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Caralluma Fimbriata An Emerging Nutraceutical Source With Multifunctional Health Benefits

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Abstract: Medicinal plants have served as essential components of human healthcare systems since ancient times, owing to their therapeutic, nutritional, and cultural significance. Their increasing global demand reflects a shift away from synthetic drugs toward natural remedies, particularly in regions where traditional medicine is still a primary source of healthcare. Among these plants, *Caralluma fimbriata*, a succulent species widely distributed in arid and semi-arid regions, has emerged as a valuable botanical resource. Traditionally used as famine food and an appetite suppressant, *Caralluma fimbriata* is rich in diverse phytochemicals including pregnane glycosides, flavonoids, saponins, steroids, and phenolic compounds, which support its broad spectrum of pharmacological activities. These include anti-obesity, anti-diabetic, antioxidant, anti-inflammatory, antimicrobial, neuroprotective, and hypolipidemic effects. Scientific evidence and traditional reports highlight its potential role in metabolic health, gastrointestinal disorders, pain management, and infectious diseases. Despite its immense therapeutic value, overexploitation, limited cultivation efforts, and habitat degradation threaten its availability. This review consolidates the traditional uses, nutritional attributes, phytochemical composition, and therapeutic properties of *Caralluma fimbriata*, while emphasizing the need for conservation and future biotechnological interventions to promote sustainable utilization and large-scale applications in the pharmaceutical, nutraceutical, and food industries.

Index Terms - *Caralluma Fimbriata*, Pregnane glycosides, Anti-obesity activity, Antioxidant properties, Nutraceutical potential

I. INTRODUCTION

Medicinal plants have played a fundamental role in human health and nutrition since ancient times, serving as essential sources of food, bioactive compounds, and therapeutic agents for various ailments.[1] While the plant kingdom comprises approximately 250,000 species, only 10% have been scientifically investigated for their medicinal properties. With the growing demand for natural and plant-based remedies, researchers are continuously exploring new species with functional and therapeutic potential. These plants are particularly vital in primary healthcare, especially in rural areas where access to modern medicine is limited.[2] Their growth and medicinal value are significantly influenced by ecological factors, including soil composition, temperature, water availability, and genetic variation. Additionally, aromatic medicinal plants play a crucial role in traditional practices such as aromatherapy, which has been used for centuries.[3]

India, recognized as one of the world's richest regions for medicinal plants, is home to approximately 8,000 species. Traditional medicine remains the primary healthcare source for around 65% of the Indian population.[4] Ayurvedic and Unani medicinal systems heavily rely on forest-derived plant resources, with nearly 80% of medicinal plant demands being met through wild harvesting.[5] However, rapid deforestation, population expansion, overexploitation, and the introduction of invasive species have led to the depletion of several medicinally important plants, pushing many toward endangerment. In recent years, medicinal plants have gained widespread global recognition due to concerns over the adverse effects of synthetic drugs. The

increasing reliance on plant-based medicine has placed immense pressure on natural ecosystems, making it imperative to develop conservation strategies to protect endangered medicinal species.[6]

Scientific approaches such as sustainable cultivation and biotechnological interventions are crucial for ensuring the long-term availability of these valuable plant resources while supporting the healthcare and pharmaceutical industries.[7] Since ancient times, medicinal plants have been widely used for treating various diseases. Due to their natural origin, they tend to have fewer side effects and are well-tolerated by the human body. Before the advent of modern synthetic medicine, medicinal herbs were commonly used to treat infectious diseases such as typhoid, measles, and cholera.[8] Additionally, these plants served as pain relievers, antidotes for poisons, treatments for inflammation, and remedies for snake bites, among other uses. Due to the adverse effects associated with synthetic drugs, there has been a renewed interest in herbal therapy.[9]

Medicinal plants contain diverse bioactive compounds, including polyphenols, flavonoids, isoflavonoids, terpenoids, carotenoids, phytosterols, and glucosinolates.[10] The presence of these compounds contributes to their therapeutic applications, such as anti-cancer, anti-aging, anti-diabetic, analgesic, anti-allergic, anti-inflammatory, and hepatoprotective properties. Medicinal plants continue to play a crucial role in modern drug development, either directly or indirectly, by serving as sources of key pharmaceutical ingredients.[11]

