A Review of Cardiospermum Halicacabum: The Wonders of An Ancient Herb

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Abstract- *Medicinal plants are an important natural resource for the treatment of chronic diseases. Depending on the country where the diseases occur, different medicinal plants can be utilized to treat similar diseases. In certain areas, medicinal plants are considered as a low-cost alternative to treat various ailments because of their historical usages.Cardiospermum halicacabum L., a member of the Sapindaceae family, is a herbaceous plant that is widely distributed throughout the world's tropical and subtropical regions. It grows on African, American, Bangladeshi, Indian, and Pakistani plains.The main phytochemical components of this plant are alcohols, phenols, alkynes, flavonoids, alkanes, and aliphatic esters. The herb contains terpenoids, flavonoids, tannins, proteins, saponins, glycosides, carbohydrates, volatile esters, and fatty acids, according to the phytochemical analysis.This plant has been revealed to exhibit an anti-oxidant, anti-viral, anti-ulcer, anti-diabetic, anti-convulsant, antipyretic, anxiolytic, anti-cancer, anti-bacterial, anti-arthritic, anti-fungal, anti-parasitic, adulticidal, and fertility properties.This review summarizes the morphological,Geographical,microscopicalcharacteristics,phytochemical constituents, pharmacological activities along with nutritional value,adverse effects,traditional uses of cardiospermum halicacabum.*

Keywords- Cardiospermum halicacabum, Balloon vine, anti-cancer, anti-parasitic,anti convulsant, antipyretic, anxiolytic.

I. INTRODUCTION

In the traditional medicinal system, drugs derived from plants have been utilized to treat a variety of diseases. Herbal medicines are used by approximately 75-80% of the world's population. The majority of the plants have therapeutic properties and were studied for new and useful substances. Plant phytochemicals play an important role in the treatment of life-threatening disorders. Cardiospermum is a combination of the Latin words "cardio" (heart) and "sperma" (seed), and is related to the seed's white heart-like in shape pattern. Halicacabum is derived from the Latin term "halicacabus," which relates to a plant with puffed fruits[1]. Cardiospermum halicacabum belongs to the Sapindaceae family. It is found throughout the tropics and subtropics. It is a climber that grows in East African tropical forests. It is used to treat Cough, hyperthermia, arthritis, Back pain, nervous illnesses, and amenia.In Ayurveda and folk medicine, this plant is used to treat joint pain, headaches, ear pain, and a high fever[2].

The plant contains a variety of phytochemicals, making it effective in the treatment of a variety of disorders.Continuous field visits to observe medicinal and aromatic plants are required for their usefulness in society in accordance with pharmaceutical standards. Traditional understanding about Medicinal and Aromatic plants influences the use of such plants for medicinal purposes in society. Herbal medicines play an important role in the society's primary health care system[3]. Willmar Schwabe discovered this plant in Africa in the middle of the last century, where it was widely used as a medicine for a variety of ailments, including anti-rheumatic, digestive and respiratory problems, joint pain, backache, injuries, muscle tears, and inflammatory conditions. The cortisonic effects of this plant have been discovered over a 70-year period[4].

This plant can be purchased as a green vegetable in local markets in rural areas of Southern India, providing a source of income for poor families. For centuries, the whole plant has been used to treat osteoarthritis, limb stiffness, and snake bite; a decoction of its roots is used as a diaphoretic, diuretic, vomiting, laxative, and for perspiration; a decoction of its leaves and stems is used to treat diarrhea, dysentery, and migraines. and a poultice of them is used to treat swelling. The juice of the leaves have been utilized to treat ear pain[5,6].C. halicacabum is used as a hair detergent and a laundry soap in its native regions due to the presence of saponins, substances that foam in water when agitated. Every part of this herb is beneficial, both as food and as a medicine[7].

It exhibits antioxidant, anti-diabetic, anti-viral, anti-convulsant, anti-diarrheal, anti-cancer and antimicrobial properties.Because of the presence of constituents such as beta-sitosterol, D-glucoside, amino acids, oxalic acid, saponins, quebrachitol, oleic acid, eicosonic acid, erucic acid, octanoic acid, n-hexadecenoic acid, and rich in

triterpenoid, this herb is beneficial for the synthesis of commercial drugs[8]. The complex chemical structure and broad range of potential uses of this plant have attracted the interest of researchers, who employed modern methodologies to verify the validity and safety of its application in the treatment of several diseases[7]. Cardiospermum halicacabum is used in alternative medicine systems such as Homeopathy, Unani, and Ayurvedic medicine. Several phytoconstituents, including flavonoids, tannins, and alkaloids, have been identified during the preliminary phytochemical analysis. The concentrations of phenols in extracts ranged from 29.697 ± 0.232 to 187.372 ± 0.615 mg pyrogallol equivalent/g, while flavonoids ranged from 27.833 ± 0.412 to 139.261 ± 0.412 mg quercetin equivalent/g[10].Cardiospermum halicacabum, a medicinal plant, is known as 'karnasphota' in traditional medicine. The root of this herb is officially included in Ayurvedic pharmacopoeia due to its beneficial effects in jvara, kusta, ksaya, as well as sandhivata[9].

