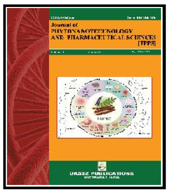
Journal of Phytonanotechnology and Pharmaceutical Sciences 5(3): 30-37, 2025

Online ISSN:2583-0376

http://jpps.ukaazpublications.com

DOI: http://dx.doi.org/10.54085/jpps.2025.5.3.5

Journal of Phytonanotechnology and Pharmaceutical Sciences



Review Article : Open Access

Caralluma fimbriata Wall.: Ethnomedicinal significance, phytochemical profile, pharmacological activities, and therapeutic prospects

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Article Info

Article history
Received 10 July 2025
Revised 10 August 2025
Accepted 11 August 2025
Published Online 30 September 2025

Keywords
Caralluma fimbriata Wall.
Appetite suppressant
Pregnane glycosides
Saponins
Flavonoids

Abstract

Caralluma fimbriata Wall., an edible succulent belonging to the family Apocynaceae, holds a prominent place in traditional Indian medicine and cuisine. Widely distributed across arid regions of peninsular India, it has been consumed for centuries as a famine food, appetite suppressant, and therapeutic agent. Rich in bioactive compounds such as pregnane glycosides, flavonoids, saponins, and triterpenes, *C. fimbriata* exhibits diverse pharmacological activities, including antiobesogenic, antidiabetic, antioxidant, hepatoprotective, nootropic, renoprotective, antimicrobial, and anti-inflammatory effects. Preclinical studies demonstrate its ability to modulate appetite, improve lipid and glucose metabolism, reduce oxidative stress, and protect organ function. Traditional preparations include its use in chutneys, pickles, and as a vegetable, while modern research explores its potential in novel drug delivery systems such as nanoparticles to enhance bioavailability and therapeutic efficacy. Toxicological assessments indicate a high safety margin, with a NOAEL of 1000 mg/kg/day in animals and only mild, transient gastrointestinal effects in humans at recommended doses. Clinical trials present mixed results, with modest benefits in central obesity and caloric intake reduction, but limited impact on anthropometric and metabolic parameters, underscoring the need for long-term, large-scale studies. This review synthesizes ethnobotanical knowledge and current scientific evidence, highlighting *C. fimbriata* as a safe, accessible, and potentially valuable functional food and nutraceutical. Future research should focus on advanced phytochemical characterization, mechanism-based pharmacological studies, and sustainable cultivation to translate its traditional use into validated modern therapeutics.

1. Introduction

Nature exemplifies the remarkable phenomenon of symbiosis, where different species coexist and mutually benefit. Since ancient times, natural products derived from plants, animals, and minerals have formed the foundation of therapeutic systems. Approximately 80% of the global population relies on plant extracts for primary healthcare, and nearly 90% of prescriptions in traditional medical systems are derived from plant-based drugs (Bhuvaneswari *et al.,* 2021; Banu *et al.,* 2024). In many developing and underdeveloped nations, traditional medicine continues to play a pivotal role, with a strong reliance on plant and animal species for the treatment of ailments. The global demand for herbal remedies has grown significantly, driven by increasing acceptance, cultural heritage, and the perception of safety compared with synthetic drugs. India possesses one of the world's richest repositories of medicinal plants, forming the backbone of traditional systems such as Ayurveda, Unani, and Siddha. Nearly 800 plant species have been traditionally used in medicine, with about 500 documented in ancient texts for their therapeutic benefits (Verma and Singh, 2008). This deep ethnomedicinal heritage positions India as a significant contributor to the global natural medicine landscape. Within this context, *Caralluma fimbriata* Wall., a xerophytic succulent belonging to the family Apocynaceae, has garnered increasing scientific attention due to its ethnomedicinal importance and bioactive constituents. Traditionally, consumed as a vegetable and recognized for its appetite-suppressing properties, *C. fimbriata* reflects both cultural significance and pharmacological promise. *C. fimbriata*, an edible succulent, is a medicinal plant belonging to the Apocynaceae family, which comprises approximately 200 genera and 2500 species (Gupta and Shinde, 2016). It is commonly found in dry and semi-arid regions and has been traditionally used by tribal communities in India to suppress hunger and enhance stamina. For centuries, it has been incorporated into the diet in the form of chutneys, pickles, and cooked vegetables. It is known by several vernacular names, including Yungmaphal Iottama (Sanskrit), Kaarallamu (Telugu), Kulleemooliyan and Kallimudayan (Tamil), and Ranshabar or Makadshenguli (Marathi) (Sukumaran *et al*., 2011). The name "*Caralluma*" is derived from the Arabic word qarh *al-luhum*, meaning "wound in the flesh" or "abscess" (Pawade and Shinde, 2021). This dwarf succulent grows widely across western Africa, southwest Asia, and the Indian subcontinent, with greater abundance in peninsular India (Asmi *et al*., 2017). It is well known for suppressing appetite and quenching thirst, with no adverse effects reported during its long history of use in India. The Indian Health Ministry's official list of medicinal plants and The Wealth of India both classify it as a vegetable. Its ability to sustain travelers and famine-struck populations has earned it the

