WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 11, 326-348. Review Article ISSN 2277–7105

ETHNOBOTANY, PHYTOCHEMISTRY AND PHARMACOLOGICAL PROFILE OF COCCINIA GRANDIS: A REVIEW

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Article Received on
10 March 2024,

Revised on 30 March 2025,
Accepted on 19 April 2025

DOI: 10.20959/wjpr202511-36858

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ABSTRACT

A versatile topical plant with significant culinary and medicinal applications is the Ivy gourd, or *Coccinia grandis.* This review article looks at its potential applications in the food and pharmaceutical industries and seeks to compile the literature currently accessible on its pharmacological characteristics, nutritional composition, therapeutic benefits, and botanical features. The necessity for a thorough understanding of *C. grandis* in order to fully utilize its medicinal potential and the growing interest in plant-based therapies worldwide are the driving forces behind the research. In terms of methodology, this review uses a literature synthesis approach, examining existing research on *C. grandis* to glean pertinent details on its characteristics and uses. According to the research, *C. grandis* is a good source of vital nutrients, has significant Anti-inflammatory, Anti-diabetic, and Antioxidant qualities, and has potential for use in pharmaceutical and nutraceutical development in the future. These findings imply that *C. grandis* may play a key role in improving nutritional health and treating chronic illnesses. To support its effectiveness and therapeutic uses, more clinical research and safety assessments are necessary.

KEYWORDS: *Coccinia grandis*, Medicinal plant, Hypoglycaemic activity, Ayurvedic plant, Botanical properties.

1. INTRODUCTION

Cucurbitaceae, also known as the gourd, melon, pumpkin, and squash family, includes the ivy gourd (*C. grandis*). It was widely distributed over Southeast Asia and Africa, and southern Vietnam had a large supply.[1] The use of plant-derived items as medicines has been documented throughout human history. *C. grandis* leaves have traditionally been used as a home medicine for jaundice, skin infections, tastebud disturbances, burns, and rheumatism. In some states, including Tripura, the leaves were used as vegetables. Traditionally, numerous plant parts such as roots, leaves, and flowers have been used as folkloric treatments for a variety of ailments, including diabetes mellitus, ulcers, stomach pain, fever, coughing, and breathing issues.[2] Individual meals can also be served. The plant extract displayed numerous bio-activities, specifically water and the stem's ethyl acetate extract demonstrated antibacterial, anti-inflammatory, and reduced plasma glucose levels.[3]

Previously indicated, phytochemical investigations resulted in the separation of polyphenols, steroids, and flavonoids. Until recently, there was minimal chemical study on *C. grandis* in Vietnam. There was an announcement that six chemicals from the stem of *C. grandis* have been extracted and isolated in the Tien Giang area.[4] The crude extract represents a broad range of antibacterial action. Hexane, ethanol, butanol, methanol, and aqueous acetone were evaluated against five bacterial species, with *C. grandis* leaf extract as a solvent. Ethanol extract was the most effective against *S. aureus, E. coli, B. cereus, and K. pneumoniae*. The ethanol extract had the lowest inhibitory concentration of the leaf extract against each test organism, with a sub-inhibitory concentration against *B. cereus, K. pneumoniae, and E. coli.* The goal of this crucial study was to analyze the scientific basis for their function and the traditional plant's in vitro antibacterial activity.[5] Most of the new research on traditional treatments resulted in a range of pharmaceuticals that were adjusted to be non-hazardous and much safer for individual usage. There existed a wide range of medicinal plants with a long history of healing qualities against various diseases. A comparison of two plant specimens is discussed in Fig.1.

Figure 1. (a) *C. grandis* plant bearing flowers and (b) *C. grandis* plant with leaves.