II. DESCRIPTION

Balloon vine, also known botanically as Cardiospermum Halicacabum. It consists of a puffy seedpod that is not only hollow as well as extremely light. This herb, which belongs to the Sapindaceae family, is a kind of annual climbing plant that develops perennially[11].

Table 1. Scientific classification

Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta
Superdivision	Embryophyta
Division	Tracheophyta
Subdivision	Spermatophytina
Class	Magnoliopsida
Superorder	Rosanae
Order	Sapindales
Family	Sapindaceae
Genus	Cardiospermum
Species	Halicacabum

Table 2.Vernacular names

English	Balloon Vein, Heart’s Pea
Sanskrit	Indravalli, Sakralata
Hindi	Kapalphoti, Kanphuti
Bengali	Lataphatkari
Marathi	Kakumardanika, Shibjal
Guajarati	Kakumardanika, Shibjal
Telugu	Ekkudutige, Buddakakara
Tamil	Mudukattan
Kannada	Agniballi
Malayalam	Karuttakunn

III. MORPHOLOGY

The plant is pubertal ornearly glabrous, with slim twigs that climb by tendrillar hooks throughout the year. The leaves of a plant are ternate bicomponent, with leaflets that are acuminate at the top. The stem has five grooves and is slim and without hair to lightly hairy. The leaf stalk is lengthy and uneven, with little stipules at the base. Its leaflets are primarily three-part and pinnately lobed, with narrowed stalks.Flowers are white and small in size. Flowers are unisexual, zygomorphic, and have a straight pedicel. Fruits are membranous and depressed, with a pyriform casing which is expanded at the angles[12].The seeds are black with a large white heart developed aril[13].This plant's flowering season is from July to August, and its seed maturing season is from the month of August to October. The petiole has three leaflets. Wings have been sparsely haired with curved hairs. Leaflets vary in shape but are ovate as well as narrowly ovate. Sepals are four in number and are ovate, imbricate, green or red in color with white borders and almost hairless. The petals are four in number, with a scale inside beyond the base of every petal, white to cream at a yellowish edge, and nearly hairless. The ovary is taller, three-angled, and three-celled, with one ovule per cell. The ovary has three carpals, the stigma has three, and the ovules are axially placed. It has a variety of hairs, a short columnar style, and a 3-lobed stigma. Fruit has a spherical casing, is inflate, has three lobes, and three cells. The base is papery and green with reddish veins. Herb possesses 16 species found in Brazil, along with 12 of them being found in South America. This plant includes the family's most diverse chromosome number, with metacentric and submetacentric chromosomes, few had subtelocentric chromosomes, but no telocentric chromosomes[14]. Herbal medicine is made from this herb's roots, leaves, and seeds [15].

Figure 1. Cardiospermum halicacabum leaves

Figure 2. Cardiospermum halicacabum puffs

Figure 3. Cardiospermum halicacabum flowers

Figure 4. Cardiospermum halicacabum seeds

IV. MICROSCOPY

Microscopy of Leaf

The leaf posses a prominent midrib and a slender dorsiventral lamina, with thick and pyramid-like adaxial and abaxial sections. The midrib is composed of different epidermal layers of big, squarish cells, and the lamina is 60-70 m thick. Palisade and parenchyma cells differentiate from the mesophyll. The anticlinal walls of the epidermal cells are thin and wavy. The stomata are abundant and diffuse, with no distinct subsidiary cells. Guard cells are elliptical with slit-like openings. The lateral veins are visible, as are the vein-islets, which have thin straight vein borders. Islets can be rectangular, squarish, or polygonal, and all have vein-terminations.

Microscopy of Stem

The stem has a continuous epidermis with spindle cells, darkly strained cells, and hyaline parenchyma cells and is pentagonal with five blunt ridges. A thick cortical sclerenchyma cylinder with several layers of small cells wraps around the stem. The vascular cylinder is angular, consisting of a phloem and xylem cylinder along with solitary vessels. The pith is made up of parenchyma cells that are angular and compact.