Among these medicinal plants, *Caralluma Fimbriata* has garnered significant attention for its nutritional and therapeutic potential.[1] The genus *Caralluma R. Br.* (Sensu lato), belonging to the Apocynaceae family, consists of 13 species and five varieties in India, with several species endemic to South India.[12] These plants are well adapted to arid conditions, thriving in rocky crevices and thorny shrubs. Traditionally, *Caralluma* species have been consumed as famine food, known for their appetite-suppressing properties, and recognized for their medicinal benefits.[13] Historically, hunting tribes chewed chunks of the *Caralluma* cactus to curb hunger and thirst during long expeditions. Despite its extensive use across centuries in the Indian subcontinent, no adverse effects have been reported. The plant is officially classified as a vegetable in *The Wealth of India* and acknowledged in the Indian Health Ministry's comprehensive documentation of medicinal plants. It is used as an ethno-medicinal and nutritional plant for different ailments in the tribal region of Sangamner tehsil of Ahmednagar district, India.[14]

Overview of *Caralluma Fimbriata*

The genus *Caralluma* R. Br. (sensu lato) belongs to the Apocynaceae family, subfamily Asclepiadoideae, and is represented by 13 species and five varieties in India.[15] Among them, *Caralluma Fimbriata* is one of the important species, along with *Caralluma* diffusa, *C. stalagmifera*, *C. stalagmifera* var. longipetala, and *Caralluma* nilagiriana, which are endemic to South India. *Caralluma Fimbriata* thrives in arid conditions and is prone to decay when exposed to excessive moisture. It commonly grows on slopes, in rock crevices, and among thorny shrubs, which provide structural support, development aid, and offer protection.[16]

Caralluma Fimbriata is an edible wild succulent plant widely distributed in the arid and semi-arid regions of India, Pakistan, and other parts of Asia.[17] The plant has a long history of traditional use and is locally known as "Choong" or "Choonga" in Pakistan and "Kalli moolian" or "Karallamu" in India. Its leaves appear only on young branches and fall off quickly, leaving spiky projections. The flowers bloom singly or in clusters, with purple petals marked with golden hairy borders.[18]

Historically, *Caralluma Fimbriata* has been consumed as a famine food by indigenous communities, particularly during periods of food scarcity.[19] It was traditionally eaten as a vegetable, pickle, or chutney and was also chewed in raw form by hunting tribes to suppress hunger and thirst during long journeys. In Ayurvedic medicine, it has been recognized for its therapeutic properties and continues to be used in various traditional practices.[20]

Caralluma Fimbriata has also been classified as a vegetable in the Indian Health Ministry's comprehensive list of medicinal plants and is mentioned in the Indian Materia Medica as a famine food, hunger suppressant, and thirst quencher.[14] It has been traditionally cooked with meat, consumed as a culinary herb, or used as an emergency food in the semi-arid regions of Pakistan and India.[21] Despite its bitter taste, the plant remains a part of traditional diets in many tribal communities.

Although *Caralluma Fimbriata* continues to be a part of indigenous diets and traditional medicine, its large-scale cultivation and conservation require greater attention. Overexploitation and habitat loss pose significant threats to its availability, making it crucial to implement sustainable cultivation practices. Given its historical significance and continued use, efforts to promote awareness and conservation of *Caralluma Fimbriata* can help preserve this valuable plant for future generations.[20] It is rich in bioactive compounds such as pregnane glycosides, flavone glycosides, megastigmane glycosides, and saponins. This plant has gained scientific attention for its role in weight management and metabolic health. Studies suggest that *Caralluma Fimbriata* influences appetite regulation, reduces hunger pangs, and aids in controlling body weight. [13,22] *Caralluma*

Fimbriata is known for its medicinal properties, including anti-inflammatory, anti-nociceptive, anti-ulcer, anti-diabetic, carminative, febrifugal, antipyretic, and antioxidant effects. Extracts of *Caralluma Fimbriata* are commercially available in capsule form under the brand name "GENASLIM," which is used for weight loss.[23]

Ayurvedic experts in traditional Indian medicine have observed that *Caralluma Fimbriata* does not cause any adverse effects and has no known toxicity to date.[24] A standardized and patented extract of *Caralluma Fimbriata* has been developed by a company, providing a concentrated form of the plant extract. In the United States, only one company utilizes the 'Slimaluma formula,' which combines the patented Slimaluma extract of *Caralluma Fimbriata* with EGCG (Epigallocatechin gallate) from green tea. This formulation is marketed under the trade name Country Life's Gena Slim supplement.[25]