However, examining plants for activity was critical to determining their worth. The plant's biological activity was fully assessed based on chemotaxonomy study or cultural plant knowledge for a specific condition. Authenticating a specific active chemical against a specific illness was a difficult and time-consuming procedure.[6] *C. grandis* was a natural herb found in most parts of the world. The leaves had expectorant and analgesic properties. Leaves included flavonoids, triterpenoids, tannins, and alkaloids. As a consequence, this plant was used as a reducing agent in the production of nanoparticles and in phyto-catalytic degradation under UV light exposure. Plant compounds are classified into two types: primary metabolites, which are helpful for fundamental metabolic functions such as growth, development, and reproduction. Directly related with essential biochemical processes needed for life, namely sugars, proteins, amino acids, etc., and the second one known as secondary metabolites, which were not directly engaged in growth since they were obtained from plant components; They possess distinctive features, including alkaloids, terpenoids, flavonoids, and phenolic chemicals.[7] More than 10,000 plant secondary metabolites with antimicrobial activity have been identified. These chemicals belonged to a large class of compounds known as flavonoids, alkaloids, tannins, and others. Infectious diseases make for a significant portion of health problems in underdeveloped nations. In India, less than 3,000 plant species are utilized to cure various ailments, with over 90% of medicinal plant species serving as raw material for herbal medicines gathered from natural environments.[8] The extensive knowledge of herbal plants and medical treatment in countries such as India has sparked great interest among pharmaceutical corporations in using this information as a reference for

research and development programs aimed at the discovery of innovative medications. Nonetheless, many other plants were utilized in India in the manufacture of crude extracts with no scientific evidence of benefit. At this point, it was intriguing to determine the research foundation for the medical use of these herbs.[6]

Coccinia grandis was a long-lived, fast-growing vine with a length of several meters. It may form a thick coating over regions where plants and tiny trees are easily covered. Its leaves, which are heart and pentagon shaped, were grouped alternately with the stalks. The underside of the leaf was hairy, whereas the upper side was hairless. The blade near the leaf stem had two to eight glands. It was sexually separated for *C. grandis*. This plant has large, white blooms that resemble stars. This plant flower's ovary was less substantial. This plant produced red fruit that was 25-60 mm long, 15-35 mm wide, and glabrous, hairless, or stalk-like. It all boils down to *C. grandis'* organoleptic properties, which were easily evaluated using necked eyes.[9]

1.1. TRADITIONAL USES

Many countries, mostly in Asia and Africa, have long employed *C. grandis*. The use was described as.

1.1.1. *C. grandis* leaves have historically been utilized for a variety of therapeutic uses. They are an expectorant and antispasmodic for chronic bronchitis and were traditionally used in tonic-like beverages.[10] In Thailand, they assist control fever-induced hypertension, but in Pakistan, root and leaf juices are used to treat hyperglycemic conditions. In southern India, the leaves are used to treat diabetes, sperm production, physical strength, and skin diseases.[11,12] The leaf paste, known as Kolakochu in Naokhali, is used to cure diabetes and cancer.[13]

1.1.2. In Nepal, *C. grandis* root juice is a common treatment for jaundice and uterine discharge.[14] In Africa, it is used to cure diabetes, and its leaves and fruits can help decrease blood pressure.[15] Dried root bark powder functions as a cathartic, while root ash is used to treat skin rashes. In Bangladesh, root juice extracted from crushed leaves and stems is used to cure jaundice.[16]

1.1.3. *C. grandis* fruit extract is used to treat unusual symptoms and spleen disorders.[15] Diabetics in metropolitan Odisha, India, take *C. grandis* fruit juice with piper nigrum powder

on a regular basis. Its green fruit relieves sore tongues, the dried fruits heal eczema, and the juice is used to treat leprosy and respiratory problems.[17]

1.1.4. The whole *C. grandis* plant is used to treat cystitis, fever, snake bites, and urinary tract infections. It is also effective against skin infections such as ringworm and chickenpox. In Northeast Thailand, its shoots, blossoms, and fruits are used as both medicine and fodder, and its plant oil is injected to treat long-term diseases.[18]

1.2. BIOLOGICAL CLASSIFICATION

A biological profile gives a detailed description of an organism, including its taxonomy, morphology, natural habitat, geographical location, chemical composition, and biological functions. It describes considerable ecological relevance or medicinal advantages.