Powder Microscopy

The powder contains glandular trichomes, which are one-celled thick stalks with a glandular body made up of two upper and two lower cells. Non-glandular trichomes are more common and can be unicellular, unbranched, straight or curved. Fragmentary lamina is common, with visible vein termini. There are also xylem elements present, such as parenchyma cells, fibers, and vessel elements. Long, scale-like, thin-walled cells can be up to 260 m long and 30 m wide and serves a storage function. There are also two types of fibers: wide fibers with wide lumens and thin walls and narrow fibers with thick walls and narrow lumens. There are also primary and secondary xylem vessels, with the primary having close spiral lateral wall thickenings and the secondary having dense, multiseriate lateral wall pits. The vessel's components are 550-750 µm long[9].

V. GEOGRAPHY

Cardiospermum L. (family Sapindaceae, tribe Paullinieae) currently includes 17 shrub, subshrub, climber, and erect species known as balloon vines. Cardiospermum halicacabum is found in Australia and other Pacific islands classified as alien or invasive, and it is also found in Europe and Asia. The native status of these species is highly debated in many of these countries, and their biogeographical history is unknown. Cardiospermum halicacabum is considered native in South and Central America, but its status in North America and tropical Africa is debatable (USDA, United States Department of Agriculture; Weeds of

Australia).Cardiospermum halicacabum is classified as either alien or native in Asia. This plant is considered a common weed in grasslands in China[16].

VI. PHYTO-CHEMICAL CONSTITUENTS

The FT-IR spectrum revealed the presence of alcohols, phenols, alkynes, flavonoids, alkanes, and aliphatic ester in the ethanolic leaf extract of the plant Cardiospermum halicacabum. GC-MS has been used to examine twenty-four compounds. The major constituents identified were cyclohexane-1, caryophyllene, neophytadiene, 4, 5-triol-3-one-1-carboxylic acid, phytol, and benzene acetic acid. The plant also contains 1-hydrotetradecane, 11-trimethyl-8-methylene, N-methyl tomatidine, 3 -methylbutanamide, Phenylethyl alcohol, hexadecane, nonadecane, heptadecane, benzene acetic acid, 14-methyl8-hexadecyne, 5-dinitrobenzene, hexadecenoic acid, and octadecanoic acid[17].Another study that utilized Cardiospermum halicacabum identified carbohydrates, proteins, tannins, saponins, flavonoids, lipids, alkaloids, steroids, and glycosides. By using gas chromatography-mass spectrometry, many active constituents in C. halicacabum were identified, including 1, 2, 4-trioxolane-2-octanic acid, 2-[9-octadecenyloxyl], ethanol, 5-octyl-methyl ester, ricinolenic acid, apigenin7-o-glucuronide, 11-octadecenoic acid, methyl ester,-2-octanic acid, 9-octadecenoic acid, oleic acid, 1,2,3-propanetriyl ester, β-sitosterol-β-o-galactoside, β-sitosterol, chryoerior-7-o-glucuronide, stearic acid, linoleic acid, arachidic acid and luteolin-7-o-glucuronide[18].The seed oil had been extracted with petroleum ether and analyzed using GC-MS. The oil contains approximately 27 different components. The primary ingredients of the oil are octanoic acid (4.57%), n-hexadecanoic acid, erucic acid (43%), eicosanic acid (12%), and oleic acid (30%)[19].

VII. PHARMACOLOGICAL ACTIVITY

Cardiospermum halicacabum possesses antioxidant, antiviral, anti-ulcer, anti-diabetic, anti-convulsant, antipyretic, anxiolytic, anti-cancer, anti-bacterial, anti-arthritic, anti-fungal, antiparasitic, anti-diarrheal, adulticidal, anti-filarial, anti-malarial, anti-inflammatory, anti-sickling, and fertility properties.

