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Review article

Beneficial effect of *Centella asiatica*: Synthesis of the last two decades

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SUMMARY

Introduction: In Asia, *Centella asiatica* is widely known, used, and consumed as a medicinal plant. This plant has been used for a long time in traditional Chinese and Indian medicine, for its numerous beneficial health properties. **Objectives:** The present study compiles all the pharmacological activities of *Centella asiatica* (CA) described during the last 2 decades. **Methodology:** The present study carried out a review of the bibliography in PubMed, Springer Journals, Web of Science, and Scopus, to select studies published between 2000 and 2024 (01/01/2000 - 01/01/2004). **Results:** A comprehensive review of the pharmacological activity of CA has been conducted over the past 24 years, and studies have conclusively demonstrated its potential to treat a wide variety of diseases and disorders. These findings support the efficacy of CA as a therapeutic option. **Conclusion:** It has been concluded that this plant has promising medicinal properties for health. This research further supports the traditional use of CA in herbal medicine, paving the way for future research and therapeutic applications.

Keywords: *Centella asiatica*; gotu kola; pharmacological activity.

RESUMEN

Efecto benéfico de *Centella asiática*: Síntesis de las últimas dos décadas

Introducción: En Asia, la Centella asiática es ampliamente conocida, utilizada y consumida como planta medicinal. Esta planta se utiliza desde hace mucho tiempo en la medicina tradicional china e india, por sus numerosas propiedades beneficiosas para la salud. **Objetivo:** Por tanto, el presente estudio recopila todas las actividades farmacológicas de *Centella asiatica* (CA) descritas durante las últimos 2 década. **Metodología:** El presente estudio realizó una revisión de la bibliografía en PubMed, Springer Journals, Web of Science y Scopus, para seleccionar estudios publicados entre 2000 y 2024 (01/01/2000 - 01/01/2004). **Resultados:** Durante los últimos 24 años se ha realizado una revisión exhaustiva de la actividad farmacológica de la CA y los estudios han demostrado de manera concluyente su potencial para tratar una amplia variedad de enfermedades y trastornos. Estos hallazgos respaldan la eficacia de la CA como opción terapéutica. **Conclusión:** Se ha concluido que esta planta tiene propiedades medicinales prometedoras para la salud. Esta investigación respalda aún más el uso tradicional de la CA en la medicina herbaria, allanando el camino para futuras investigaciones y aplicaciones terapéuticas.

Palabras clave: *Centella asiática*; gotu kola; actividad farmacológica.

RESUMO

Efeito benéfico da *Centella asiatica*: Síntese das últimas dois décadas

Introdução: Na Ásia, a *Centella asiatica* é amplamente conhecida, utilizada e consumida como planta medicinal. Esta planta é utilizada há muito tempo na medicina tradicional chinesa e indiana, pelas suas inúmeras propriedades benéficas para a saúde. **Objetivo:** O presente estudo compila todas as atividades farmacológicas da *Centella asiatica* (CA) descritas durante os últimos 24 anos. **Métodos:** O presente estudo realizou uma revisão da literatura no PubMed, Springer Journals, Web of Science e Scopus, para selecionar estudos publicados entre 2000 e 2024 (01/01/2000 - 01/01/2004). **Resultados:** Nos últimos 24 anos, houve uma revisão abrangente da atividade farmacológica do CA e estudos demonstraram conclusivamente o seu potencial para tratar uma ampla variedade de doenças e distúrbios. Esses achados apoiam a eficácia da CA como opção terapêutica. **Conclusão:** Concluiu-se que esta planta possui propriedades medicinais promissoras para a saúde. Esta pesquisa apoia ainda mais o uso tradicional de CA na fitoterapia, abrindo caminho para futuras pesquisas e aplicações terapêuticas.

Palavras-chave: *Centella asiatica*; gotu kola; atividade farmacológica.

1. INTRODUCTION

Due to their recognized effectiveness and more natural approach to health care, the use of medicinal plants has seen a significant resurgence today [1]. An increase in the use of medicinal plants as an alternative to conventional medicines has been observed globally [2, 3]. For many centuries, *Centella asiatica* (CA), also known as Gotu Kola, is a perennial herbaceous plant native to the Asian continent that has been appreciated for its various healing properties and health benefits [4, 5]. It is popularly known by several names, including: Indian pennywort, Asiatic pennywort, spadeleaf, coinwort, vallaarai, brahmi, Antanan, Pegaga, cica, herb de tiger, among others [6-9].