However, despite its historical importance, immense medicinal and nutritional significance, *Caralluma Fimbriata* remains underutilized and faces threats due to overexploitation, habitat loss, and limited commercial development.[26] The increasing demand from the pharmaceutical industry, coupled with agricultural expansion, mining activities, and uncontrolled fodder collection, has placed this plant at risk. Given these challenges, biotechnological interventions such as *in vitro* culture techniques offer a sustainable solution for large-scale propagation, conservation, and innovative product development using *Caralluma Fimbriata*.[27] By harnessing scientific advancements, this valuable medicinal plant can be preserved, ensuring its availability for future generations while unlocking its full potential for therapeutic applications.

Nutritional and phytochemical constituents

Caralluma Fimbriata is a nutrient-rich wild edible plant known for its balanced composition of macronutrients, micronutrients, and bioactive compounds. Studies have reported that *Caralluma Fimbriata* contains approximately 45% moisture, 9% ash, 4.8% fat, 0.67% fiber, 0.66% protein, and 40% carbohydrates, with an energy value of 207 kcal per 100 grams. Other research indicates slight variations, reporting 8% fat, 6% ash, 30% sugar, and a caloric content of 554 kcal per 100 grams.[1] Additionally, it is a rich source of essential minerals such as iron, manganese, zinc, and copper, which are crucial for various physiological functions. The plant also contains important amino acids, including isoleucine (1578.24 mg/100 g), phenylalanine (141.58 mg/100 g), tryptophan (157.36 mg/100 g), and valine (342.95 mg/100 g), making it nutritionally beneficial for metabolic health and overall well-being. With its total free amino acid content accounting for 27.5% and dietary fiber at 15.3%, *Caralluma Fimbriata* has potential digestive health benefits, supporting gut function and metabolic regulation.[13]

The phytochemical composition of *Caralluma Fimbriata* is responsible for its medicinal potential. It is particularly rich in flavonoids, saponins, alkaloids, pregnane glycosides, phenolic compounds, tannins, terpenoids, and steroids, all of which contribute to its wide range of pharmacological activities.[28] Flavonoids provide antioxidant, anti-inflammatory, and antimicrobial properties, while saponins exhibit anti-tumor, anti-inflammatory, and neuroprotective effects. Alkaloids are involved in anti-adipogenic and anti-hyperglycemic activities, which help regulate metabolism. Pregnane glycosides are responsible for appetite suppression and weight management, while phenolic compounds and tannins contribute to antioxidant, cardioprotective, and anti-diabetic effects. Additionally, terpenoids and steroids provide anti-inflammatory, anti-cancer, and lipid-lowering properties, making *Caralluma Fimbriata* a valuable plant for health applications.[29]

Table 1: Phytochemical constituents in *C.fimbriata*

Phytochemical Constituents	Bioactive Potential
Alkaloids	Antiadipogenic; antihyperglycemic; and antioxidant
Anthocyanins	Protective against cardiovascular diseases; cancers; neurodegenerative disorders; and aging-associated bone loss
Anthraquinones	Diuretic; antibacterial; antiulcer; anti-inflammatory; anticancer; and antinociceptive
Coumarins	Antioxidants; antitumor
Diterpenes	Anti-obesogenic, Anti-hyperlipidemic; and anti-carcinogenic
Flavonoids	Antioxidant; Anti-aging; anti-inflammatory; antifungal; Immunomodulatory; cardioprotective; antiviral; antimicrobial; antibacterial; and antiparasitic
Phytosterol	Antihyperlipidemic; anticancer; antiapoptotic; cardioprotective
Pregnane glycosides	Antidiabetic; anti-obesity; antinociceptive; antiulcer; anti-inflammatory; anti-arthritis; and wound healing activities
Saponins	Antitumor; antioxidative; anti-inflammatory; antidiabetic; and neuroprotective
Steroids	—
Tannins/Gallic tannins	Anti-ulcerative; anti-inflammatory; antioxidant; antidiabetic; anticancer; and cardioprotective
Terpenoids	Anti-inflammatory; antitumor; and antiparasitic
Total polyphenolic compounds	Antioxidant; cardioprotective; neuroprotective; and antihyperglycemic
Trigonelline	Anti-inflammatory; antioxidant; antipathogenic; and anti-aging

