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Review Article

A Comprehensive Review of the Phytochemical Constituents and Pharmacological Properties of *Clerodendrum infortunatum* Linn

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ABSTRACT

Clerodendrum infortunatum Linn. is a medicinal plant commonly used in traditional medicine for treating a range of ailments such as fever, cough, inflammation, and skin diseases. The plant is rich in phytochemicals like flavonoids, terpenoids, and phenolic compounds responsible for its medicinal properties. Studies have shown that *C. infortunatum* has anti-inflammatory, antioxidant, antimicrobial, and antidiabetic effects. Despite its traditional use, research on its safety and toxicology is still limited, though it is generally considered safe in therapeutic doses. There is also a lack of detailed studies on its pharmacokinetics and pharmacodynamics, which explore how the plant's compounds are processed by the body. Additionally, *C. infortunatum* has been widely used in ethnomedicine to treat respiratory problems, digestive disorders, and skin conditions. Current research is focused on identifying its bioactive compounds and understanding their potential health benefits. Further studies are needed to confirm its safety, understand its mechanisms of action, and explore its potential use in modern medicine. With its wide range of traditional uses and promising pharmacological properties, *Clerodendrum infortunatum* holds significant potential for the development of new therapeutic agents.

INTRODUCTION

Plants have been the primary source of medicine since ancient times¹. Plants produce a wide variety of chemical compounds that can be used as the main ingredients of medicines, functional foods, and cosmetic ingredients. Bioactive compounds in plants are synthesized as secondary metabolites

with complex chemical compositions and in small amounts². Using traditional medical practitioners with indigenous knowledge is a valuable approach to discovering new medications³. Although medicinal plants are widely explored for their antibacterial properties, few systematic investigations have been conducted⁴. Newly

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discovered plant-based bioactive molecules possessing potent antibacterial capabilities have been made possible by traditional medical knowledge⁵. Drug development programs based on Ayurvedic principles are quite popular since plant-derived medications are more tolerable and less harmful to normal cells. The human body utilizes a number of phytochemicals as well as their metabolites for a range of therapeutic purposes. The elements that are responsible are glycosides, alkaloids, flavonoids, phenolics, tannins, oils, resins, and gums⁶. The plant's alcoholic and aqueous extracts of the root and leaf have been reported to have anti-cancer properties in a number of studies, however, the specific chemicals causing this effect have not been found. Only a small number of papers have determined the active ingredients, and all of them have shown cytotoxicity in one or two cell lines^{7,8}. In the Verbanaceae family, *Clerodendrum infortunatum* Linn. This terrestrial shrub, known by several names such as Bhat in Hindi, Ghentu in Bengali, and Bhania in Oriya, has a square, blackish stem as well as decussate, simple, petiolate, coriaceous, exstipulate, opposite, hairy leaves exuding an unpleasant odour⁹. The shrub grows to a height of 2-4 feet and has white or bluish-purple flowers in terminal panicles with a pyramidal shape¹⁰. The plant has blunt, quadrangular stems and branches, and it resembles a slightly woody shrub. Usually three at a node, the leaves are serrate, oblong or elliptic in shape, as well as occasionally opposite. Blue flowers in long cylindrical thyrus clusters are followed by four-lobed purple drupe fruits that are rather succulent and contain one pyrene each¹¹. This plant is frequently found on the plains of India, predominantly in West Bengal, Jharkhand, and Odisha. *Clerodendrum* species have been utilized for millennia and have shown to have antioxidant and hepatoprotective properties¹². Tribes utilize plant parts to cure skin disorders, tumors, colic, snake bites, as well as

