaceutical Sciences* 2(1): 20–25.

Arthia R, Maheshkumar K, Venugopal V, Mangairkarasi N, Manikannan M & Poonguzhali S (2019) Anti-arthritic effect of leaf's of *Cardiospermum halicacabum* juice in patients with rheumatoid arthritis – a case report. *Pharma Nutrition* 10: 100170.

Ashwini BK, Arivuchelvan A, Jagdeeswaran A, Sivaseelan S & Sunandhadevi S (2017) Haemato-Biochemical changes due to ethanolic extract of *Cardiospermum halicacabum* in Arthritic rats. *Environment and Ecology* 35(2D): 1571–1574.

Babu KC & Krishnakumari S (2005) Anti-inflammatory and antioxidant compound, rutin in *Cardiospermum halicacabum* leaves. *Ancient Science of Life* 25(2): 47–49.

Balamurugan V & Muruganandam L (2021) In-Vitro Anti-Inflammatory and Anti-Arthritic Activity of *Cardiospermum halicacabum* and Moringa oleifera Leaves Extract. *Journal of Advance Science and Research* 12(1 Suppl. 2): 78–82.

Britannica (2015) The Editors of Encyclopaedia. "List of plants in the family Sapindaceae". *Encyclopedia Britannica*. Available from: https://www.britannica.com/topic/list-of-plants-in-the-family-Sapindaceae-2039143. (accessed: 31 Mar. 2024).

Chandran T, Arivarasu L & Rajeshkumar S (2020) Green Synthesis, Anti Inflammatory and Antioxidant Property of *Cardiospermum halicacabum* Mediated Copper Nanoparticle. *Plant Cell Biotechnology and Molecular Biology* 21(57&58): 17–21.

Das SR, Sharma BP, Jena N & Kumar S (2023) Love in a puff [*Cardiospermum halicacabum* (L.)]: a medicinal climber of India. *Medico Bio-wealth of India* Chapter 1, XII: pp. 1–7.

DeFilipps RA, Krupnick GA & Pensoft (2018) *Cardiospermum halicacabum* L. The medicinal plants of Myanmar. *Plazi.org taxonomic treatments database* Checklist dataset 2018. Available from: https://doi.org/10.3897/phytokeys.102.24380 (accessed: 31 Mar. 2024).

Dinithi LC Peiris, Dhanushka MAT & Jayathilake TAHDG (2015) Evaluation of Aqueous Leaf Extract of *Cardiospermum halicacabum* (L.) on Fertility of Male Rats. *BioMed Research International* 2015: Article ID 175726 [https://doi.org/10.1155/2015/175726]

Dowlath MJH, Karuppannan SK, Darul RGI, Mohamed KSB, Subramanian S & Arunachalam KD (2020) Effect of Solvents on Phytochemical Composition and Antioxidant Activity of Phcogj.com *Cardiospermum halicacabum* (L.) Extracts. *Pharmacognosy Journal* 12(6): 1241–1251.

Elangovan A, Ramachandran J, Lakshmanan DK, Ravichandran G & Thilagar S (2022) Ethnomedical, phytochemical and pharmacological insights on an Indian medicinal plant: The balloon vine (*Cardiospermum halicacabum* Linn.). *Journal of Ethnopharmacology* 291: 115143. [DOI: 10.1016/j.jep.2022.115143]

Ferrara L (2018) *Cardiospermum halicacabum* Linn.: Food and Drug. *International Journal of Medical Reviews* 5(4): 146–150.

Gandhi Y, Kumar R, Grewal J, Rawat H, Mishra SK, Kumar V, Shakya SK, Jain V, Babu G, Sharma P, Singh A, Singh R & Acharya R (2022) Advances in anti-inflammatory medicinal plants and phytochemicals in the management of arthritis: A comprehensive review. *Food Chemistry Advances* 1: 100085.

Gessner DK, Ringseis R & Eder K (2017) Potential of plant polyphenols to combat oxidative stress and inflammatory processes in farm animals. *Journal of Animal Physiology and Animal Nutrition* 101(4): 605–628.

Ghasemian M, Owlia S & Owlia MB (2016) Review of anti-inflammatory herbal medicines. *Advances in Pharmacological and Pharmaceutical Sciences* 2016: Article ID 9130979. [DOI: 10.1155/2016/9130979]

Gonfa YH, Tessema FB, Bachheti A, Rai N, Tadesse MG, Singab AN, Chaubey KK & Bachheti RK (2023) Anti-inflammatory activity of phytochemicals from medicinal plants and their nanoparticles: A review.

