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Review Article

Phytochemical Characterization and Standardization of *Caralluma Fimbriata* and *Ocimum Sanctum* Linn: A Review

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ABSTRACT

Medicinal plants have long been a foundation of traditional and ultramodern pharmacotherapy, offering a wealth of bioactive composites with remedial eventuality. This review focuses on the phytochemical characterization and standardization of two considerably used medicinal plants *Caralluma fimbriata* Wall. (Family Apocynaceae) and *Ocimum sanctum* Linn. (Family Lamiaceae), generally known as Tulsi or Holy Basil. *Caralluma fimbriata* is a succulent cactus traditionally used as an appetite suppressant, anti-obesity agent, and anti-diabetic factory, with pharmacological conditioning including antioxidant, nootropic, analgesic, and anti-nociceptive goods. Its primary bioactive ingredients are pregnane glycosides, polyphenols, flavonoids, alkaloids, and tannins. *Ocimum sanctum* is a sweet condiment deified in Ayurvedic drug, containing eugenol, rosmarinic acid, ursolic acid, flavonoids (apigenin, luteolin, vicenin), tannins, alkaloids, saponins, and terpenoids. It demonstrates notable antioxidant, antimicrobial, anti-inflammatory, anti-diabetic, and adaptogenic conditioning. The review consolidates findings from multiple phytochemical webbing studies, standardization parameters, and pharmacological examinations, furnishing a comprehensive reference for experimenters and drugstore scholars. Standardization of herbal medications from both plants is emphasized as a critical quality assurance step to insure thickness, safety, and efficacy.

INTRODUCTION

Since ancient times, medicinal plants have been used as therapeutic agents by humans and are one of the greatest sources of pharmacologically active

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chemicals. Strict phytochemical characterisation and standardization of plant-based medications are becoming more and more necessary in order to guarantee their efficacy, safety, and quality as interest in natural products and herbal medicine grows. A member of the Apocynaceae (previously Asclepiadaceae) family, *Caralluma fimbriata* Wall. is a delicious succulent cactus that is found throughout southwest Asia, western Africa, and peninsular India. The plant, which is sometimes called to as a "famine food" in India, has been utilized for generations by tribal people as a portable food, hunger reducer, and thirst quencher during hunting trips. It is a 20–30 cm tall, upright, branching herb with thick, 4-angled, leafless stems. Many of its traditional benefits have been confirmed by recent scientific research, which has also uncovered additional pharmacological qualities as anti-obesity, anti-diabetic, antioxidant, nootropic, and analgesic effects. One of the most revered and significant medicinal herbs in the Indian subcontinent is *Ocimum sanctum* Linn. (Tulsi/Holy Basil), a member of the Lamiaceae (Labiatae) family. It is a fragrant, upright, branching herb that grows to a height of 30 to 75 cm and is widely grown in Southeast Asia and India. *O. sanctum* has been utilized in Ayurvedic and Unani medicine systems to cure a variety of ailments, from fever and the common cold to diabetes, inflammation, and cancer. The Charaka Samhita mentions the plant's many therapeutic qualities. A crucial step in guaranteeing the reproducibility of pharmacological effects and

preserving product quality is the phytochemical standardization of herbal remedies. Based on published research literature, the current review thoroughly examines the botanical descriptions, phytochemical components, standardization techniques, and pharmacological activities of both *C. fimbriata* and *O. sanctum* l.

2. Botanical Description-

2.1 *Caralluma fimbriata*

There are about fifty different species of succulent plants in the genus *Caralluma* (Family: Apocynaceae). A common dwarf stem succulent in western Africa, southwest Asia, and the Indian subcontinent, *C. fimbriata* is particularly prevalent in peninsular India. The plant is a 20–30 cm tall, upright, branching herb with fleshy, green, 4-angled, leafless stems that taper to a point. Only immature branches have tiny leaves that quickly fall off, leaving a tooth-like projection on the angles. Flowers, which are wheel-shaped, 2 cm diameter, with narrow purple petals with yellow markings and hairy frilly borders, are carried at the tips of branches either singly or in groups of two to three on short stalks. Fruits are cylindrical and measure 10 to 12 cm in length. It is sometimes found as a wayside shrub or boundary marker and has been consumed for ages in rural India, either raw, as a vegetable with spices, or preserved in pickles and chutneys.

Table 1- Characteristics and Properties of *Caralluma fimbriata*

Content	Description
Plant Image	 Fig :- <i>Caralluma fimbriata</i>
ScientificName	<i>Caralluma fimbriata</i>
Kingdom	Plantae
Order	Gentianales
Family	Apocynaceae
Genus	Caralluma
Species	<i>C. fimbriata</i>
Synonym	<i>Caralluma adscendens</i> var. <i>fimbriata</i>
Common Names	Caralluma, Slimaluma, Appetite Suppressant Plant
Traditional Uses	Appetite suppressant, anti-obesity, anti-diabetic, endurance enhancer
Pharmacological Properties	Anti-obesity, anti-diabetic, antioxidant, anti-inflammatory, anti microbial.
Chemical Constituents	Pregnane glycoides, flavonoids, saponins, alkaloids,

2.2 *Ocimum sanctum* L

Ocimum sanctum L is a member of the class Magnoliopsida, order Lamiales, family Lamiaceae, division Magnoliophyta, and kingdom Plantae. At maturity, the plant grows into an upright, fragrant shrub that is 30 to 75 cm tall. Its simple, fragrant, opposing, elliptic-oblong leaves have dentate margins and can grow up to 5 cm in

length. Flowers are purple, lengthy racemes arranged in tight whorls..The plant smells strongly of aromas. In addition to Sri Lanka, the Himalayan area, Bangladesh, Southeast Asia, portions of Africa, and Australia, it is widely grown and revered in temples and Hindu homes across India.