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reputation of a "portable food" or "famine food" (Kature *et al.,* 2024). Belonging to the *Asclepiadaceae* (milkweed) group, *Caralluma* produces a characteristic milky latex that is rich in phytochemicals such as pregnane glycosides, flavone glycosides, bitter principles, saponins, triterpenes, and flavonoids. These compounds have been investigated for their therapeutic potential in infections and metabolic disorders. *C. fimbriata* is most widely recognized for its hypoglycemic, antiobesity, and antirheumatic properties (Qayyum *et al.,* 2018). In addition, several studies have highlighted its hepatoprotective, nootropic, analgesic, antioxidant, anti-inflammatory, antimicrobial, and wound-healing effects (Asmi *et al.,* 2017; Kature *et al.,* 2024). Despite its extensive use as a famine food and medicinal resource, the genus remains underutilized and is not widely cultivated on a commercial scale (Qayyum *et al.,* 2018).In light of its rich ethnomedicinal heritage, diverse phytochemical composition, and broad pharmacological spectrum, this review aims to provide a comprehensive evaluation of *C. fimbriata*. By synthesizing traditional knowledge with emerging scientific evidence, it highlights the plant's multifaceted role in health management and its potential as a safe, accessible, and innovative candidate in the development of anti-obesity and other therapeutic interventions.

1.1 Botanical description

C. fimbriata is a distinctive xerophytic succulent herb adapted to arid environments. It is an erect, branched plant, typically 20-30 cm tall, with fleshy, four-angled stems that taper sharply. Small leaves appear only briefly on young branches and soon fall off, leaving behind tooth-like projections (Asmi *et al.,* 2017). Flowers are borne in clusters at the branch tips, measuring about 2 cm in diameter. They are purple to black, often with yellow or red markings, and fringed with fine hairs. The cylindrical fruits may reach up to 12 cm in length and generally occur singly (Asmi *et al.,* 2017). This edible succulent, widely valued in Indian ethnomedicine, is known for both its resilience in dry regions and its traditional uses as food and medicine (Gayathri Devi and Dhamotharan, 2018).

1.2 Geographical distribution

C. fimbriata is a tender succulent widely found in the wild across Africa, the Canary Islands, Arabia, southern Europe, Ceylon (Sri Lanka), and Afghanistan. It belongs to the genus *Caralluma*, which is recognized as edible and has been a part of the daily diet of many native Indian communities for centuries due to its abundance in the region. Among the genus, *C. fimbriata* is the most common species, growing wild in urban areas, planted as roadside shrubs, and used as boundary markers in gardens. This versatile plant is consumed daily in various forms, cooked as a vegetable, preserved in chutneys and pickles, or eaten raw, highlighting its cultural and nutritional significance in traditional diets (Gayathri Devi and Dhamotharan, 2018).

1.3 Ethnomedicinal and traditional uses

C. fimbriata has been valued for centuries in traditional diets and ethnomedicine, particularly in India and adjoining regions. Its uses encompass nutritional, cultural, and therapeutic applications.