This plant lives mainly in tropical and subtropical areas of Asia [10]. They can be found naturally in places such as India, Indonesia, China, Japan, and Sri Lanka [11, 12]. In addition, it has spread to other places on the planet, such as Australia and areas of the United States, where it has adapted to suitable growing conditions, such as moist soils and shading, such as the banks of rivers, lakes, and ponds [13]. CA has stems up to one and a half meters high that can be creeping or climbing [14]. It has fan-shaped leaves with crenate edges and pink or white flowers [15]. The smooth and compressed diakenium with a discoid appearance is the fruit of CA [16]. Below, Table 1 shows the taxonomic classification of the CA.

Table 1. Taxonomic classification CA [17].

Kingdom	Plantae
Phylum	Magnoliophyta
Clase	Equisetopsida
Class	Magnoliopsida
Order	Apiales
Family	Apiaceae
Genus	Centella
Species	*Centella asiatica*

The leaves, stems, and roots of CA are used as medicine due to the phytococonstituents (Table 2) of this plant [18]. These leaves are glabrous and ruffled in shape, entire or with rounded protuberances on the edges [15]. Due to its beneficial properties for the skin and other therapeutic uses, CA is used in both traditional medicine and the cosmetic industry [19].

Table 2. Main phytoconstituents of the CA.

Main phytoconstituents	**Chemical constituent**
Essential oil	Betacaryophyllene, transbetafarnesene, and germacrene D.
Free amino acids	Alanine, serine, aminobutyrate, aspartate, glutamate, lysine, and threonine.
	Quercetin, kampferol, 3-glucosyl-quercetin, 3-glucosyl-kampferol.
Fatty acids	Linoleic acid, lignoceric acid, linolenic acid, oleic acid, palmitic acid, eladic acid, and stearic acid.
Triterpene saponins	Asiaticoside, madecassoside, brahmosid, brahminoside, centellosaponins B, C, and D.
Mucilage	—---
Resin	—---
Phytosterols	Sitosterol.
Tannins	Condensed tannins.
Alkaloids	Hydrocotiline, vallerina.

2. METHODOLOGY

In the month of April 2024, a bibliographic search was carried out searching Pubmed, Scopus, Web of Science, and Springer journals. The words used for the search were (*Centella* and *asiatica* or Gotu and kola), (*Centella asiatica* and pharmacological activity), (Gotu kola and pharmacological activity) in all databases except Pubmed. In Pubmed it was used ("*Centella asiatica*" [MeSH] OR "Gotu kola" [MeSH]), ("*Centella asiatica*" [MeSH] OR "Pharmacological activity" [MeSH]), ("Gotu kola" [MeSH] OR "Pharmacological activity" [MeSH]).

This study will consider the publication date of the documents, which must be from January 1, 2000 to January 1, 2024. The rest of the documents that were published before the year 2000 will be excluded. Another criterion to consider is the type of study, which means that only review articles and systematic review articles with or without meta-analysis are included in this study, the rest of the studies will be excluded.

Likewise, studies that are only published in English and Spanish will be included in this study, the rest of the documents will be excluded. Finally, studies that do not mention pharmacological activities of *Centella asiatica* (CA) or Gotu kola in the content will be excluded. A flow chart was used to facilitate the selection of studies for the next review. At the end of the search, a total of 28 articles were selected.

3. RESULTS

3.1. Search results

From an initial 29,041 documents found from 2000 to 2024, a total of 28 articles were obtained after following a search flow including inclusion and exclusion criteria (Fig. 1).