scorpion stings. The mildly bitter leaves are beneficial for treating inflammation, skin disorders, and smallpox¹³. Numerous pharmacological benefits, for example, anti-snake venom activity, analgesic and anticonvulsant activity, nootropic activity, and antibacterial, antioxidant, and hepatoprotective qualities, have been linked to these chemical substances found in *C. infortunatum*¹⁴. Traditionally, roots as well as leaves have been employed as emetics, cholagogues, anthelmintics, & laxatives. Additionally, the plants are applied externally to treat skin conditions, tumors, snakebite injuries, along with scorpion stings¹⁵. The leaves fresh juice has been used to treat malaria as well as as a vermifuge¹⁶. Saponin, clerodin (bitter diterpene), alkyl sterols, enzymes, along with 2, -(3, 4-dehydroxyphenyl)ethanol-1-O- α -2 rhamnopyranosyl (1 $\rightarrow$ 3)- β -D-(4-Ocaffeoyl) are all found in the leaves of *Clerodendrum infortunatum*¹⁷. Indian folk medicine uses plant components to cure asthma, bronchitis, epilepsy, inflammation, burning feelings, blood disorders, as well as fever¹⁸. It was found that the plant contained flavonoids, steroids, as well as triterpenes. The plant's antioxidant, antibacterial, anti-malaria, anthelmintic, and analgesic properties have led to increased research on it¹⁹. The plant is employed as an anthelmintic, tonic, aphrodisiac, and antipyretic in Ayurveda, and it has a strong, bitter flavour. Bilioussness, "kapha," "tridosha," leukoderma, thirst, scorching feelings, bad odor, and blood disorders can all benefit from it. Up to an elevation of 1200 meters, warmer regions of India are inhabited by the herbaceous plant *Alternanthera sessilis* (Amaranthaceous), commonly referred to as Gudari saag or Matsyaakshi²⁰. Saturated hydrocarbons, aliphatic esters, stigmasterol, as well as β -sitosterol are abundant in the plant. It was stated that the plant's petroleum ether extract produced nonacosane, 16-



hentriacontane, β -sitosterol, stigmasterol, as well as handianol²¹.

Vernacular Names:

Common name	Hill Glory Bower
Manipuri	Kuthap manbi
Hindi	Titabhamt, Bhant
Kannada	Esaga, Ittevu, Ibbane
Sanskrit	Bhandirah
Tamil	Perukilai
Malayalam	Peruku
Bengali	Bhant
Marathi	Bhandira
Nepali	Raajbeli, Chitu, Bhentaa
Telugu	Gurrapu katilyaku
Mizo	Phuihnem-chhia

Table No 1: - Vernacular Names of C. Infortunatum

Geographical Distribution:

- Odisha: Mayurbhanj district
- Assam: Assam
- Maharashtra: Thane district
- Arunachal Pradesh: Arunachal Pradesh
- Kerala: All districts of Kerala
- Karnataka: Dakshina Kannada district, Chikkamagaluru district

- Andhra Pradesh: Vishakapatnam district, East Godavari district
- Andaman and Nicobar Islands: Andaman & Nicobar Islands
- World Distribution: Andaman and Nicobar Islands, Bangladesh, China, Bhutan, India, Nepal, Laos, Sri Lanka, Myanmar, Thailand, Philippines

India: In India, *Clerodendrum infortunatum* is found in various states including West Bengal, Kerala, Assam, Karnataka, as well as Tamil Nadu. It is frequently observed in the Western Ghats and in moist deciduous woods.

Sri Lanka: The plant is common in Sri Lanka's wet zone, where it grows along streams and in secondary forests.

China: In China, it is primarily distributed in the southern regions, including Yunnan, Guangdong, and Guangxi provinces.

Malaysia and Indonesia: *Clerodendrum infortunatum* is also prevalent in the lowland and hill forests of Malaysia and Indonesia

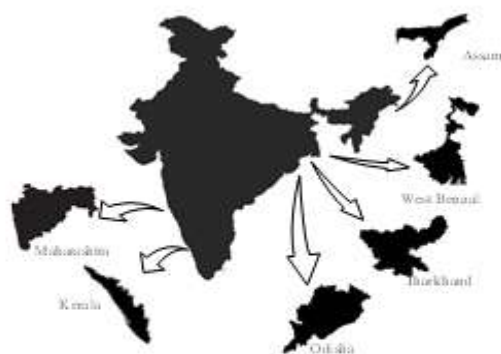


Figure 1: Geographical distribution of *Clerodendrum infortunatum*

Taxonomical Characteristics:

Habit: Large shrubs or else small trees ca. 4m tall.

Branchlets: Branchlets quadrangular, fulvous tomentose.

Leaves: Decussate, opposite, and simple leaves; terete, fulvous tomentose petiole; broad, elliptic-ovate or suborbicular lamina (7–17(–23) x 7.5–

15cm), acuminate apex, cordate base, entire or else dentate edge, sub coriaceous, fulvous tomentose; midrib elevated with tomentose above; 5–7 nerves at the base; secondary nerves ca. 2–3pairs; tertiary nerves horizontally as well as distantly spaced per current.