1.3.1 Appetite suppressant and famine food

For generations, tribal and rural communities have consumed chunks of *C. fimbriata* during long hunts or periods of food scarcity to suppress hunger and thirst, earning it the reputation of a "famine food" and "hunger quencher." This effect is attributed to pregnane glycosides, which are believed to act on the hypothalamic appetite-regulating centers, inducing satiety without adverse effects (Gayathri Devi and Dhamotharan, 2018).

1.3.2 Culinary uses

Beyond its role as a hunger suppressant, *C. fimbriata* has been integrated into local diets across India:

- **Vegetable preparation:** Tender stems and aerial parts are cooked with spices and consumed as a staple vegetable, particularly in South India.
- **Raw consumption:** Despite its mildly bitter taste, it is occasionally consumed raw during times of scarcity for its satiating effect.
- **Pickles and chutneys:** In arid regions such as Andhra Pradesh, the plant is preserved in pickles and chutneys, enhancing both shelf life and palatability (Gayathri Devi and Dhamotharan, 2018).

1.3.3 Medicinal uses

In Ayurvedic and folk medicine, *C. fimbriata* has been traditionally employed to treat a wide spectrum of ailments, including inflammation, fever, pain, diabetes, obesity, leprosy, and paralysis. Ethnopharmacological studies further report its antimalarial, antitrypanosomal, antiulcer, antioxidant, antinociceptive, and antiproliferative properties, highlighting its therapeutic versatility (Lakshmi *et al.,* 2014).

2. Phytochemical profile of *C. fimbriata*

C. fimbriata contains a broad spectrum of phytochemical constituents that are central to its nutritional and medicinal value. The plant is particularly rich in pregnane glycosides, which are considered its hallmark bioactive compounds. These glycosides are reported to suppress appetite by acting on the hypothalamus, stimulate lipolysis, inhibit lipogenesis in adipose tissue, and reduce fat accumulation through inhibition of citrate lyase activity, thereby contributing to its well-documented antiobesity effects (Ravindra *et al.,* 2013). In addition to pregnane glycosides, it contains a variety of secondary metabolites, including flavonoids, flavone glycosides, megastigmane glycosides, saponins, phytosterols (such as stigmasterol), triterpenoids, diterpenes, phenolic compounds, tannins, coumarins, hydrocarbons, and alkaloids (Gayathri Devi and Dhamotharan, 2018). These constituents exhibit a wide range of pharmacological activities, such as antidiabetic, antioxidant, antimicrobial, hepatoprotective, immunemodulatory, anti-inflammatory, analgesic (antinociceptive), antipyretic, antihelminthic, antiproliferative, and antirheumatic properties. Among these, flavonoids and saponins have been extensively studied for their immuneenhancing and antioxidant activities, while phytosterols and triterpenoids contribute to antidiabetic and antimicrobial effects. Traditional uses linking *C. fimbriata* to the management of rheumatism, diabetes, leprosy, and parasitic infections are strongly supported by these phytochemical findings. Extensive phytochemical investigations have facilitated the isolation, purification, and structural characterization of these compounds using diverse analytical techniques. Traditional extraction methods such as maceration, Soxhlet extraction, and hydrodistillation are widely used, alongside advanced techniques like microwave-assisted and supercritical fluid extraction. Purification typically employs column chromatography, HPLC, or preparative TLC, while structural elucidation relies on UV-Vis, FTIR, NMR, GC-MS, and LC-MS/MS. The comprehensive strategies employed for phytochemical analysis in *C. fimbriata* are summarized in Table 1.