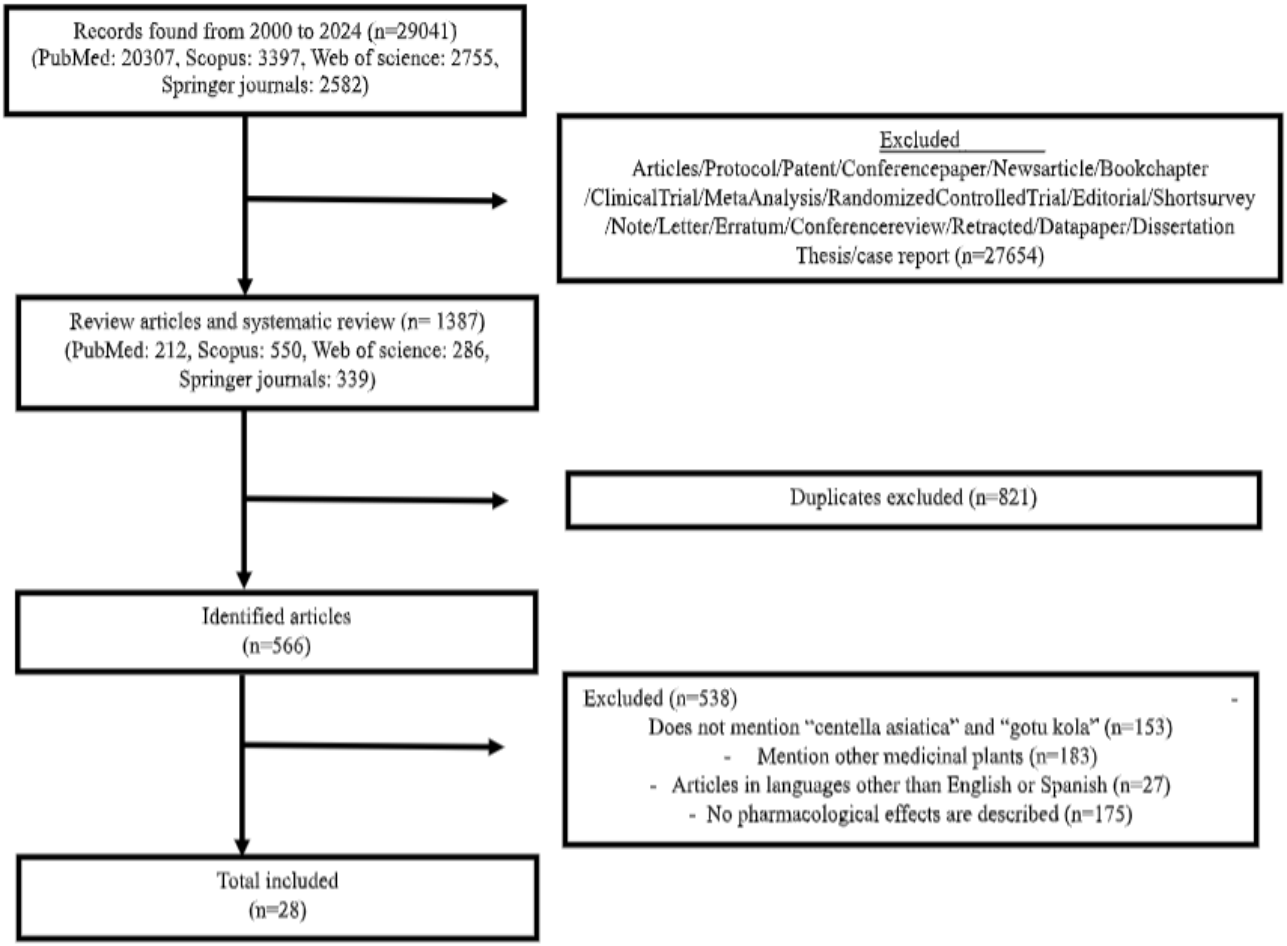

Figure 1. Flow chart of the study selection process

Table 3. Extraction of all selected studies

Study (Year)	Type of study	Databases	Search period	Pharmacological activity
Brinkhaus *et al.* (2000) [20]	Review	German Institute of Medical Documentation and Information (DIMDI), Embase, Medline, Natural Products Alert (NAPRALERT), and Phytodoc.	Not specific	Antimicrobial, antiviral, immunomodulatory effects, spasmolytic, gastrointestinal, dermatological, infectious, venous, nephrological, urogenital, neurological, psychiatric diseases, chronic venous insufficiency, striae, wound healing disorders, treatment of leprosy and effects on varicose veins.
Incandela *et al.* (2001) [21]	Review	Not specific	Not specific	Vascular, venous, and arterial diseases.
James and Dubery (2009) [22]	Review	Not specific	Not specific	Treatment of skin disorders such as eczema, psoriasis, wound healing, burn, and scar. Revitalising connective tissue, cleaning up skin infections, leprosy, arthritis, rheumatism, memory enhancement, circulation, bronchitis, asthma, cancer, detoxifying the body, slimming, diuretic, treatment of liver, kidneys and antifungal, antibacterial activity.
Gohil *et al.* (2010) [23]	Review	Not specific	Not specific	Wound healing, venous insufficiency, sedative, anxiolytic, antidepressant, antiepileptic, cognitive, antioxidant, gastric ulcer, antinociceptive,