Table 1: Plant Biological Profile Of *C. grandis.*[19]

1.	**Kingdom**	**Plante**
2.	**Class**	Magnoliopsida
3.	**Order**	Cucurbitales
4.	**Family**	Cucurbitaceae
5.	**Genus**	*Coccina*
6.	**Species**	Grandis

1.3. BOTANICAL DESCRIPTION OF C. GRANDIS

A botanical description was defined as precise plant physical and structural characteristics. It involves an evaluation of numerous qualities.

Table 2- Plant Botanical Profile of *C. grandis.*[20]

PLANT PARTS	BOTNICAL DESCRIPTION	BOTNICAL ILLUSTRATION
Growth form	Type- Perennial vine Habit-climbing and sprawing Height-grow upto 10 meters in length Growth pattern-vigorous and fast growing	
Leaves	Arrangement- along with stem Shape-heart shaped or lobed Size- typically 5-10 cm Texture- rough and slightly coarse Color- deep green	

Fruit	Type-berry Shape-elongated, cucumber like Size- approximately 2-3 cm long Color- starts green and turn a red or orange Surface- slightly warty	
Flowers	Type-Unisexual Shape-Tubular and bell shaped Color-white, sometimes yellow Size-along2-3cm long Arrangement-arising from leaf axils	
Seeds	Shape- small and flat Size- 1-2 cm in length Color- typically brown Surface-smooth	
Stem	Type-herbaceous climber Shape-angular and ridge Color-typically green Surface-smooth, may be pubescent Texture-soft and fibrous	
Roots	Types-fibrous root system Characteristics-typically thin and spread out Growth pattern-sprawling or climbing habit	

1.4. PHYTOCHEMISTRY OF C. GRANDIS:

Phytochemistry was the study of the chemical substances, or phytochemicals, generated by plants. C. grandis phytochemistry showed a diverse set of bioactive chemicals, which contribute to its therapeutic usefulness.

Table 2- Plant Botanical Profile of C. Grandis.[20]

GROUPS	BIOACTIVE PHYTOCHEMICAL	PART USED	ISOLATED FROM	THERAPEUTIC PROFILE
Alkaloids	β-Sitosterol	Leaf	Methanol extract	Anti-inflammatory, antioxidant activity.[22]
	Cathinone	Fruit	Ethyl acetate extract	Antidepressant, anti-cataleptic activity.[23]
	Tri tetracontane	Leaf	Petroleum ether extract	Antioxidant and antimicrobial activity.[24]

Alkanes	Hexadecane	Leaf	Ethyl acetate extract	Antimicrobial and antioxidant activity.[25]
	Pentatriacontane	Callus	Petroleum either extract	Antibacterial and insecticidal activity.[26]
Esters	Sulfurous acid, 2-propyl tridecyl ester	Callus	Ethyl acetate extract	Anti-asthmatic, anti-HIV, and anti-pyretic activity.[27]
	Methyl caffeate	Leaf	Methanol extract	Anti-cancer and anti-mycobacterial activity.[28]
Fatty acids	Pentadecanoic acid	Callus	Petroleum ether extract	Anti-cancer, anti-inflammatory activity.[30]
	n-pentadecanoic acid	Fruit	Aqueous extract	Anti-cancer activity.[31]
Alkyl ethers Phenols	Octadecane,1-[ethenyloxy] Kaempferol caffeic acid Ferulic acid	Leaf Root Leaf	Petroleum ether extract Methanol extract Methanol extract	Anti-diarrheal, antioxidant activity.[32] Neuroprotective and anti-oxidant activity.[33] Hepato-protective, anti-coagulant activity.[34]
Steroids	β-Sitosterol	Fruit	Methanol extract	Anti-inflammatory, antioxidant activity.[22]
	Campesterol	Fruit	Methanol Extract	Anti-carcinogenic, anti-angiogenic aactivity. [35]
Terpenoids	Abscisic acid	Fruit	Methanol extract [80%]	Antioxidant activity.[36]
	Betulinic acid	Root	Methanol Extract	Anti-diabetic, anti-HIV activity.[37]
	β-Sitosterol acetate	Fruit	Methanol extract	Anti-diabetic anti-helminthic, Hypocholesterolemia Activity.[38]
Benzoic Acid	Salicylic acid	Fruit	Methanol extract [80%]	Antioxidant and anti-inflammatory