The study[30] analyzed *Caralluma* aqueous extract using UV-Visible Spectroscopy, FTIR, and GC-MS techniques to determine its bioactive compounds and pharmacological potential. The UV-Visible Spectroscopy analysis showed an absorption peak indicating its significant role in maintaining body weight. The FTIR analysis revealed prominent absorbance bands at 3392.17 cm^{-1}, confirming the presence of functional groups associated with bioactive compounds. The GC-MS analysis identified key phytochemical constituents, including n-Hexadecanoic acid (38.20%) and Oleic acid (26.59%), among others.[31] These bioactive compounds contribute to the plant's medicinal properties, particularly its anti-obesity, anti-diabetic, and antiseptic effects. The findings support the traditional use of *Caralluma Fimbriata* in the treatment of various ailments, reinforcing its potential as a natural therapeutic agent.

Appetite Suppressant and Anti-Obesogenic Activity

Caralluma Fimbriata is widely recognized for its appetite-suppressing and fat metabolism-regulating properties, making it an effective weight management supplement.[32] The plant contains pregnane glycosides, a group of naturally occurring compounds known to inhibit fat formation, thereby assisting in reducing central adiposity, a major factor contributing to metabolic syndrome, hypertension, and cardiovascular diseases. However, long-term safety data remain limited and require further research.[16]

The pharmaceutical option for treatment of obesity is lipase inhibitors that suppress appetite and stimulate the CNS (Central Nervous System).[33] The interesting fact that caratuberside-bouceroside found in the *Caralluma* species has the CBR (Cardiac Binding Ratio) of glycoside content that belongs to the pregnane group. Clinical trials have shown that 1g of *C. fimbriata* extract administered daily for 60 days resulted in a statistically significant reduction in waist circumference, while body weight and fat percentage showed a trend toward reduction.[34] Similarly, a Diet-Induced Obesity (DIO) rat model demonstrated that administering 25–100 mg/kg/day of *C. fimbriata* extract for 90 days led to lower food intake, reduced body weight, improved lipid profiles, and decreased leptin levels, further supporting its anti-obesity potential.[35]

Anti-diabetic and Insulin Resistance Effects

Traditional medicine has long utilized *Caralluma* species for diabetes management, with multiple species demonstrating blood glucose-lowering properties. *C. attenuata*, commonly consumed raw or cooked in Andhra Pradesh, India, and *C. tuberculata*, brewed into tea in Pakistan, are widely used for controlling blood sugar levels.[36] Additionally, *C. sinaica* and *C. edulis* have shown significant hypoglycemic effects, with their extracts sometimes combined with phlorizin for enhanced therapeutic benefits. In Quetta, Pakistan, a

traditional practice involves chewing fresh C. tuberculata after meals, three times a day for one month, as a natural remedy for diabetes.[37]

Furthermore, research on the methanol extract of *C. fimbriata* (MCF) in streptozotocin (STZ)-induced diabetic rats demonstrated that MCF significantly lowered blood sugar levels and reduced oxidative stress in the liver and kidneys, indicating its potential role in diabetes management.[38] Another study investigating the hydro-alcoholic extract of *C. fimbriata* in high-fat diet-fed Wistar rats found that the extract helped suppress insulin resistance and oxidative stress, highlighting its potential as a natural agent for metabolic disorder management.[39]

Antioxidant and Hypolipidemic Activity

Research has shown that *Caralluma Fimbriata* exhibits strong antioxidant and lipid-lowering properties, attributed to its high phenolic and flavonoid content. A study analyzing methanol and water extracts of *C. fimbriata* found that these extracts had significant free radical scavenging activity, which correlated with their high total phenolic content. This suggests that *C. fimbriata* could serve as a natural antioxidant supplement for food and nutraceutical applications.[40]

Additionally, an alloxan-induced diabetic rat study demonstrated that butanolic extract of *C. fimbriata* lowered fasting blood glucose from 273.1 mg/dL to 82.1 mg/dl within 150 minutes. The study also reported a marked reduction in total cholesterol, LDL (low-density lipoprotein), triglycerides, and TC/HDL (high-density lipoprotein) ratio, along with an increase in HDL levels. The DPPH radical scavenging, lipid peroxidation inhibition, and reductive ability tests further confirmed the plant's potent antioxidant properties, supporting its potential in diabetes and cardiovascular health management.[41]