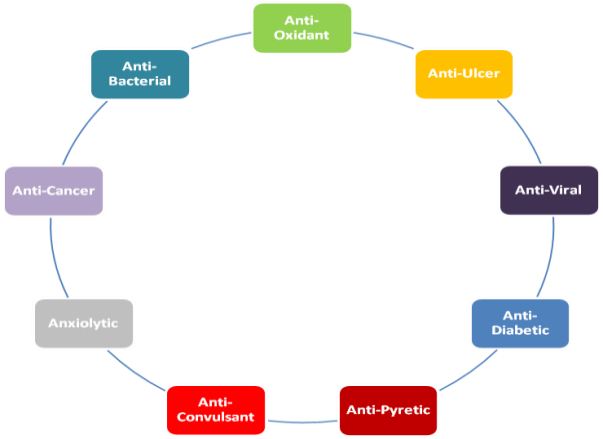

Figure 5. Pharmacological activities of C. halicacabum

Anti-Oxidant Activity

Reactive oxygen species have been linked to chronic diseases such as cancer, plaque buildup, arthritic conditions and other age-associated concerns. Cardiospermum halicacabum's anti-oxidant activity has been investigated using its methanol extract with different in vitro methods such as superoxide nitric oxide radical scavenging, -carotene-linoleate model system, reducing power, 1, 1-diphenyl-2picrylhydrazyl (DPPH), and iron ion chelating activity. The methanolic extract showed significant inhibitory activity against the -carotenelinoleate model system and moderate concentration dependent inhibition of DPPH radical ion chelating activity.This extract also has reducing power, nitric oxide scavenging activity, superoxide scavenging capacity, and ferrous ion chelating capacity, all of which contribute to its anti-oxidant activity. The antioxidant property of Cardiospermum halicacabum methanolic extract was demonstrated in these models[20].Another study was carried out with the plant's chloroform and ethanolic extracts. The free radical models used for screening anti-oxidant activity were nitric oxide scavenging, DPPH, hydrogen peroxide scavenging, reducing power assay, ABTS, and superoxide scavenging. When compared to the ethanol extract, the chloroform extract of the plant demonstrated significant anti-oxidant properties[21].

Anti-Viral Activity

Plant bioactive compounds had been extracted using various solvents were examined for anti-HBV and anti-HIV activity, as reported by the researchers. All HBsAg (79%) and HIV-RT (91%), were decreased by methanol extract, that contains 11 constituents. To test the inhibitory activity of the extracts on HIV-1 reverse transcriptase, a Reverse Transcriptase assay was used, as recommended by previous research. The extract's anti-HBsAg activity was determined

using an Enzyme-Linked Immunosorbent Assay (ELISA). Benzene dicarboxylic acid has a docking score of -4.71 towards the HBV receptor and -4.85 against the HIV receptor. The results suggested that the bioactive principles of C. halicacabum may be employed to develop new HBV and HIV co-infection-controlling procedures[22].

Anti-Ulcer Activity

An ulcer is an injury in the continuity of the stomach or duodenum mucosa to pepsin and gastric acid. It develops by an imbalance between the protective and aggressive mechanisms of the mucous membrane or by a combination of various endogenous factors which include hydrochloric acid and pepsin, along with exogenous factors which includes tobacco, alcohol, NSAIDs, as well as Helicobacter pylori infection. The drug's anti-ulcer activity has been investigated in male Wistar rats using an ethanolic extract of Cardiospermum halicacabum towards an Indomethacin-induced gastric ulcer model. 200 and 400 mg/kg of ethanolic extract of Cardiospermum halicacabum were administered orally 30 minutes prior to inducing ulcer. Omeprazole 10 mg/kg/day was the standard drug employed andare administered orally. In both the test and standard drug-treated groups, the ulcer index was high. In ulcer-induced models, ethanolic extract reduced the extent of gastric mucosal damage in a dose-dependent manner. According to this study, plant antiulcer activity might be due to the presence of active substances such as phenols, flavonoids, saponins, tannins, phenols, along with caffeic acid[23].

Anti-Diabetic Activity

Diabetes mellitus is a complex condition characterized by significant loss of glucose homeostasis as well as disruptions in carbohydrate, protein, and lipid metabolism arising from both defects in insulin production and action.The plant's anti-diabetic activity and glucose uptake were investigated using n-hexane, aqueous, methanol, and ethanol leaf extracts.The leaf extracts were tested for their capacity to inhibit the utilization of glucose through a standard in vitro procedure. 1 ml of crude extracts in 1% CMC along with 1 ml of 0.15M NaCl with 0.22M D-glucose have been added to a dialysis tube in this experiment. The dialysis tube was sealed on each end before being put in a 50-ml centrifuge tube comprising 45-ml of 0.15M NaCl. An orbital shaker was used to keep the dialysis tubes at room temperature. The amount of glucose entering the external solution has been determined at established periods. The results showed that among the different leaf extracts, the methanol extract at a concentration of 50 g plant extract/liter was more active than the others, with the lowest mean glucose levels of 201.69 mg/dl. As a result, the study found that methanol extract had a significant inhibitory effect on glucose uptake[24].