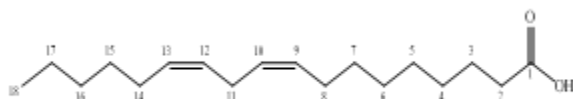
Flowers: florescence flowers are zygomorphic and white; terminal panicle is up to 18cm long and fulvous pubescent.

Fruit& seed: Black, almost globose drupe seated on an expanded pinkish-acrescent calyx²².

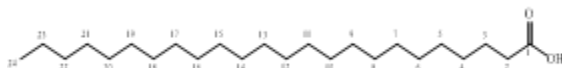


Figure 3: - *Clerodendrum infortunatum* Linn

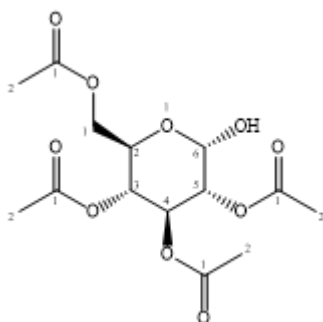
Clerodendrum in fortunatum	
Kingdom	Plantae
Clade	Tracheophytes
Subclade	Angiosperms



9-cis,12-cis-Linoleic acid



Tetracosanoic acid



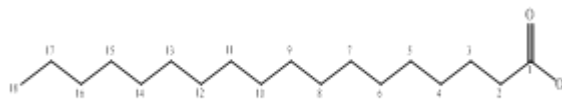
2,3,4,6-tetra-O-acetyl-D-glucopyranosides

Order	Lamiales
Family	Lamiaceae
Genus	Clerodendrum
Species	C. infortunatum

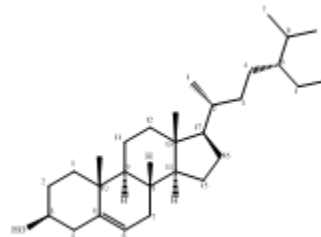
Table No 2: - Taxonomical Classification of C. infortunatum

Phytochemical Properties:

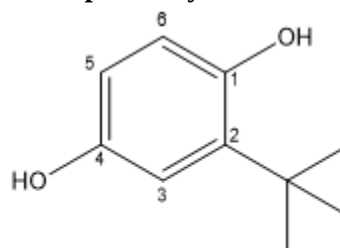
Early analysis of the chemical composition of leaves from *Clerodendrum infortunatum* Linn. showed the presence of 4, 6, enzymes, & clerodin, a bitter diterpene. A fixed oil consisting of glycerides of lignoceric, stearic, oleic, as well as linoleic acid is present in the leaves. Root extracts contain lupeol as well as β -sitosterol^{23,24}. Findings from the roots revealed the identities of clerodolone (lup-20-en 3β -diol-12-one), clerodone (lup-20-hydroxylupan-12-one), as well as clerosterol (5,25-sigmastadien 3β -ol)²⁵.