Table 1: Extraction, purification, identification, and characterization methods of key phytochemical constituents in *C. fimbriata*

Phytoconstituent	Extraction technique	Purification method	Identification /characterization	Quantification methods	References
Pregnane glycosides	Extraction with methanol/ethanol; partitioning with dichloromethane and n-butanol	Column chromatography (*e.g.*, silica gel); TLC monitoring	Acid hydrolysis for sugar analysis; TLC; optical rotation; NMR, MS, FT-IR	Gravimetric methods or HPLC	Kunert *et al.*, 2008; Choucry*et al.,* 2021; Rajendran and Rajendran, 2011
Flavonoids	Methanol/ethanol solvent extraction	HPTLC, other chromatographic methods	Colourimetric/spectrophotometric assays; ABTS, FRAP, TRAP, FTC antioxidant assays	Spectrophotometric/colorimetric	Gayathri Devi and Dhamotharan, 2018; Lakshmi *et al.*, 2014
Saponins	Solvent extraction (petroleum ether, chloroform, ethyl acetate, methanol)	Column chromatography, GC-MS	Qualitative foaming and hemolytic tests; GC-MS	Qualitative usually	Vyshali *et al.*, 2023; Anwar *et al.*, 2022
Other phytochemicals (triterpenoids, diterpenes, phenolics, tannins, coumarins, phytosterols, alkaloids)	Soxhlet extraction with methanol, ethanol, chloroform, ethyl acetate	Chromatographic separation	Combined spectroscopic characterization (NMR, MS, FT-IR); qualitative screening.	Qualitative and quantitative phytochemical screening	Gayathri Devi and Dhamotharan, 2018; Lakshmi *et al.*, 2014