Anti-Pyretic Activity

Cardiospermum halicacabum has been used to treat fever for many years. This plant's anti-pyretic properties have been demonstrated using alcohol, n-hexane, and aqueous extracts. The anti-pyretic activity of the different extracts towards yeast-induced pyrogenesis was examined in adult male Wistar rats. Tween80 was used as a control and paracetamol as a standard. Plant extracts are taken orally. All of the extracts had a different degrees of anti-pyretic activity at 400 mg. Alcohol was the most effective extract, followed by n-hexane. The higher dose of 400 mg/kg had significantly more anti-pyretic activity than the lower dose of 200 mg/kg. The efficacy of paracetamol 100 mg/kg at 2 hours after drug treatment was identical to that of 400 mg/kg extract. According to the findings, all Cardiospermum halicacabum extracts have anti-pyretic properties with no known side effects[25].

Anti-Convulsant Activity

Epilepsy is a chronic brain disorder, and the anticonvulsant activity of the plant Cardiospermum halicacabum was studied pharmacologically using its alcoholic root extract, as well as the mechanisms. For this study, different murine models were used. Prior to testing, mice (male Swiss albino) were administered 300, 100, and 30 mg/kg of the plant's root extract orally. The levels of monoamines in the brain were checked two days after administration. The alcoholic root extract of Cardiospermum halicacabum decreased the emergence of clonus as well as tonus in convulsions caused by isoniazid, pentylenetetrazol, and picrotoxin at doses of 100 and 300 mg/kg. In the maximal electroshock condition, it also reduced tonic hind limb extension compared to vehicle control. There was no evidence of significant motor toxicity when higher doses, 900 mg/kg, were given. HPLC analysis of brain monoamines explained an increase in GABAergic activity in C+ (in the cerebellum) and C- (except in the cerebellum). The results showed that the alcoholic root extract possesses anticonvulsant properties while causing only minor motor damage. More research is needed to determine exactly how it works[26].

Anxiolytic Activity

The anxiolytic effects of the plant Cardiospermum halicacabum were investigated in mice using alcoholic as well as aqueous root extracts. The mice were administered 100 or 300 mg/kg of the plant's aqueous and alcoholic extracts orally

one hour prior to being subjected to different anxiety models. The models used to study the anti-anxiety effects were the Elevated Plus Maze (EPM), Open Field Test (OFT), and Light-Dark Model (LDM). In the elevated plus-maze model, researchers discovered an increase in time utilized in the open arm and total movement time in animals treated with alcoholic as well as aqueous extracts. These extracts increased the time utilized in the light compartment through the light-dark model, but decreased time utilized in the central compartment through the open field test. These results suggest that the alcoholic and aqueous extracts of Cardiospermum halicacabumpossess antianxiety properties[27].

Anti-Cancer Activity

Cancer is a serious medical condition caused by the uncontrolled proliferation of altered genetic cells. Regardless of the numerous approaches used to treat those conditions, herbal medicines are in high demand due to their numerous benefits as immune boosters and healing agents, as well as their low side effects. The examiner had been tasked with determining the cytotoxic impact of C. halicacabum seeds based entirely on conventional claims. Using a Soxhlet extractor, different extracts of C. halicacabum seeds have been extracted. The cytotoxic effects of different extracts on HCT-15 colon carcinoma, MCF-7 breast carcinoma, HT-29, and SK-MEL-2 pores and skin carcinoma has been examined using a Sulforhodamine B colorimetric assay and Doxorubicin as the standard drug.The current study observed that an n-hexane extract of Cardiospermum halicacabum seeds possessed a strong cytotoxic interest in the MCF-7 breast cancer cell line in an extra 50% inhibition value (GI50) of 12.8 g/ml, but various extracts possessed less effects in different cell lines tested. The findings revealed the ability of the seeds with the highest extraction produces an anti-cancer agent.[28] The plant's ethanol and chloroform extracts were tested for anti-cancer properties. In vitro cytotoxic studies, including trypan blue dye exclusion and MTT assays, have been carried out on the Ehrlich Ascites Carcinoma cell line. According to the outcomes of this study, the chloroform extract of Cardiospermum halicacabum has significantly more anti-cancer activity than the ethanolic extract[21].