Current Research in Biotechnology 2023: 100152. [DOI: 10.1016/j.crbiot.2023.100152]

Gopalakrishnan C, Dhananjayan R & Kameswaran L (1976) Studies on the pharmacological actions of *Cardiospermum helicacabum*. *Indian Journal of Physiology and Pharmacology* 20(4): 203–208.

Huang MH, Huang SS, Wang BS, Wu CH, Sheu MJ, Hou WC, Lin SS & Huang GJ (2011) Antioxidant and anti-inflammatory properties of *Cardiospermum halicacabum* and its reference compounds *ex vivo* and *in vivo*. *Journal of Ethnopharmacology* 133(2): 743-750.

Hudson G, Bradtke J, Sonday Re B & Burnham RJ (2013) *Cardiospermum halicacabum* L. Plant Diversity Website. Robyn J. Burnham, University of Michigan. https://climbers.lsa.umich.edu/cardiospermum-halicacabum/

Jeyadevi R, Sivasudha T, Rameshkumar A & Dinesh Kumar L (2013) Anti-arthritic activity of the Indian leafy vegetable *Cardiospermum halicacabum* in Wistar rats and UPLC-QTOF-MS/MS identification of the putative active phenolic components. *Journal of Inflammation Research* 62(1): 115–126.

Kousalya K, Priya T & Venkatalakshmi P (2020) Studies on the Anti-inflammatory potential of selected medicinal plants *in vitro*. *Research Journal of Pharmacy and Technology* 13(7): 3147–3150.

Kumar KE, Mastan SK, Reddy GA, Raghunandan N, Sreekanth N & Chaitanya G (2008) Anti-Arthritic Property of the Ethanolic Leaf Extract of *Cardiospermum Halicacabum* Linn. *Biomedical and Pharmacology Journal* 1(2): 395–400.

Kumaran A & Joel Karunakaran R (2006) Antioxidant Activities of the Methanol Extract of *Cardiospermum halicacabum*. *Pharmaceutical Biology* 44(2): 146–151.

Mahmood R, Najam R, Sayeed BZ, Sayeed FZ & Sayeed QMA (2023) Assessment of Anti-inflammatory Activity of Leave Extract of *Cardiospermum halicacabum* (L.), in Rats. RADS. *Journal of Pharmacy and Allied Health Sciences* 1(3): 108–112.

Maroon JC, Bost JW & Maroon A (2010) Natural anti-inflammatory agents for pain relief. *Surgical Neurology International* 1: 80. [DOI: 10.4103/2152-7806.73804]

Menzel CM (2003) Fruits of Tropical Climates | Fruits of the Sapindaceae. *Encyclopaedia of Food Sciences and Nutrition* (Second Edition): Elsevier Science Ltd., pp. 2786–2790.

Merighi S, Travagli A, Tedeschi P, Marchetti N & Gessi S (2021) Antioxidant and Antiinflammatory Effects of *Epilobium parviflorum*, *Melilotus officinalis* and *Cardiospermum halicacabum* Plant Extracts in Macrophage and Microglial Cells. *Cells* 10(10): 2691. [DOI: 10.3390/cells10102691]

Mohaddesi B, dudhrejiya A & Chauhan M (2016) Pharmacognostical and physico-chemical evaluations of *Cardiospermum halicacabum* L. seeds. *Research Journal of Pharmacognosy* 3(1): 35-41.

Mruthunjaya K, Suresh AP, Paramakrishnan N & Basavaraju MA (2023) Comprehensive Review on *Cardiospermum halicacabum*. *Journal of Natural Remedies* 23(2): 283–293.

Narayani PC, Anbu J, Vasuki R & Rajeswari Hari (2014) *In vitro* and *In vivo* Anti–Arthritic Activity of Combined Ethanolic Extracts of *Calotropis gigantea* and *Cardiospermum halicacabum* in Wistar Rats. *Journal of Natural Remedies* 14(1): 58–66.

Pabasara WM, Liyanage GLGS, Thanayamwatta DMRB, Rajapaksha RGWDB, Pathirana RN, Siriwardhene MA & Silva ARN (2021) Evaluation of *In vitro* Anti-inflammatory Activity of Ethanol and Aqueous Extracts of the Whole Plant of *Cardiospermum halicacabum*, *General Sir John Kotelawala Défense University – 14th International Research Conference.*

Padmini N, Sundaramoorthy SD, Tripathi H & Hari R (2016) *In vitro* and *In vivo* Anti-Arthritic Activity of Combined Ethanolic Extracts of Pisonia grandis and *Cardiospermum halicacabum* in Wistar Rats. *Journal of Applied Pharmaceutical Science* 6(09): 102–108.