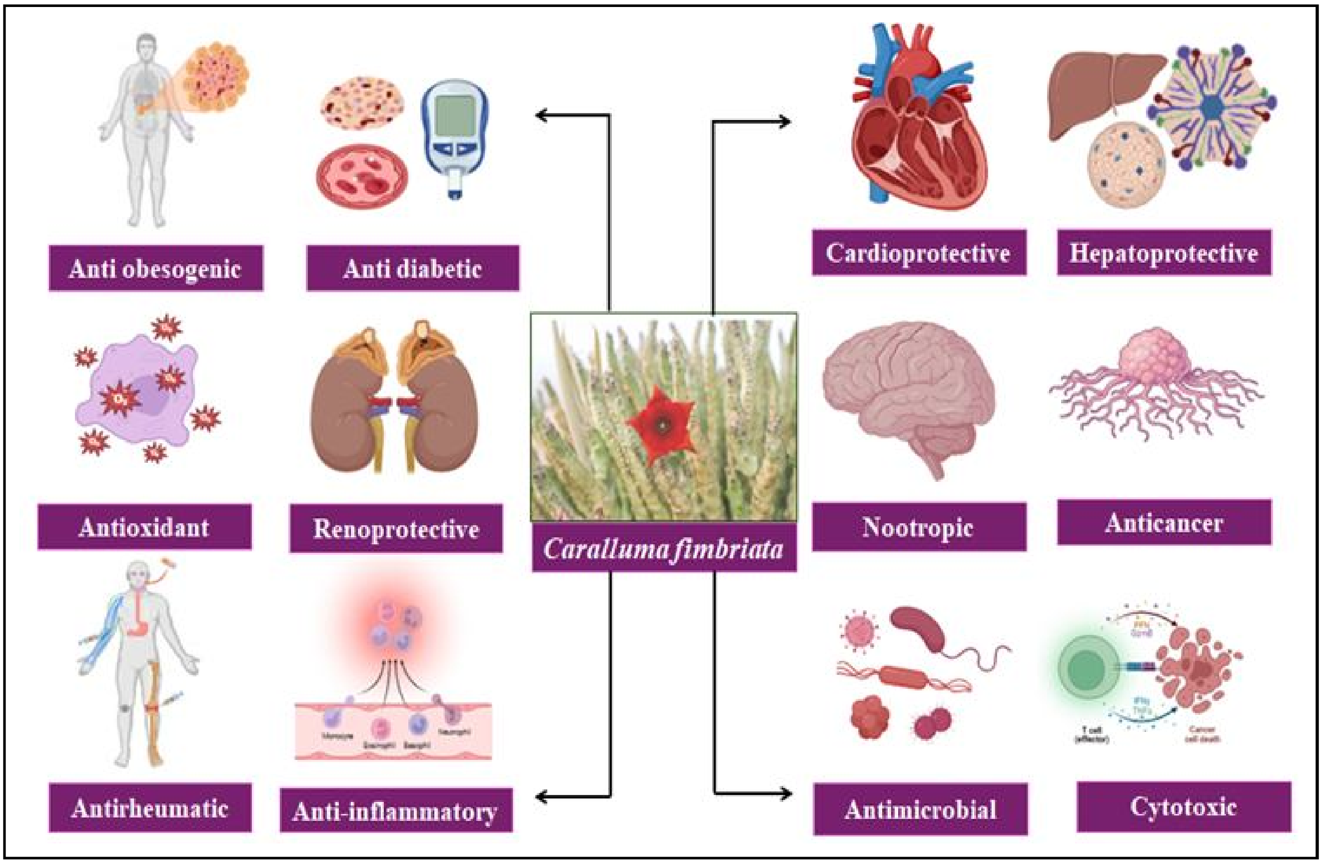

Figure 1: Biological activities of *C. fimbriata*.

3. Pharmacological potential of *C. fimbriata*: experimental evidence and bioactive constituents

C. fimbriata has gained significant attention for its diverse pharmacological properties, attributed to its rich phytochemical profile. Extracts from various parts of the plant demonstrate antiobesogenic, antiatherosclerotic, hepatoprotective, antioxidant, anti-inflammatory, and appetite-suppressant effects (Figure 1). These activities have been validated through *in vitro* and *in vivo* models, including diet-induced obesity, hepatotoxicity, biochemical, and histological assessments. The therapeutic potential of *C. fimbriata* is closely linked to its bioactive constituents, notably pregnane glycosides, saponins, flavonoids, and antioxidants. Evidence indicates its ability to regulate metabolism, improve lipid profiles, protect hepatic function, reduce fat accumulation, and prevent vascular lesions, highlighting its promise in managing metabolic syndrome and related disorders. Table 2 summarizes the major pharmacological activities, experimental models, principal findings, and putative bioactive compounds of *C. fimbriata*.

Table 2: Summary of pharmacological activities of *C. fimbriata*

Pharmacological activities	Experimental models/ assays	Key findings	Bioactive constituents	References
Antiobesogenic and Antiatherosclerotic property	*In vivo* rat model on a cafeteria diet.	Reduces food intake; inhibits adipocyte proliferation; improves plasma lipid pro-files;enhances endothelial function; reduces oxidative stress.	Pregnane glycosides	Kamalakannan *et al.*, 2010
Antidiabetic activity	Alpha-amylase and alpha -glucosidase inhibitory assays (dose: 1 -1000/ µg/ml). Glucose uptake assay in L6 myotubes (1–100/ µg/ml). Cytoto-xicity by MTT assay on L6 myotubes	Inhibition of carbohydrate-digesting enz-ymes (alpha-amylase, alpha-glucosidase) reduces postprandial glucose absorption and enhances glucose uptake in muscle by GLUT-4 translocation.	Pregnane glycosides	Ashwini and Anitha, 2017
Antioxidant activity	Experimental models measuring free-radical scavenging	Mostly attributed due to phenolic com-pounds which act by donating hydrogen atoms to stabilize free radicals and protect cellular components from damage.	Polyphenols, flavonoids,	Adnan *et al.,* 2014; Patil *et al.,* 2014
Nootropic and Anxiolytic activity	*In vivo*-animal behavioral studies	Improves learning, memory, reduces anx-iety, and inhibits stress-related neurotrans-mitter increases.	Pregnane glycosides	Rajendran *et al*., 2014; Fayyazuddin *et al*., 2025
Renoprotective activity	*In vivo* studies-high-fat diet induced kidney damage	Prevents the rise in plasma markers of kidney dysfunction; reduces oxidative stress; preserves antioxidant enzymes; improves tissue structure.	Polyphenols, flavonoids, saponins	Gujjala *et al*., 2015
Anti-inflammatory	Ethanolic extract tested on RAW 264.7 macroph-age cell lines enhanced with LPS; NO measured by Griess reagent; iNOS gene expression by q-PCR	Significant, dose-dependent decrease in NO production and iNOS gene expression (possibly *via* MAPK and NF-κB pathways), indicating anti-inflammatory activity.	Megastigmane glycosides	Krishnaa *et al.,* 2018; Qayyum *et al.*, 2018
Antimicrobial activity	MIC, MBC and MFC assays against bacteria and fungi	Water and methanol extracts showed signi-ficant inhibition of Gram-positive bacteria (*S. aureus, E. faecalis*) and fungi; MIC values ranged from 78.12 to 156.25 mg/ml.	Pregane glycosides	BinMowyna and Alsayadi, 2020; Kature *et al*., 2024
Activity in vascular dysfunction	*In vivo* study in obese mice fed high-fat diet	Enhances vascular relaxation; increases eNOS expression; reduces oxidative and nitrosa- tive stress markers.	Pregnane glyco-sides, flavonoids, glycosides and flavone	Thomugunta *et al*., 2020
Cytotoxic /antipro-liferative activity	MTT assay on COLO 320 human colon cancer cells treated with ethanolic leaf extract (100-300 µg/ml)	Dose-dependent cytotoxicity with IC_{50} of 233.87 µg/ml; antiproliferative effect on colon cancer cells.	Pregnane glycosides	(Ashwini *et al.,* 2017)
Antibacterial activity	Agar disc diffusion using root and stem extracts (various solvents) against Gram-positive and Gram-negative bacteria	*Caralluma* extracts showed strong anti-bacterial activity against Gram-positive bacteria and *E. coli* (except *P. aeruginosa)* by interfering with bacterial membranes and protein synthesis.	Pregnane glyco-sides, saponins, flavonoids, and flavone glyco-sides	(Babu *et al*., 2014)