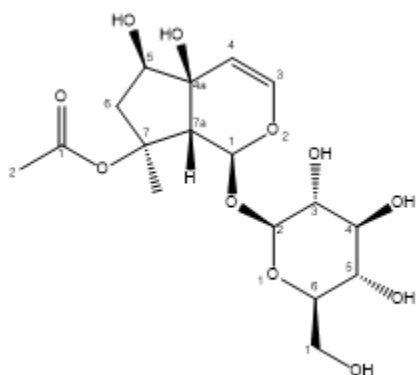
n-Octadecanoic acid



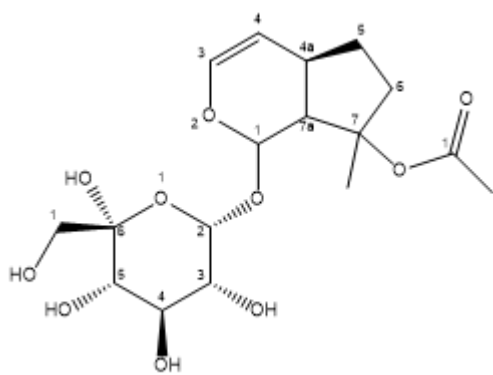
24-alpha-Ethylcholesterol



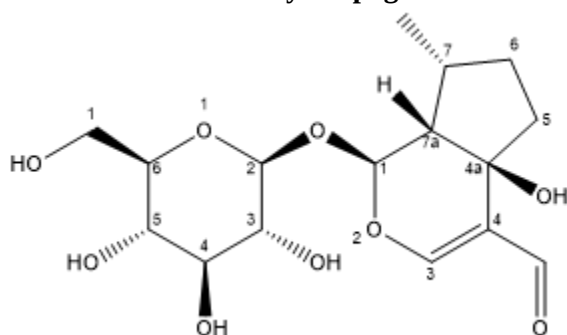
Tert-butylhydroquinone



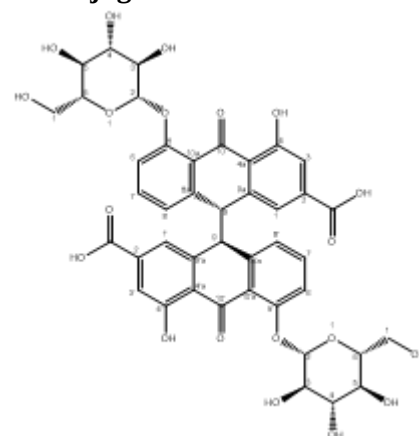
8-O-acetylharpagide



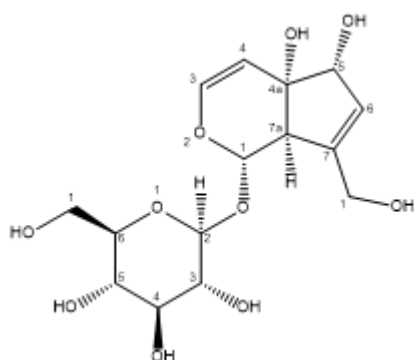
Ajugoside



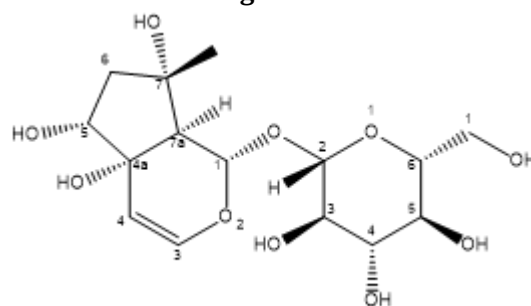
Plantarenloside



Sammangaoside B



Monomelittoside



Harpagide

Table No: - Chemical Constituents of *C. infortunatum*

Plant part	Chemical constituents
Aerial parts	Serratumin A, Serratumin B, Monomelittoside, Sammangaoside C, Inerminosides A Inerminosides C, Inerminoside A hexaacetate, Inerminoside B heptaacetate
Roots	8-Ofoliamenthoyleuphroside, Aucubin Odifoliamenthoyleuphroside, Euphroside, Plantarenalloside,
Leaves	Ajugoside, 5-O-b-glucopyranosylharpagide, Sammangaoside A, Sammangaoside B
Stems	Mandarone A, Mandarone B, Crolerodendrum A, Bungone A, Bungone B
Whole plants	Aucubin, 8-O-acetylharpagide, Harpagide, Ajugoside

Table No 4: - Parts where Chemical Constituents found

Total phenolic assay:

The total phenolic content in the petroleum ether, chloroform, as well as ethanol extracts, was quantified according to the specified protocol²⁶. Initially, 1mL of each *C. infortunatum* solvent extract, 1mL of 95percent ethanol, 5milliliters of distilled water, as well as 0.5milliliters of 50 percent Folin-Ciocalteu reagent were put in a test tube. After allowing the mixture to react for five minutes, one milliliter of five percent sodium carbonate was added²⁷. The UV-visible spectrophotometer was employed to measure the

absorbance at 725 nm after it had been well mixed and placed in the dark for one hour²⁸. Gallic acid equivalents were employed to express the total phenolic contents of *C. infortunatum* in milligrams per gram of extract²⁹.

Extraction method:

Air-dried as well as powdered leaves had been employed in a Soxhlet system to extract petroleum ether, chloroform, as well as ethanol. To create dried extracts, the extracts were concentrated in a rotary evaporator with reduced pressure³⁰.