Neuroprotective and Cognitive-Enhancing Effects

The nootropic and neuroprotective properties of *Caralluma Fimbriata* were evaluated in studies examining learning and memory functions in mice. Behavioral tests confirmed that a standardized extract (CFE) exhibited both memory-enhancing (nootropic) and anxiety-reducing (anxiolytic) properties, making it beneficial for cognitive health.[42]

Anti-Nociceptive (Pain-Relieving) and Anti-Inflammatory Effects

The analgesic (pain-relieving) properties of *Caralluma Fimbriata* were examined using hot plate and acetic acid-induced abdominal constriction models in mice. Petroleum ether, chloroform, and aqueous methanolic extracts at 100 and 200 mg/kg doses were tested, and results demonstrated significant pain reduction, indicating that *C. fimbriata* could be a natural alternative for pain management.[23] Research on ethanolic and aqueous extracts of *C. europaea* administered at 250 mg/kg in rats, found that these extracts significantly reduced inflammation, producing effects comparable to diclofenac sodium, a commonly used anti-inflammatory drug.[43]

Antibacterial and Anticancer Activity

The antibacterial activity of *Caralluma* species has been tested against *Bacillus pumilus, Escherichia coli,* and *Staphylococcus aureus,* with petroleum ether extracts of *C. europaea* showing the most significant antibacterial effects, suggesting its potential use as a natural antimicrobial agent.[44] The ethyl acetate fraction of *C. tuberculata* has shown potent anticancer activity, particularly against breast cancer (MCF7, MDA-MB-468) and colon cancer (Caco-2) cell lines.[45] Studies have also found that β-sitosterol, a compound extracted from *C. adscendens*, acts as a chemo preventive agent, inhibiting cancer cell proliferation without toxic side effects, reinforcing its potential as a natural alternative for cancer treatment.[46]

Skin Infection Treatment

Skin infections, often caused by cuts, burns, stings, or exposure to fungi, bacteria, and viruses, are treated using various *Caralluma* species in traditional medicine. *C. laciantha*, *C. stalagmifera*, *C. arabica*, and *C. tuberculata* have been widely utilized in India, Iran, Nigeria, Oman, Pakistan, and Saudi Arabia for their antiseptic and wound-healing properties[47]. Traditional remedies include crushed *C. laciantha* stems mixed with lime and cherry, applied to the affected area for four days. Another common method involves a mixture of *C. laciantha, Mimosa pudica, Curcuma longa*, and lime juice, which is applied for seven days to treat infections. Additionally, a blend of *C. stalagmifera* and *Azadirachta indica* (Neem) leaves with oil is used to treat various skin disorders. In some regions, fresh *C. fimbriata* is chewed to help with pimples, freckles, and blood purification.[48]

Gastrointestinal Disorders

Caralluma Fimbriata is used for treating digestive disorders such as constipation, diarrhea, abdominal pain, and ulcers. It can be cured in a short period of time or may persist for a long period of time. Species of this are used traditionally for treating by burning the plant in fire and eaten for 5 days regularly on an empty stomach for ulcer and abdominal pain. It can also be ground into powder, which is taken for dysentery, constipation, and other gastric problems and it was found to be nontoxic even up to the dose of 2000 mg/kg body weight.[49,50]

CONCLUSION:

Medicinal plants continue to serve as indispensable resources in healthcare and nutrition, and *Caralluma fimbriata* stands as a valuable example of such biological wealth. Its longstanding use in traditional medicine, coupled with growing scientific validation, underscores its relevance in addressing modern lifestyle disorders such as obesity, diabetes, and metabolic syndrome. The diverse range of bioactive constituents found in *C. fimbriata* contributes to its therapeutic versatility, including appetite suppression, antioxidant, hypolipidemic, neuroprotective, antibacterial, and anti-inflammatory activities. However, its increasing utilization has raised concerns regarding habitat loss and overharvesting, which call for urgent conservation strategies. Advances in sustainable cultivation, in vitro propagation, and commercial product development offer promising pathways for preserving the species while expanding its applications in nutraceutical and pharmaceutical sectors. Overall, the current evidence positions *Caralluma fimbriata* as an underutilized yet highly valuable medicinal plant with significant potential for future research, clinical application, and development of natural health products.

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