4. Clinical evidence on *C. fimbriata*

Clinical trials investigating *C. fimbriata* extract (CFE) in overweight and obese adults have predominantly employed randomized, placebo-controlled designs. A commercially available extract administered at an oral dose of 1 g/day was well tolerated but did not demonstrate significant improvements in anthropometric parameters or appetite suppression compared with placebo. No substantial changes were observed in clinical or biochemical markers, underscoring the need for further studies before CFE can be recommended as an antiobesity intervention (Arora *et al.*, 2015). Conversely, another trial reported that supplementation with CFE, in combination with dietary regulation and physical activity, contributed to reductions in central obesity, a key risk factor for metabolic syndrome (Astell *et al.*, 2013). However, a systematic review of seven intervention studies concluded that evidence supporting the efficacy of CFE in weight management and appetite regulation remains insufficient. A pooled analysis of four placebo-controlled trials revealed no significant reductions in body weight, BMI, or hip circumference, except for minor decreases in waist circumference and waist-to-hip ratio. Appetite-related measures, including cravings, desire to eat, and satiety, showed little change, with hunger being the only parameter exhibiting some variability. Furthermore, metabolic outcomes did not improve, and mild to moderate adverse effects were commonly reported (Jayawardena *et al.*, 2021).

In contrast, another 16-week study demonstrated that CFE maintained body weight, reduced waist circumference, and decreased daily caloric intake compared to placebo. Notably, these changes occurred without alterations in satiety hormones within the CFE group, whereas the placebo group exhibited elevated levels of leptin, neuropeptide Y (NPY), and cortisol. These findings suggest a possible interaction between CFE and satiety receptor sensitivity, warranting further investigation (Rao *et al.*, 2021). Overall, current clinical evidence indicates that *C. fimbriata* may confer modest benefits in reducing central obesity and caloric intake; however, its overall efficacy as an anti-obesity agent in humans remains inconclusive. Larger, long-term, and well-controlled trials are necessary to establish its therapeutic role.

5. Novel drug delivery systems (NDDS) of *Caralluma*

Caralluma species, particularly *C. fimbriata*, are gaining increasing attention in the development of novel drug delivery systems (NDDS). Their phytochemical constituents play a dual role in both reducing and stabilizing metallic ions during nanoparticle biosynthesis, providing an eco-friendly, cost-effective, and biocompatible alternative to conventional chemical synthesis. These nanoparticles not only enhance therapeutic efficacy and bioavailability but also hold promise for antimicrobial, antioxidant, and targeted drug delivery applications.