				antiinflammatory, and radioprotection properties.
Orhan (2012) [24]	Review	ScienceDirect, Web of Science, Scopus, PubMed, and Google Scholar.	Not specific	Neuroprotective activity.
Bylka *et al.* (2013) [25]	Review	Not specific	Not specific	Treatment of small wounds, hypertrophic wounds, burns, psoriasis, scleroderma, photoaging skin, cellulite, and striae.
Bylka *et al.* (2014) [26]	Review	Ovid Medline, PubMed, and The Cochrane Library.	From 1988 up to March 2013	Wound healing, antimicrobial, antioxidant, and anti-psoriatic activity.
Chandrika and Prassad-Kumarab (2015) [27]	Review	Not specific	Not specific	Antioxidant, antimicrobial, cytotoxic, neuroprotective, antibacterial, antioxidant, antiulcer, antidiabetic, anti-inflammatory, cytotoxic, cardio, neuro, and skin protective activities, radioprotective activity, immunomodulatory effect.
Yogeswaran *et al.* (2016) [28]	Review	Not specific	Not specific	Treat neurodegenerative diseases, increase memory performance, alzheimer and parkinson disease.
Sabaragamuwa *et al.* (2018) [29]	Review	Not specific	Not specific	Anti-oxidative properties to attenuate oxidative stress, a high anti-inflammatory potent, neuron regenerative ability, potential for neuron damage prevention, neurotoxicity inhibition effect, anti-anxiety, anti-depressive properties, and ability to reduce the accumulation of amyloid plaques.
Gray *et al.* (2018) [30]	Review	Not specific	Not specific	Cognitive enhancer, anxiolytic, anticonvulsant, anxiolytic, anti-ischemic effect.
Razali *et al.* (2019) [31]	Review	PubMed and Google Scholar	From 2004 up to March 2018	Cardioprotective, anti-atherosclerotic, antihypertensive, antihyperlipidemic, antidiabetic, antioxidant, anti-inflammatory activities, neurological, dermatological, and metabolic diseases.
Archana *et al.* (2019) [32]	Review	PubMed, Scopus, Google Scholar, SciFinder, Medline, and ScienceDirect.	Not specific	Memory loss, platelets aggregation, insomnia, psoriasis, burn wounds, hypertonic scars, and skin cell reconstruction.
Kant *et al.* (2019) [33]	Review	Not specific	Not specific	Wound healing, antimicrobial, antifungal, antioxidant, antiviral, antiprotozoal, antifilarial, memory enhancement, cardiovascular, antiulcer, antidiabetic, hepaprotective, antiproliferant, antidepressant, autoimmune, anticancer, liver protection, gastric ulcer, dermatologic, and radioprotective activity.
Sun *et al.* (2020) [34]	Review	PubMed	Between January 1, 2015, and October 19, 2019	Neurological, endocrine, skin, cardiovascular, digestive, respiratory, gynecological, and rheumatoid arthritis effects.
Park (2021) [35]	Review	PubMed, Web of Science, Scopus, ScienceDirect, and SciFinder.	Not specific	Skin Diseases (acne, burns, atopic dermatitis, and wound effects).
Wong *et al.* (2021) [36]	Review	Not specific	Not specific	Anti-inflammatory, neuroprotective, neuroactive effects.
Biswas *et al.* (2021) [37]	Review	Not specific	Not specific	Neuroprotective, antidiabetic, wound healing, cardiovascular, pulmonary, hepatic, renal, gastrointestinal, skin, endocrine system effects, and treatment of venous insufficiency.
Torbati *et al.*	Review	Google Scholar, Scopus,	Not specific	Neuroprotective, wound healing, and treatment