derivative				activity.[39]
	Vanillic acid	Stem	Ethyl acetate Extract	Antioxidant, Wound healing Activity.[40]
Amine	2-Aminophenyl, n-[tertbutyl di methyl silyl]	Fruit	Alcoholic extract	Anti-diarrheal and anti-pyretic activity.[41]
Alcohols	2,4-Pentadien-1-ol,3-pentyl-[2z]	Fruit	Alcoholic extract	Anti-candidal Activity.[21]
Glycosides	Coniferin	Fruit	Ethyl acetate extract	Anti-inflammatory, antifungal activity.[42]
	Coccinioside-k	Root	Ethyl acetate extract	Antioxidant, anti-coccidia activity.[43]
Aldehydes	3-Heptadecenal	Callus	Petroleum ether extract	Anti-inflammatory, anti-meningitis activity.[44]
	9-Hexadecanal	Leaf	Petroleum ether extract	Antioxidant, antimicrobial activity.[45]
	Cinnamaldehyde	Fruit	Ethyl acetate extract	Anti-fungal, anti-bacterial activity.[46]
Ketone	3-Buten-2-one,4-[2,2,6,7-tetramethyl-7-azabicyoloheptane-1-yl]	Fruit	Alcoholic extract	Anti-diabetic, antioxidant activity.[41]

2. PHARMACOLOGICAL EFFECT OF *C. GRANDIS*

Pharmacological effects of plants refer to the physiological and biochemical changes that occur in the body when phytochemicals are consumed. *C. grandis* contains bioactive compounds that produce specific effects on human health.

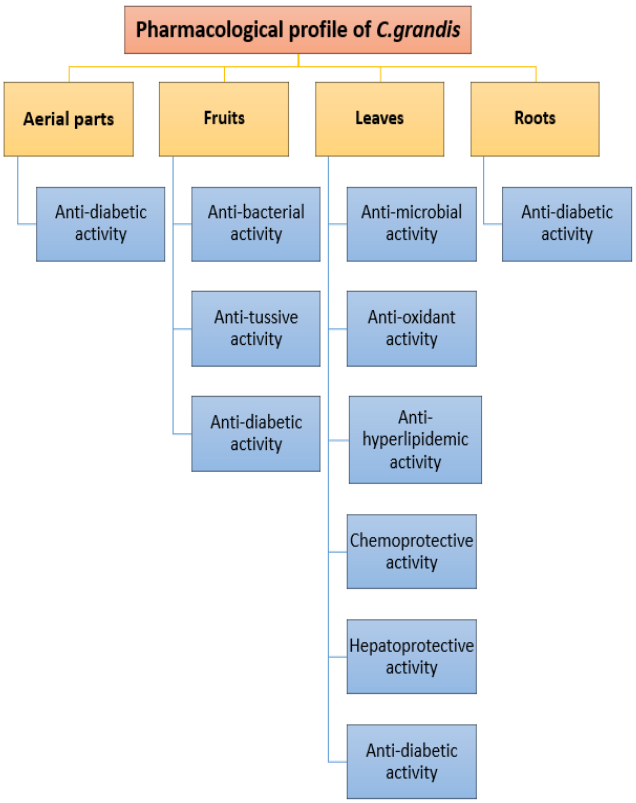

Fig 2: Pharmacological effect of *C. grandis.*

2.1. ANTI-BACTERIAL ACTIVITY

The water-soluble extract of *C. grandis* leaves has high antibacterial properties, which inhibit the ethanolic extract. It has shown efficient against *Shigella aflexneri, Bacillus subtilis, and Salmonella choleraesuis*.[47,48] Methanol extract has writhing-reducing effects.[49] While hexane extract is effective against *Pseudomonas aeruginosa*.[50] A research demonstrated that *C. grandis* ethanolic leaf extract had the strongest antibacterial activity against *E. coli and S. aureus*, with an inhibition zone of 22.7±0.5 mm at 75 mg/100µl. Various solvents, including alcohol, methanol, and acetone, have been employed to investigate the antibacterial potential.[51]