5.1 Green-synthesised nanoparticles from *C. fimbriata* extracts

5.1.1 Copper nanoparticles (CuNPs)

An aqueous extract of *C. fimbriata* has been utilized for the green synthesis of copper nanoparticles (CuNPs). The formation of CuNPs was confirmed by a characteristic color change due to surface plasmon resonance, further validated by UV-Visible spectroscopy. FTIR analysis demonstrated that phytochemicals such as flavonoids, saponins, and glycosides acted as reducing and stabilizing agents. Changes in pH and conductivity suggested redox reactions and successful ion reduction. Particle size analysis confirmed nanoscale dimensions with minimal aggregation, while zeta potential measurements indicated good dispersion stability. Storage studies showed that the nanoparticles retained stability for at least two weeks under varying temperatures (Gaikwad *et al.,* 2025).

5.1.2 Zinc oxide nanoparticles (ZnO NPs)

Sustainable synthesis of zinc oxide nanoparticles (ZnO NPs) has been achieved using *C. adscendens* stem extract. Bioactive compounds in the extract functioned as both reducing agents, converting zinc ions to nanoparticles, and capping agents, preventing aggregation. FTIR confirmed the presence of organic functional groups bound to nanoparticle surfaces, highlighting their role in stabilization. This eco-friendly approach avoids toxic chemicals and produces biocompatible ZnO NPs suitable for biomedical applications (Ragavendran *et al.,* 2025).

5.1.3 Palladium nanoparticles (Pd NPs)

Biosynthesized palladium nanoparticles (Pd NPs) generated from *C. fimbriata* extract exhibited significant antimicrobial and antibiofilm activity. Pd NPs inhibited Streptococcus mutans at $\leq$ 25 µg/ml and *Candida albicans* at 100-200 µg/ml, with strong concentration-dependent effects. At 100 µg/ml, Pd NPs significantly reduced biofilm formation. SEM and XRD analysis revealed polydispersity with crystalline (31.9%) and amorphous (68.1%) phases, which likely contributed to enhanced reactivity. These findings suggest Pd NPs as promising antimicrobial candidates, particularly for dental applications, though further studies are required to elucidate safety and clinical potential (Vignesh *et al.,* 2025).

5.1.4 Silver Nanoparticles (AgNPs)

Eco-friendly synthesis of silver nanoparticles (AgNPs) using *C. fimbriata* extract has also been reported. Characterization through UV-Vis spectroscopy, FTIR, SEM, and XRD confirmed nanoparticle formation, with an average particle size of 18.35 nm. Preliminary findings indicated potential biological activity of the AgNPs, suggesting further exploration for therapeutic applications (Pande *et al.,* 2015).

6. Safety and toxicity profile of *C. fimbriata*

C. fimbriata extract (CFE) is generally regarded as safe at recommended dosages. However, mild to moderate, transient side effects have been reported in both human and animal studies.

6.1 Reported adverse effects in human studies

In clinical settings, the most frequently reported adverse effects are mild gastrointestinal disturbances such as flatulence, constipation, abdominal discomfort, nausea, and diarrhea. These symptoms are typically self-limiting, resolving within one week without the need to discontinue supplementation (Sakshi *et al.,* 2025).Randomized clinical trials have shown no serious or long-term adverse effects with daily doses of up to 1 g/day for 16 weeks. Importantly, no significant alterations in hepatic or renal function, haematological indices, or vital signs were observed (Arora *et al.,* 2015).

6.2 Reported adverse effects in animal studies

6.2.1 General tolerance

Preclinical studies confirm that CFE is well-tolerated in animal models. A 6-month rat study established a no observed adverse effect level

(NOAEL) of 1000 mg/kg bw/day, with no significant impact on body weight, hematology, serum biochemistry, or histopathology of vital organs such as liver, kidney, and gastrointestinal tissues (Odendaal *et al.,* 2013).

6.2.2 Toxicological assessments

The safety of *C. fimbriata* has been further validated through multiple toxicological investigations, including acute, subchronic, chronic, genotoxicity, and developmental toxicity studies. These findings collectively support its favorable safety profile when consumed within recommended limits (Table 3).