(2021) [38]		PubMed, and Web of Science.		of venous insufficiency, and antidiabetic activity.
Arribas-Lopez *et al.* (2022) [39]	Systematic Review and Meta-analysis	PubMed, ScienceDirect, Medline, grey literature research with Google Scholar.	From 2017 up to March 2019	Anti-inflammatory and wound healing effects.
Diniz *et al.* (2023) [40]	Review	PubMed.	Until December 2022	Wound healing activity.
He *et al.* (2023) [41]	Review	Google Scholar, PubMed, Web of Science, Elsevier.	Up to 2022	Anti-neural inflammation, anti-cancer, protective properties for the skin, cardiovascular, and pulmonary system.
Bandopadhyay *et al.* (2023) [42]	Review	Not specific	Between 2005 and 2022	Neuroprotective, cardioprotective, hepatoprotective, wound healing, anti-inflammatory, antioxidant, anti-allergic, anti-depressant, anxiolytic, antifibrotic, antibacterial, anti-arthritic, anti-tumour, and immunomodulatory activity.
Shafin *et al.* (2023) [43]	Review	Scopus	Between 1857 and 2022	Healing, antimicrobial, anti-inflammatory antioxidant, anti-cancer, anti-diabetic, immunomodulatory, hepatoprotective, cardioprotective and neuroprotective activity.
Yang *et al.* (2023) [44]	Review	Google Scholar, PubMed, and China National Knowledge Infrastructure (CNKI)		Treatment of chronic kidney diseases, malignant intestinal obstruction, radiation dermatitis, precancerous lesions, chronic prostatitis, alzheimer, and other diseases.
Wicińsk *et al.* (2024) [45]	Review	Not specific	Not specific	Treatment of chronic kidney diseases, malignant bowel obstruction, radiodermatitis, precancerous lesions, chronic prostatitis, medical cosmetology, and the production and processing of skin care products.
Adline *et al.* (2024) [46]	Review	Not specific	Not specific	Anti-inflammatory, anti-fibrotic, antioxidant, and neuroprotective effects.
Min *et al.* (2024) [47]	Review	PubMed and Google Scholar	Since the year 2000 up to the latest information	Anti-inflammatory effects, skin wounds, scar treatments, and cosmetics agents.

3.2. Pharmacological effects

3.2.1. Anti-inflammatory effect

Studies on *Centella Asiatica* (CA) have demonstrated its anti-inflammatory capacity [23, 27, 29, 31, 48-50]. Several active components, such as Asiatic acid and CA asiaticosides, have been found to have anti-inflammatory effects [51, 52]. In addition to its anti-inflammatory properties, CA has also been successfully used to treat conditions such as phlebitis, varicose veins, hemorrhoids, surgical wounds, burns, and insect bites due to its dermoprotective properties [39, 42, 53, 54]. Other studies have found that CA contains triterpenes, such as ursane- and olean-type compounds, which also have anti-inflammatory effects [43, 46, 47, 55-57].

3.2.2. Cardiovascular effect

Asiaticoside is the active ingredient in CA that has effects on the heart [27, 31, 33, 42, 43, 58]. The beneficial effects of asiaticoside on the cardiovascular system include antihypertensive, antiatherosclerotic, and antihyperlipidemic properties [29, 30, 59, 60]. In addition, asiaticoside

has anti-ischemic and antiplatelet effects, which helps protect the heart and improve blood circulation [37, 41, 61-63].

3.2.3. Effects on skin

CA asiaticoside has an effect on the skin, treating disorders such as eczema, psoriasis, cellulite, and stretch marks [22, 26, 34, 64, 65]. This compound has been shown to have healing, soothing, and collagen formation-stimulating properties, which improves the appearance of the skin and promotes wound healing, such as small wounds, hypertrophic wounds, burns, scars, and reconstruction of skin cells [25, 32, 35, 37, 66, 67].

In addition, thanks to its content of asiaticoside and antioxidant components (ascorbic acid), CA protects the skin against skin photoaging [27, 41, 42, 46, 47, 68]. These antioxidants protect the skin from damage caused by free radicals and help combat oxidative stress [38-40, 69, 70].

3.2.4. Effect on infections

Asiaticoside is the active ingredient in *centella asiatica* that acts against infections [33, 71, 72]. It has antimicrobial, antiviral, antifungal, antibacterial (such as leprosy), antiprotozoal and antifilarial effects [20, 27, 42, 73]. This compound is found in *centella asiatica* and has been shown to act against a variety of microorganisms [26, 74-76].

3.2.5. Effect on the respiratory system

The active ingredient of CA that affects the respiratory system, such as bronchitis and asthma, is not specified in the literature search. However, it is mentioned that *centella asiatica* contains active ingredients such as asiaticoside and madecasside, which are triterpene pentacyclic saponosides [34, 77, 78]. These compounds have therapeutic properties, but their effects on the respiratory system are not mentioned [41, 79].