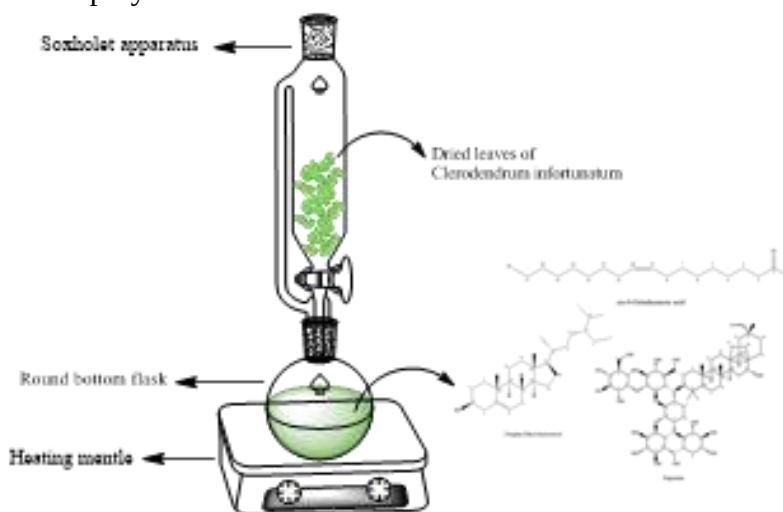


Figure 4: - Extraction method of *C. infortunatum*

Anthelmintic activity:

The adult Indian earthworm *Pheretima posthuma*, which resembles human intestinal roundworm parasites in both morphology as well as physiology, was employed to assess the anthelmintic action³¹. This method was applied to anthelmintic screening. Six equal-sized Indian earthworm groups were released into 50 milliliters of the suitable mixture³². The following treatments were given to each group: extracts (20, 40, or 60mg/ml), piperazine citrate (15mg/ml), albendazole (10mg/ml), or else vehicle (1 percent gum acacia in normal saline). Observations had been done on the time it took for individual worms to paralyze or die. Paralysis occurs when worms fail to recover in normal saline. When the worms

lost their pigmentation as well as motility, they died^{33,34}.

Hepatoprotective activity:

Rats' hepatotoxicity caused by carbon tetrachloride was evaluated against a methanolic extract of *Clerodendrum infortunatum* Linn. The research assessed serum biochemical markers including ALT, ALP, AST, total protein, as well as bilirubin³⁵. The amount of MDA (malondialdehyde), decreased GSH (glutathione) content, along with CAT (catalase activity) had been all measured. The extract significantly corrected the significantly raised serum enzymatic levels of AST (SGOT), total bilirubin, ALT (SGPT), as well as ALP towards normality³⁶. The hepatoprotective activity of the methanolic extract had been validated by histological investigations,

as the normal rats had no abnormalities in their liver architecture. This study's outcome showed that the *Clerodendrum infortunatum*'s methanol extract exhibits mild hepatoprotective activity³⁷. The hepatoprotective effect of *Clerodendrum infortunatum*'s methanolic extract may be attributed to the presence of saponins, terpenoids, as well as flavonoids in the extract^{38,39}.

Analgesic activity:

Clerodendrum infortunatum leaf saponin inhibited writhing in adult Swiss albino mice when exposed to 1.2 percent v/v acetic acid. Saponin was administered intravenously at dosages of 30, 50, 75, & 100mg/kg. Common medications utilized were morphine sulfate, paracetamol, along with aspirin⁴⁰. In mice subjected to the hot plate method, saponin induced analgesia as well as enhanced analgesic effects of both aspirin as well as pentazocine⁴¹.

Anticonvulsant activity:

The saponin that was extracted from the leaves of *Clerodendrum infortunatum* also exhibited anticonvulsant properties. The anticonvulsant efficacy was evaluated by seizures induced by leptazol⁴². Saponin had been given ip in distinct doses (20-100)mg/kg body weight. It had been found that saponin protected against leptazol-induced convulsions in a dose-dependent manner as well as shortened duration of seizures. The findings indicated a significant anticonvulsant effect of the saponin⁴³.

Antioxidant activity: -

The antioxidant impacts of an ethanolic extract of *Clerodendrum infortunatum* leaves were tested at different concentrations (0.020-0.10)mg/ml in the DPPH radical scavenging assay as well as (20-100)mcg/ml in the FRAP (Ferric Reducing Antioxidant Power) assay relative to vitamin C at the similar concentration⁴⁴. The assay for scavenging radicals with hydrogen peroxide was also performed on the ethanolic extracts. The

study's findings demonstrated the plant extract's strong antioxidant potential⁴⁵.