Anti-Bacterial Activity

The antibacterial testing was performed using crude extracts of C. halicacabum stem and leaf in various solvents towards selected gram-negative as well as gram-positive bacteria. Alcohol, chloroform, acetone, benzene, and aqueous extracts of the leaf and stem were used in the testing. Bacillus subtilis, Citrobacter freundi, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Streptococcus aureus, and Salmonella typhi had been stock cultures used. The growth media were nutrient agar and nutrient broth. The disc diffusion method was used to assess antibacterial efficacy. All of the extracts tested inhibited all of the bacteria tested to different degrees. The leaf extracts obtained with acetone and chloroform had higher inhibitory activity towards Salmonella typhi and Streptococcus subtilis. Acetone extracts of the stem had the greatest inhibitory action towards Salmonella typhi, while benzene extracts of the stem had a moderate inhibitory action towards Escherichia coli[29]. Another study found that the ethanolic leaf extract of the plant Cardiospermum halicacabum tested positive for antibacterial activity towards different strains of bacteria, with the minimum inhibitory concentration ranging from 80 to 125g of extract. The extract has been shown to be effective towards Staphylococcus aureus, Escherichia coli, and the fish pathogen Aeromonas hydrophila. A few of the multidrug-resistant bacteria tested positive for the ethanolic extract of Cardiospermum halicacabum reveals moderate efficacy[17].

Anti-Arthritic Activity

Rheumatoid arthritis is an autoimmune disorder that destroys the articular and periarticular structures over a time. It is recognized as the most common cause of morbidity worldwide. The antiarthritic effect of an ethanolic extract of the leaves of Cardiospermum halicacabum was investigated. The extract was given to rats at 125 mg/kg and 250 mg/kg doses to treat arthritis caused by FCA (Freund's complete adjuvant). To assess the efficacy of the treatment (ESR), different haematological measures such as haemoglobin (Hb) content, white blood cell count (WBC), total red blood cell count (RBC), and erythrocyte sedimentation rate are used. The extract reduced FCA-induced arthritis in a dose-dependent manner, with the effect being significantly greater (p0.001) with a 250 mg/kg dose and Indomethacin (10 mg/kg) as the standard drug employed**.** If it has been compared to FCA-induced arthritic animals, extract administration significantly enhanced body weight. According to the findings, the ethanolic extract had anti-arthritic properties[30].

Anti-Fungal Activity

Dermatophytosis is a fungal infection which affects the stratum corneum, nails, and hair. Because of its increased frequency and morbidity, it is a major public health issue. Trichophyton mentagrophytes and Trichophyton rubrum are the pathogens responsible for this infection. Cardiospermum halicacabum extract has been investigated for antifungal activity towards T. rubrum, indicating that a possible interaction with Hsp90 is important in susceptibility and pathogenicity. Different concentrations of C. halicacabum

(from 500 to 31.25 g) have been evaluated in vitro towards a T. rubrum isolate, and the interaction across some active compounds of C. halicacabum and the fungal Hsp90 was computationally examined. The highest concentrations of the plant extract (250 and 500 g) showed distinct antifungal activity. Rutin and luteolin were identified in silico as the most likely Hsp90 inhibitors among all C. halicacabum compounds tested. Individual anti-fungal activity tests were performed on rutin and luteolin. Individually, rutin and luteolin have an antifungal effect, but not as much as the total plant extracts. This study shows that C. halicacabum has a significant fungistatic effect on T. rubrum, showing its pharmacological activity in the management of dermatophytosis. Rutin and luteolin are Hsp90 interactors, which demonstrates their fungistatic activity. An ethanolic extract of Cardiospermum halicacabum was found to have antifungal activity towards Candida albicans in a study[31].

Anti-Parasitic Activity

Humans may be infected with the parasitic worm Strongyloidesstercoralis. It can cause a fatal sickness and survive for years in a human host. Therefore, it's important to utilize anti-parasitic medications quickly and effectively. Extracts from the medicinal plant Cardiospermum halicacabum have been examined in vitro against third-stage larvae of Strongyloidesstercoralis. Dog feces cultures were used to produce S. stercoralis larvae using the agar plate culture method. The larvae (1,000 larvae/ml) in phosphate buffer saline solutions were exposed to aqueous and alcoholic extracts (2,000 µg/ml) of C. halicacabum at 37 °C and 5% CO2. Ivermectin (250 µg/ml) and piperazine (2,000 µg/ml) were the standard drugs utilized. For seven days, the motility of Strongyloides larvae was used to determine how many of them will survive each day. The larvae were able to survive when exposed to C. halicacabum extracts for 72 and 48 hours, but not to ivermectin, which took 72 to 144 hours, or piperazine, which took more than 7 days. However, many of the larvae were becoming immobile after being exposed to C. halicacabum solutions. The findings indicated that S. stercoralis' vitality was lowered by the plant Cardiospermum halicacabum[32].