2.2. ANTI-TUSSIVE EFFECT

One research discovered that a methanolic extract of *C. grandis* fruit had anti-tussive qualities and can minimize coughing. It detected the presence of carbohydrates, reducing sugar, triterpenoids, alkaloids, tannins, and glycosides. *C. grandis* plant extract exhibited potent anti-tussive properties. Doses of 100 mg/kg, 200 mg/kg, and 400 mg/kg were significantly beneficial ($P<0.01$). According to the study, a dosage of 400 mg/kg of plant extract for 90 minutes inhibited coughing more effectively (56.7%). Finally, it was suggested

that the herb was an effective antitussive.[52] The plant's pharmacological activity alone was insufficient to establish its efficacy and mechanism. This part should be related to the whole study.

2.3. ANTI-DIABETIC ACTIVITY

C. grandis has powerful antidiabetic characteristics, equivalent to glibencamide, since it lowers blood sugar and increases insulin levels.[53,54] Its fruits, leaves, and roots are rich in polyphenols, flavonoids, alkaloids, and saponins, which contribute to its effectiveness.[6,53] The fruit extract contains β-sitosterol, which improves insulin sensitivity by boosting PPAR-ϒ and GLUT-4 protein expression.[55] The plant extract inhibits α-glucosidase (IC_{50} = 1.24 ± 0.07 mg/ml), and quercetin (5 mg/kg) increases glucose, insulin, and HDL levels in diabetic rats.[56, 57] Furthermore, *C. grandis* silver nanoparticles show promise for targeted medication delivery in diabetes therapy.

2.4.

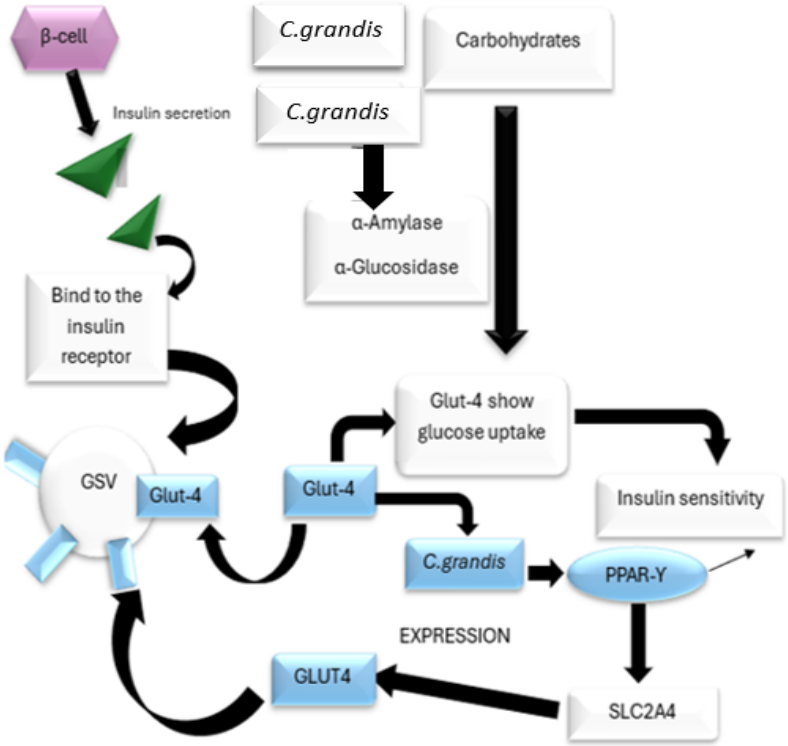

Figure 3: Anti-diabetic Mechanism of *C. grandis*.