3.2.6. Endocrine effect

The active ingredients of CA have antidiabetic properties and endocrine effects [37, 38, 80]. Asiaticoside is an active ingredient that has an antidiabetic effect [27, 31, 33, 81].

3.2.7. Effect on the urinary system and gynecological system

The results regarding the effect on the urinary and gynecological system of CA do not contain specific evidence. However, CA has been investigated for its healing properties and traditional use in herbal medicine to treat a variety of diseases of the urinary and gynecological system [20, 34].

3.2.8. Effect on cancer

CA has been studied for its immunomodulatory properties and has been found to help the immune system destroy cancer cells [27, 42-45, 78]. According to some studies, CA has antiproliferative effects in some types of cancer, such as breast cancer, and can enhance the action of other antitumor treatments [41, 82]. At the same time, there is no specific evidence on *Centella asiatica* regarding the radioprotective effect.

According to some studies, Asiatic acid is the active ingredient in gotu kola, which has been studied for its effects on cancer [22, 83]. Several studies have shown that Asiatic acid has properties that can stop the growth of tumors and fight cancer cells in the colon, liver, prostate, and breast, among others [84]. Additionally, Asiatic acid has been found to inhibit cell growth and apoptosis in colon cancer cells through a mitochondrial death cascade [23, 82, 85].

3.2.9. Gastrointestinal effects

Traditionally, CA has been used to detoxify the body. However, no precise evidence of this effect was found [37, 86]. There was also no clear evidence of a slimming effect. It has been suggested that CA may have diuretic characteristics, meaning that it may help increase urine production and promote the elimination of toxins through the urinary system [20, 87].

AC has been found to have hepatoprotective properties in relation to gastric protection, meaning it can protect the liver from damage and improve its health [44, 45, 82]. It also has gastroprotective properties, which can protect the stomach lining and prevent the formation of ulcers [23, 86]. Likewise, it has antispasmodic properties, which means that it can help relieve muscle spasms from ingestion [88-90].

3.2.10. Neurological effect

Progressive loss of memory and cognitive function is a symptom of a neurodegenerative disease known as Alzheimer's disease [91]. Research has been carried out on the neuroprotective effects of some natural compounds, such as verbascside and echinoside, in Alzheimer's disease [20, 24, 28, 31, 44, 91, 92]. These substances have been shown to have antioxidant and neuroprotective properties, and have been shown to improve Alzheimer's disease and other neurological disorders. Research has been carried out on the neuroprotective effects of some natural compounds, such as verbascoside, in Parkinson's disease [30, 36-38, 42, 93]. No specific evidence was found regarding the neuroprotective effect in epilepsy or insomnia.

3.2.11. Psychiatric effect

Some of the active ingredients of CA have been investigated for the treatment of psychiatric disorders, but there is not enough scientific evidence to conclusively support the specific psychiatric effects of CA. Triterpenes, such as Asiatic acid, madecassic acid, have been studied for their anxiolytic and antidepressant effects. These chemicals can calm, relieve anxiety and depression [20, 30, 42, 94, 95].

3.2.12. Rheumatology effect

There is limited evidence on the specific effects of CA in rheumatological diseases, its potential benefit in some related disorders has been investigated. The active ingredients present are triterpenes such as Asiatic acid and madecassic acid, these elements can reduce inflammation and protect against oxidative stress, which is crucial for many rheumatological diseases [34, 96]. Contains saponins, which are chemicals with anti-inflammatory and analgesic effects, which relieve pain and inflammation of rheumatological diseases [22, 97, 98].

4. CONCLUSION

Centella asiatica (CA) has demonstrated significant therapeutic potential as an alternative to conventional pharmacological treatments for various diseases. However, there are still areas of research that require more evidence, such as its effect on the rheumatological system, respiratory system, psychiatric system, urinary and gynecological system, as well as its disinfectant capacity and radioprotective effect on the body. This review highlights the need for further pharmacological research on CA, especially concerning contagious, venereal, fatal, rare and orphan diseases. Likewise, future studies are required to evaluate its pharmacological properties, including possible toxic effects of this plant and environmental impact. In summary, we trust that this review will be a valuable tool for researchers in their future explorations.

CONFLICT OF INTERESTS

The authors of this research have no conflict of interest.

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