Anti-Filarial Activity

Lymphatic filariasis (LF) refers to a mosquito-borne worm illness characterized by chronic and progressive limb and testicular oedema, leading in significant deformity and disability. It is still a prominent cause of permanent disability in tropical and subtropical countries. A long-term infestation with vector-borne filarial worms causes lymphatic malfunction, which leads to gradual, irreversible inflammation of the breasts, limbs, and genitals[33]. Adult worms and microfilariae of Brugiapahangi were studied in vitro using aqueous and ethanolic Cardiospermumhalicacabum preparations. Microfilariae, worms, and microfilariae release from female worms were all tested daily in the culture medium with or without extracts. The MTT assay was employed to determine the vitality or tissue damage of adult worms after 7 days of culture. The sequence of microfilariae discharge from female worms were time and dose dependent, and adult worm motility were inhibited. According to the findings, the ethanol extract quickly inhibited microfilariae motility, and the aqueous extract of C. halicacabum showed a mild but obvious direct activity against B. pahangi[34].

Anti-Inflammatory Activity

When infectious bacteria, viruses, or fungi invade the body, settle in certain tissues, and circulate in the bloodstream leads to inflammation. It can also happen as a result of tissue damage, cell death, cancer, degeneration, or ischemia. In most situations, the development of inflammation is linked to both innate and adaptive immune responses[35]. The plant's anti-inflammatory properties were examined using ethanolic and aqueous extracts. In mice with carrageenan-induced paw oedema, the anti-inflammatory effects of ethanolic extract were investigated. In anti-inflammatory tests, ethanol extract inhibited the formation of paw oedema caused by Carrageenan and enhanced the activities of (glutathione peroxidase) GPx, (superoxidase dismutase) SOD, and CAT (catalase) in liver tissue. The results showed that the ethanolic extract could be used as an anti-inflammatory agent[36].

Anti-Diarrheal Activity

Diarrhoea is a typical serious illness in many tropical locations around the world, affecting 4-5 million people each year. The anti-diarrheal efficacy of aqueous and alcoholic leaf extracts of the plant Cardiospermum halicacabum was studied in various animals. The anti-diarrheal efficacy was tested using castor oil-induced diarrhoea. Cardiospermum halicacabum extracts reduced defecation rate and weight of wet faeces in experimental animals, comprising charcoal meal propulsion through the gastrointestinal tract. This extract also reduced the volume of oedema in the intestines of drug-treated mice. The studies found that the extracts have anti-diarrheal activity[37].

Fertility Activity

On male rats, an aqueous extract of the herb Cardiospermum halicacabum was used in a fertility test. For approximately 30 days, the aqueous extract was given at doses

of 100 and 200 mg/kg body weight. This led to a dose-dependent increase in sperm count and motility in the caput and cauda regions. In all doses, the serum testosterone level increased significantly. The weight of the genital organs and the total cholesterol level in the blood remained unaltered. In pregnant females, the leaf extract (aqueous) increased the number of females inseminated, implantations, and survivable foetuses while reduced the overall number of resorption areas. Regardless of the lack of evidence of renal damage, ALE was discovered to possess hepatoprotective properties. The study found that Cardiospermum halicacabum aqueous leaf extract have enhanced sperm concentration, motility, and testosterone, leading to better fertility[38].

Adulticidal Activity

Mosquitoes carry a wide range of diseases that affect humans and animals throughout the world. They are the major vectors of malaria, filariasis, dengue, schistosomiasis, yellow fever, Japanese encephalitis, and other diseases, which cause millions of deaths each year. They can also cause allergic reactions, such as localized skin irritation. C. halicacabum extracts were tested for repellent activity against Anopheles stephensi, Culex quinquefasciatus, and Aedes aegypti in benzene, hexane, methanol, ethyl acetate, and chloroform. The crude leaf preparations were applied to the exposed portion of the forearm, with ethanol serving as a control. The extracts prevented the test subjects against mosquito bites without generating an allergic reaction, and the repellent action have been found to be proportional to the concentration of the extract. The plant extract that was tested successfully repelled all three mosquitos[39]. The adulticidal action of the plant Cardiospermum halicacabum towards Anopheles stephensi, Culex quinquefasciatus, and Aedes aegypti was examined using hexane, ethyl acetate, benzene, chloroform, and methanol extracts. The WHO approach was implemented and a bioassay was performed. Mosquito mortality was found after 24 hours. Adult mosquitos revealed symptoms of a moderately harmful effect after the exposure time. When compared to the other extracts, the methanolic extract of the plant exhibited the greatest rate of mortality. The results showed that the plant's crude extract has outstanding adulticidal properties towards all three mosquitoes[40].