Patel DK & Dixena D (2019) Morphology and Medicinal values of *Cardiospermum halicacabum*. *Flora and Fauna* 25(2): 167–176.

Pillai NR & Vijayamma N (1985) Some Pharmacological Studies on *Cardiospermum halicacabum* Linn. *Ancient Science of Life* 5(1): 32–36.

Preethi J, Chitra L & Palvannan T (2018) Anti-gout effect of *Cardiospermum halicacabum* through antioxidant and xanthine oxidase inhibition property. *Journal of Pharmacognosy and Phytochemistry* 7(2): 1300–1304.

Rajasekaran A, Govindarjan A & Ramasamy A (2016) Formulation and evaluation of topical herbal gel for the treatment of arthritis in animal model. *Brazilian Journal of Pharmaceutical Sciences* 52: 493–507.

Raza SA, Hussain S, Riaz H & Mahmood S (2013) Review of beneficial and remedial aspects of *Cardiospermum halicacabum* L. *African Journal of Pharmacy and Pharmacology* 7(48): 3026–3033.

Sadigue J, Chandra T, Thenmozhi V & Elango V (1987) Biochemical modes of action of Cassia occidentalis

and *Cardiospermum halicacabum* in Inflammation. *Journal of Ethnopharmacology* 19: 201–212.

Savitha G, Vishnupriya V & Surapaneni Krishnamohan (2017) *Cardiospermum halicacabum* Linn. - A Review. *Asian Journal of Pharmaceutical and Clinical Research* 10(10): 23–26.

Shaily Sharma & Sarmad Moin (2018) Pharmacological Properties of *Cardiospermum halicacabum* L.: A Review. *Journal of Environment, Science and Technology* 4(2): 48–52.

Shakunthala B, Sambuddha G, Shobha D &Shruthi SD (2021) Medicinal Importance of Plants Used for Treating Rheumatoid Arthritis in Dakshina Kannada, Karnataka, India. *Quantum Journal of Medical and Health Sciences* 1(1): 28–51.

Sheeba MS & Asha VV (2009) *Cardiospermum halicacabum* ethanol extract inhibits LPS induced COX-2, TNF-α and iNOS expression, which is mediated by NF-κB regulation, in RAW264.7 cells. *Journal of Ethnopharmacology* 124 (1): 39–44.

Sreedevi K & Venkateswara Rao J (2017) Evaluation of Acute and Chronic Anti-Inflammatory Activity in Ethanolic Extract of Aerial Parts of *Cardiospermum halicacabum* and Cardiospermum Canescens in Animal Models. *Journal of Scientific Research and Pharmacy* 6(12): 179–184.

Swaminathan P & Saleena L (2017) Evaluation of *Cardiospermum halicacabum* leaf compounds against human Dihydro-Orotate Dehydrogenase: a target for Rheumatoid Arthritis using Structure based Drug Designing. *Journal of Applied Pharmaceutical Science* 7(8): 48–61.

Thamizh Selvam N, Sanjaya Kumar YR, Anand M, Vasantha Kumar KG & Nair PKS (2013) Ethnomedicinal Value of *Cardiospermum halicacabum* Linn.: A Review. *World Journal of Pharmaceutical Research* 2(6): 3348–3355.

Vedhachalam V, Sampath Kumar T, Jothimanivannan C, Kayalvizhi Chanduru & Gokulraj (2022) Pharmacognostical Studies and Pharmacological Activities of *Cardiospermum Halicacabum* - A Review, *International Journal of Pharmaceutical Research and Applications* 7 (5): 327–334.

Venkatesh Babu KC & Krishnakumari S (2006) *Cardiospermum halicacabum* suppresses the production of TNF-alpha and Nitric oxide by Human Peripheral Blood Mononuclear cells. *African Journal of Biomedical Research* 9: 95–99.

Vijayakumar N & Kumar KS (2021) *Cardiospermum halicacabum* Linn. - A Review of its Medicinal Effects on Human Healthcare System. *Journal of Pharmaceutical Research International* 33(21B): 57–63.

Yatoo M, Gopalakrishnan A, Saxena A, Parray OR, Tufani NA, Chakraborty S, Tiwari R, Dhama K & Iqbal H (2018) Anti-inflammatory drugs and herbs with special emphasis on herbal medicines for countering inflammatory diseases and disorders-a review. *Recent Patents on Inflammation & Allergy Drug Discovery* 12(1): 39–58.

Zalke AS, Duraiswamy B, Gandagule UB & Singh N (2013) Pharmacognostical evaluation of *Cardiospermum halicacabum* Linn. leaf and stem. *Ancient Science of Life* 33(1): 15–21.