Antimicrobial Activity:

Utilizing the disc diffusion method, antimicrobial activity was calculated as the diameter of the inhibitory zone⁴⁶. Sterilized Petri dishes were filled with nutrient agar and Sabouraud dextrose agar, respectively, for bacteria as well as fungus⁴⁷. To achieve this, 10µL of the extract was placed on a tiny (6mm) filter paper disc^{48,49}. This disk was set up on an agar growth medium with a confluent microbial lawn on it. Additionally, the organism's concentration was 10µL/Petri dish⁵⁰. The lack of fungal and bacterial development surrounding the disc suggested that the plant extract had antibacterial qualities directed against that specific organism^{51,52}.

Anti-inflammatory activity:

Clerodendrum infortunatum has been demonstrated to have an anti-inflammatory effect against carrageen-induced paw edema; the outcomes were similar to those of the reference drug phenylbutazone⁵³. The methanol extract of *Clerodendrum infortunatum* inhibited carrageenan-induced paw edema by 49.64 & 65.63 percent at doses of 250 as well as 500mg/kg body wt. Correspondingly, after 3 hours of treatment, the reference drug produced 76.29% inhibition at 100mg/kg body weight^{54,55}. At doses of 250 and 500mg/kg body weight, correspondingly, the methanol extract reduced histamine-induced paw edema by 45.85 as well as 58.02 percent, whereas the reference drug gave 71.22 percent inhibition. The methanol extract inhibited dextran-induced paw edema by 39.65 and 57.90% at doses of 250 & 500mg/kg body weight, correspondingly⁵⁶. Methanol extract of *Clerodendrum infortunatum* inhibited paw volume statistically significantly at dosages of 250 as well as 500mg/kg body weight, correspondingly, This was lower than what was discovered while

utilizing phenylbutazone, a standard medication, at a dose of 100mg/kg body weight^{57,58}.

Anticancer Activity:

A primary examination of the methanol extract of *C. infortunatum* revealed the existence of flavonoids, saponins, as well as terpenoids. With an LD₅₀ of 1015.63mg/kg, acute toxicity was recorded⁵⁹. The crude methanol extract was subjected to HPLC analysis, which identified more than 20 components. It was discovered that the extract included three major compounds. Two bioactive terpenoids, identified by spectroscopic investigation as clerodinin A as well as oleanolic acid, were extracted by chromatographic separation^{60,61}. It is demonstrated how the methanolic extract affects the survival period of mice with EAC (Ehrlich's ascites carcinoma). The MST elevated to 23.44±2.69 d & 27.57±2.57 d for the groups treated with methanolic extract at 100 & 200mg/kg, correspondingly, while the EAC control group's MST had been observed to be 19.42±0.91 d⁶². The tumor volume was higher in the EAC control group compared to the normal group. Compared to EAC control mice, the treatment greatly declined tumor volume as well as viable cell count; however, the treated groups' non-viable cell count had been discovered to be much higher^{63,64}.

Anti-diarrheal activity:

Defecation in castor oil-induced diarrhea tests was suppressed by the methanolic extract and chloroform fraction of *C. indicum* at a dose of 400mg/kg by 21.74% & 26.96%, correspondingly. The severity of diarrhea was similar to these results and the usual medication loperamide (37.39% inhibition at 50mg/kg)⁶⁵. The rats' castor oil-induced diarrhea along with PGE2-induced enteropooling were dramatically suppressed by the methanolic extract (600 and 800mg/kg) derived from *C. infortunatum* leaves. Rats' gastrointestinal motility was considerably decreased by the extract during a test utilizing charcoal meal⁶⁶. The anti-

diarrheal properties of the plant support its traditional application for diarrhea among the populations of Australia along with India⁶⁷.

CONCLUSION:

The current research demonstrates that the extract of *C. infortunatum* exhibits different pharmacological actions, including anti-diarrheal, anti-inflammatory, anticancer, antibacterial, antioxidant, anticonvulsant, analgesic, and hepatoprotective effects. The existence of these diverse chemicals in the plant extracts has demonstrated significant pharmacological as well as antioxidant properties. The ethanolic extract of *C. infortunatum* exhibits significant anti-diarrheal action. Furthermore, significant actions, including anti-hypertensive, anti-obesity, and hepatoprotective effects, suggest that *C. infortunatum* may serve as a promising source of biologically active chemicals for these conditions.

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