2.4. ANTIOXIDANT ACTIVITY

C. grandis declining power ability and the antioxidant activity was caused by its ability to scavenge hydrogen peroxide.[59] Cell damage caused by free radicals was referred to as oxidative stress.[60] Ethanol and methanol extracts have antioxidant action.[61] The DPPH method anti-oxidant activity test revealed that samples containing a 1:1 combination of Averrhoa bilimbi fruits and C. grandis leaves had the maximum radical scavenging activity, with the lowest IC_{50} value (IC_{50} = 0.75 ±0.45 mg/mL).[62] The solvents petroleum, chloroform, and ethyl acetate indicate the antioxidant activity of *C. grandis* stem extract. Compared to petroleum, ethyl acetate has higher anti-oxidant action.[59] Fruit from the *C. grandis* plant included flavonoids such as quercetin, rutin, and kaempferol, all of which were shown to be antioxidant.[63]

2.5. ANTI-INFLAMMATORY ACTIVITY

The aqueous extract of *C. grandis* leaves and stem has anti-inflammatory properties and inhibits formaldehyde-induced paw edema in rats. Formaldehyde caused cell damage and stimulated the production of histamine, serotonin, and prostaglandins.[59] The water-soluble extract of leaves has a higher percentage prevention of paw edema than the water extract of the stem, which is utilized as indomethacin. Formaldehyde produced inflammation in the generation of endogenous mediators such as histamine, prostaglandin, bradykinin, and serotonin, which was treated by *C. grandis* extract.[64] Thus, the anti-inflammatory specimen demonstrates that the plant's methanolic fruit extract has anti-arthritic and antiproliferative properties.

2.6. ANTI-CANCER ACTIVITY

C. grandis has anticancer effects due to its antioxidant activity, which inhibits ferrocyanide to ferrous conversion and reduces nitrite breakdown.[65,66] The water extract has anti-cancer activities, and a protease inhibitor (PI) found in it effectively suppresses colon cancer cell proliferation and promotes apoptosis in He-La cells (IC_{50} value 25 µm, $P < 0.01$).[68] Telomerase activity has a significant impact on tumor survival.[67] Furthermore, flavonoids and other phytoconstituents in *C. grandis* extract help to protect against benzidine-induced hepatocellular carcinoma, which is a leading cause of cancer-related fatalities globally.[68]