C. fimbriata extract has been extensively evaluated for toxicity and is regarded as safe for oral consumption at recommended doses. Animal studies show no evidence of significant systemic, genotoxic, or developmental toxicity, while human trials report only mild and transient adverse effects. Nonetheless, consultation with healthcare professionals is advised prior to use, particularly during pregnancy or in individuals with chronic health conditions.

Table 3: Summary of toxicological studies on *C. fimbriata* extract

S.No.	Study type	Dose range tested	Key findings	References
1.	Acute oral toxicity (rats)	5 g/kg	No deaths or toxic effects.	Odendaal *et al.*, 2013
2.	Chronic oral toxicity (rats)	100-1000 mg/kg/day	No observed toxicity, NOAEL = 1000 mg/kg.	Odendaal *et al.*, 2013
3.	Genotoxicity (*in vitro*)	5000 µg/ml	No mutagenicity or clastogenicity.	Odendaal *et al.*, 2013
4.	Developmental toxicity (rats)	250,500,1000 mg/day	No fetal or maternal toxicity.	Odendaal *et al.*, 2013
5.	Human use (clinical/observational)	1g/day(12weeks)	Generally safe with mild gastro-intestinal toxicity.	Arora *et al.*, 2015

7. Future prospects

Although, encouraging findings have been reported, *C. fimbriata* remains insufficiently explored, offering considerable opportunities for further research. Its potential as a nutraceutical and therapeutic agent is particularly relevant for obesity, metabolic syndrome, diabetes, and possibly cancer. Future investigations should prioritize robust clinical validation, advanced phytochemical characterization, long-term safety evaluation, and the development of sustainable cultivation and production strategies. Additionally, innovative drug delivery approaches such as nanoparticle-based systems may improve bioavailability and therapeutic efficacy. Such efforts could help translate its traditional use into modern healthcare applications.

8. Conclusion

C. fimbriata is a promising botanical resource with a strong ethnomedicinal background and a diverse phytochemical profile, particularly rich in pregnane glycosides, flavonoids, and saponins. Preclinical and clinical studies support its antiobesity, antidiabetic, antioxidant, cardioprotective, anxiolytic, nootropic, and renoprotective properties. While animal studies demonstrate significant benefits, clinical trials have produced modest and sometimes inconsistent outcomes, underscoring the need for larger, long-term investigations. Safety assessments confirm that it is generally well tolerated, with only mild gastrointestinal side effects and no major toxicity in animal models. Integrating advanced phytochemical research, sustainable utilization, and innovative delivery systems may further enhance its therapeutic viability. With continued rigorous research, *C. fimbriata* has the potential to become a scientifically validated, globally relevant natural agent for managing obesity, metabolic disorders, and oxidative stress related conditions, bridging traditional knowledge and modern pharmacological science.

Availability of data and material

All data are provided within the manuscript.

Authorship Contribution Statement

Shaik Rubina: Contributed to writing the original draft, reviewing and editing the manuscript, software handling, project administration, and methodology. **Zeenath Banu:** Contributed to conceptualization, data curation, investigation, methodology, supervision, validation, and visualization of the study.

Consent for publication

All authors gave their full consent for publication and submission to this journal.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

Funding

The author(s) stated that the work presented in this article received no associated funding.

Ethics approval

Not applicable.

Acknowledgements

We extend our heartfelt gratitude to RBVRR Women's College of Pharmacy, Barkatpura, Hyderabad, Telangana, India, for their constant encouragement, infrastructure facilities, and access to academic resources that greatly supported the completion of this review. Their unwavering support played a pivotal role in facilitating literature access, technical assistance, and an intellectually stimulating environment essential for this work. We also acknowledge that the figures included in this manuscript were created using BioRender (www.biorender.com).

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Citation **Shaik Rubina and Zeenath Banu (2025). *Caralluma fimbriata* Wall.: Ethnomedicinal significance, phytochemical profile, pharmacological activities, and therapeutic prospects. J. Phytonanotech. Pharmaceut. Sci., 5(3):30-37. http://dx.doi.org/10.54085/jpps.2025.5.3.5**