Anti-Malarial Activity

Cardiospermum halicacabum, a plant that has traditionally been used to treat malaria symptoms in several parts of the world, was examined for anti-malarial activity in vitro and in vivo. Cardiospermum halicacabum aqueous extract were hazardous to mice, with none lasting past the fourth day that follows oral dosage and no evidence for protection towards Plasmodium berghei malaria. This study demonstrates the likelihood of discrepancies between in vitro and in vivo plant-derived extract screening, along with the relevance of considering anti-plasmodial outcomes in vitro[41].

Anti-Sickling Activity

The stems and leaves of Cardiospermum halicacabum are used in traditional medicine to cure a range of ailments, such as angina, the common cold, and other diseases. C. halicacabum extracts significantly reversed crenation in hemoglobin AA blood that had crenated in acidic citrate-dextrose saline. When C. halicacabum isolate was added to haemoglobin AS samples, sickling of RBCs was reversed to normal form. The results were found to be considerably superior than those obtained with testosterone propionate at the concentrations that were used. It is uncertain whether the claimed anti-sickling and anti-crenation effects have been triggered by the extract's direct effect on the erythrocyte membrane or through the extract's oxygenation of the hemoglobin[42].

VIII. NUTRITIONAL VALUE

Flame emission spectroscopy was used to study the macroelement analysis of Cardiospermum halicacabum.This includes analysis of sodium,potassium,and calcium.Trace element analysis of Cardiospermum halicacabum was measured using atomic absorption spectroscopy.Additional constituents were also analyzed.The extract contains a wide range of micro-and macronutrients that can be used as dietary supplements to improve health and immunity[43].

IX. TRADITIONAL USES

Cardiospermum halicacabum is a climbing plant that is used to treat a wide range of ailments. The Decoction of the leaves relieves diarrhea and dysentery. The juice of this plant can be applied to hemorrhoids. It aids in the treatment of a variety of respiratory ailments. Colds, asthma, and pertussis are all treated with the plant decoction. Because of their diuretic qualities, the roots are used to treat renal diseases. The entire herb is used to treat urinary tract infection, edema, nephritis, and oliguria[44]. It can be used to treat boils, as a refrigerant, emetic, diuretic, laxative, stomachic, anti-bacterial, antidiarrheal, anti-inflammatory, anti-ulcer, wound healing, nerve disorders, and itching[45]. The aqueous extract of the leaf can be used to alleviate earache. A Decoction of the root and stem is used to treat bladder catarrh.A leaf decoction is used to cure eczema and purities[46]. The leaves are believed that they might have been used to wash textiles. The oil extracted from the plant's seeds contains antifeedant and insect repellent

properties[47]. The plant extract has a sedative impact on the central nervous system. It possessed numerous anti-inflammatory and analgesic effects. The medicine also has vasodepressant properties that were considered to be temporary. In vitro antispasmodic efficacy was also discovered. These findings support the use of it in Ayurvedic medicine[48]. Tea made from the plant is used to treat itchy skin, and salted leaves are applied as a poultice on swellings[49].

X. ADVERSE DRUG REACTION

There haven't been many reports of this plant causing problems. A formulation containing Cardiospermum halicacabum (10%) is used to treat skin disorders such as itching, redness, and skin irritation. But it is recommended that this cream is not be used during pregnancy[50].

XI.CONCLUSION

Cardiospermum halicacabum L provides several significant features which contribute to its importance in the field of medicine.Numerous studies have been conducted to determine the anti-oxidant, anti-viral, anti-inflammatory, anti-filarial, anti-malarial, anti-bacterial, anxiolytic, anti-arthritic, anti-parasitic, anti-cancer, anti-diarrheal, anti-fungal, anti-pyretic, anti-sickling, adulticidal, and fertility properties of the plant.The results confirmed its traditional usage in treating human illnesses and helped to a better understanding of its role in herbal treatments as a source of phytochemical components such as phenols, steroids, tannins, saponins, terpenoids, and flavonoids.Therefore, thisplant may be employed to serve as a pharmaceutical substitute.This review focuses on the biological activity potential of this widely distributed plant, that might benefit the public at large.

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