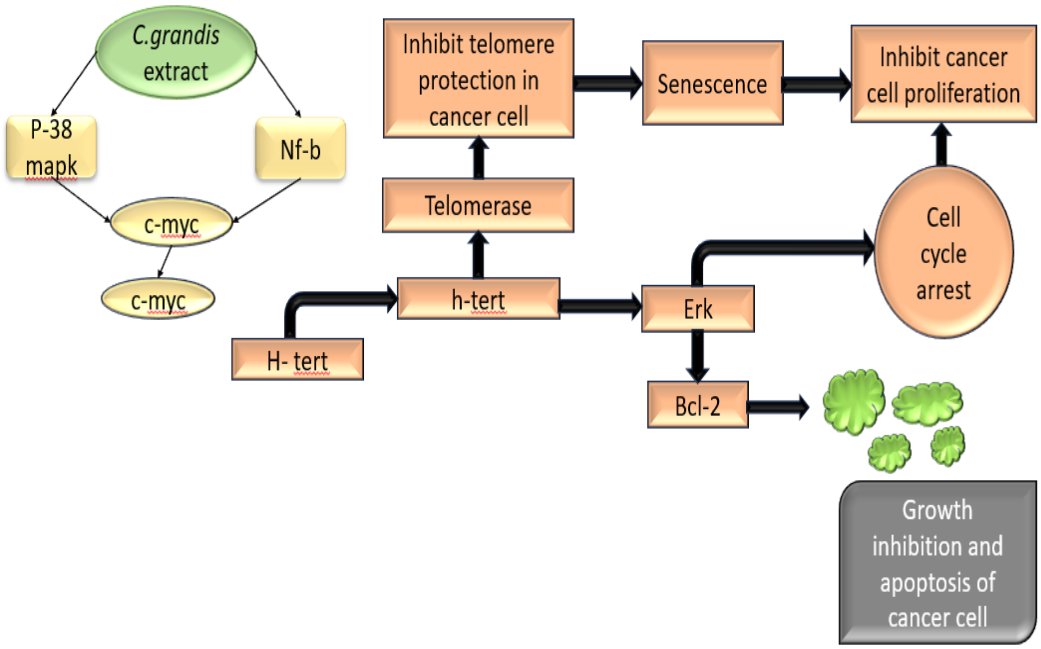

Fig. 4. Anti-cancer activity Of C. grandis.

2.7. ANTHELMINTIC ACTIVITY

The methanolic extract of *C. grandis* possesses antihelmintic effects. Anthelmintic action is responsible for flaccid paralysis in nematodes, which is the primary response.[69] Tambe's method showed that *C. grandis* leaves could paralyze and kill worms like P*heretima posthuma, human tapeworms (Taenia Na), and roundworms (Ascaris lumbricoides)*. The standard study on the anthelmintic medication albendazole. Seventy was connected with wisdom. The activity was determined using the time it took for worms to paralyze and die.

2.8. ANTIPYRETIC ACTIVITY

The purpose of these drugs was to reduce body temperature. The methanolic extract of *C. grandis* leaves, like the standard medication, lowers fever.[71] The water-soluble extract (CIAE) of fresh *C. grandis* leaves was discovered to have antipyretic activities in rats using the yeast-induced hyperpyrexia approach.[72] When CIAE was given to a healthy rat, its body temperature did not drop. Prostaglandin was studied as a potential indicator of body temperature.

2.9. HEPATOPROTECTIVE EFFECTS

CCL4 lowers hepatotoxic effects, which cause oxidative damage. *C. grandis* fruit extract included flavonoids and other phenolic components.[73,74] An additional part shows that in a rat liver segment, a diethyl ether extract of *C. grandis* leaves eliminated inflammatory

infiltrates around the portal triad and reduced inflammatory infiltrates in the centrosomal region. It also revealed hepatic cell breakdown and proper cellular representation.[75]

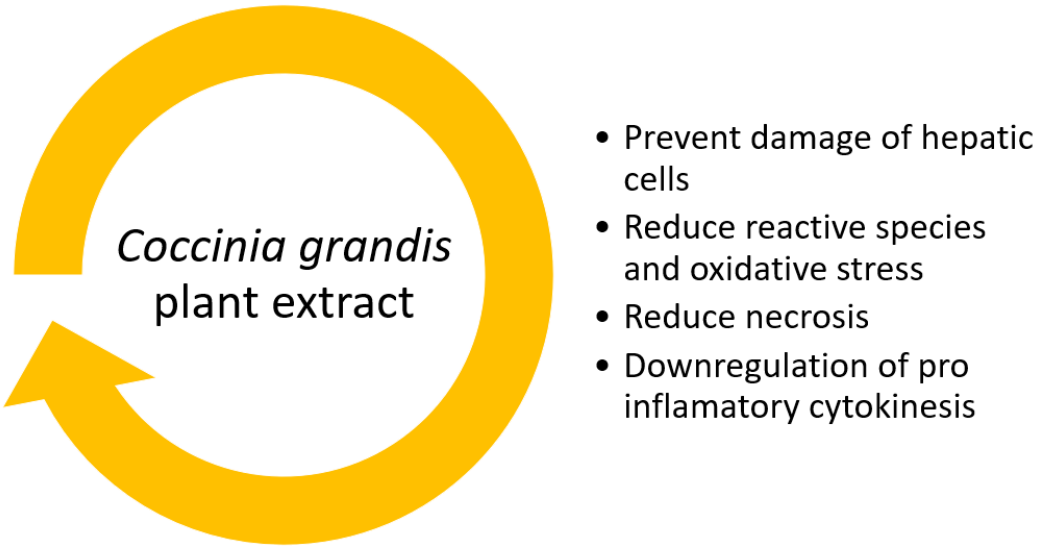

Figure 5: Hepatoprotective effect of C. grandis.

2.10. ANALGESIC ACTIVITY

When mice were exposed to an irritating chemical that caused peripheral pain, the frequency of writhing reduced.[76] The amount of acetic acid produced inside is successfully reduced by 68.72% and 70.92%, respectively, by methanolic leaf extract and its component at 100 mg/kg body weight.[77] According to a survey, the water-soluble leaf extract had analgesic effectiveness at 300 mg/kg that was equivalent to morphine, showing the involvement of a central mechanism.[72] According to the findings, *C. grandis* inhibited the cyclo-oxygenase (COX) pathway, preventing prostaglandin formation and providing analgesic effects.[78]

2.11. ANTI-ULCEROGENIC ACTIVITY

The ethanolic extract of *C. grandis* significantly reduced the stomach ulcers caused by indomethacin. The leaf extract comprised glycosides, alkaloids, tannins, and other secondary metabolites derived from plant components.[79] Flavonoids improve the mucosal barrier and reduce stomach acid production by increasing the synthesis of prostaglandins. Rats with pylorus ligation and ethanol-induced ulcer models were utilized to assess the leaf extract's anti-ulcer activity at 250 mg/kg and 500 mg/kg, respectively. The study found a substantial ($P<0.05$) decrease in stomach ulcers.[80]

2.12. IMMUNOMODULATORY EFFECTS

The ethanolic extract of *C. grandis* leaves (EEIL) has an immunomodulatory impact, boosting both nonspecific and specific immune responses.[81] In BALB/c mice, EEIL at 200 mg/kg and 50 mg/kg enhanced antibody production, footpad thickness ($P<0.05$) in the DTH test, and phagocytic index in the carbon clearance test. The impact was highest at 200 mg/kg. Furthermore, in Salmonella typhimurium-infected mice, EEIL exhibited immunostimulatory activity by decreasing symptoms, clinical indicators, and mortality.[5]

3. CONCLUSION

C. grandis, a tropical plant, boasts a rich array of bioactive compounds. These compounds have demonstrated impressive medicinal properties, including antioxidant, anti-inflammatory, and anti-microbial activities. Notably, the plant's anti-fungal properties have shown significant promise. Research has revealed that *C. grandis* extracts effectively inhibit the growth of various fungal strains. This breakthrough has far-reaching implications for the development of novel anti-fungal agents.

4. FUTURE PROSPECTIVE

C. grandis, a tropical plant, boasts a rich array of bioactive compounds. These compounds have demonstrated impressive medicinal properties, including antioxidant, anti-inflammatory, and anti-microbial activities. Notably, the plant's anti-fungal properties have shown significant promise. Research has revealed that *C. grandis* extracts effectively inhibit the growth of various fungal strains. This breakthrough has far-reaching implications for the development of novel anti-fungal agents.

Further research is warranted to fully harness the potential of *C. grandis*. Its unique combination of bioactive compounds makes it an exciting prospect for the discovery of new, natural remedies. As scientists continue to explore the properties of this tropical plant, we may uncover even more innovative applications for *C. grandis*.

Consent for publication

All authors final approval of the version to be published.

Availability of Data and Materials

Not applicable.

Funding

Not applicable.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Credit authorship contribution statement

Arpita Gupta - Writing-original draft, conceptualization, editing, visualization.

Sushankar Par - Writing- review, visualization.

Harsh Tripathi - Writing-Review, Editing.

Tarun Parashar - Investigation, editing.

Dr. Mohit Sanduja - Writing - review, visualization, editing, investigation.

ACKNOWLEDGMENT

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