Table 2- Characteristics and Properties of *Ocimum sanctum* Linn

Content	Description
Plant Image	 Fig :- <i>Ocimum sanctum</i> linn
Scientific Name	<i>Ocimum sanctum</i> (syn. <i>Ocimum tenuiflorum</i>)
Kingdom	Plantae
Order	Lamiales
Family	Lamiaceae
Genus	Ocimum
Class	Magnoliopsida
Synonym	<i>Ocimum tenuiflorum</i> , <i>Ocimum sanctum</i> var. <i>album</i> .
Common Names	Tulsi, Holy Basil
Traditional Uses	Antitussive, anti-cold, adaptogen, antimicrobial, stress reliever
Pharmacological Properties	Antioxidant, anti-inflammatory, antimicrobial, antidiabetic,
Chemical Constituents	Eugenol, ursolic acid, rosmarinic acid, flavonoids, tannins, essential oils.

3. Phytochemical Characterization-

3.1 Phytochemical Constituents of *Caralluma fimbriata*

A wide variety of secondary metabolites are responsible for the medicinal and pharmacological characteristics of *C. fimbriata*. Numerous investigations have thoroughly examined this plant's phytochemical components. In a phytochemical screening of *C. fimbriata* aqueous stem extracts, based on literature review found alkaloids, flavonoids, carbohydrates, glycosides, sterols, saponins, oils and fats, tannins, phenolic compounds, proteins and amino acids, gums, and mucilage. Mayer's test for alkaloids, ferric chloride test for flavonoids and phenolics, lead acetate test for tannins, foam test for saponins, Legal test for glycosides, Biuret test for proteins,

and Ninhydrin test for free amino acids were among the common chemical tests used in the study. Interestingly, the study's own findings showed that tannin and phenolic compounds were present in *C. fimbriata* aqueous stem extracts. In *C. fimbriata*, the most pharmacologically relevant class of chemicals are pregnane glycosides. The plant's appetite-suppressive and anti-obesity qualities are believed to be mainly caused by these naturally occurring steroidal chemicals. A commercial *C. fimbriata* extract (Slimaluma®) was subjected to a thorough NMR-based phytochemical analysis by literature review which revealed a number of molecule classes, including amino acids (leucine, isoleucine, alanine, glutamine, and tryptophan), organic acids (lactate, acetate, and formate), carbohydrates (glucose and sucrose), trigonelline, and pregnanes. In terms of

pregnane equivalents, the pregnane content was measured at roughly 12% (120 mg/g). The study also found that the glycoside moiety of the pregnanes varied from one another, with the majority (76%) having acetyl groups substituted at position 12 and the remainder having aromatic groups.

3.2 Phytochemical Constituents of *Ocimum sanctum* l

O. sanctum l phytochemistry is quite complicated, with several bioactive chemicals found using different analytical and extraction methods. In their qualitative phytochemical analysis of *O. sanctum* leaf aqueous extracts, found positive results for alkaloids (Mayer's test, Wagner's test, Dragendorff test), flavonoids (Shinoda test, lead ethanoate test, sodium hydroxide test, alkaline reagent test, ferric chloride test), tannins (ferric chloride test, gelatine test, lead acetate test), and saponins (foam test). The results of tests for glycosides (Liebermann's, Salkowski's, and Keller-kilani), oil (stain test), carbohydrates (Molisch's, Benedict's), steroids, and proteins were all negative. Alkaloids, terpenoids, phenol and tannins, steroids, coumarins, and glycosides were found to be positive in a more thorough screening conducted. using methanolic extracts of *O. sanctum* leaves, but reducing sugar, saponins, proteins, anthocyanin, and leucoanthocyanin were found to be negative. In a similar ethanolic extracts of *O. sanctum* leaves contained alkaloids, flavonoids, saponins, phenolic compounds, glycosides, carbohydrates, reducing sugars, proteins and amino acids, phytosterols, steroids, and terpenes, with the exception of tannins and reducing sugars in the 7-day extract and acidic compounds in subsequent extracts. Based on current research significantly advanced the phytochemical characterisation of *O. sanctum* by analyzing ethyl acetate and n-butanol fractions using LC-MS. Ten flavones apigenin, vitexin,

isovitexin, vicianin 2, apigenin-7-O-glucuronide, luteolin, orienting, isorientin, galuteolin, and luteolin-7-O-glucuronide were found among the fifteen flavonoid compounds. Additionally, the flavonol quercetin (found for the first time in *O. sanctum* in this study) and the coumarin glycoside aesculin were identified. Rosmarinic acid, chlorogenic acid, and caffeic acid were identified as three hydroxybenzoic acid derivatives. Cirsimaritin, a dimethoxy flavone, was found in the residue fraction. By using ESI-MS/MS analysis, rosmarinic acid was identified as the main phenolic acid. Oleanolic acid, ursolic acid, rosmarinic acid, eugenol (1-hydroxy-2-methoxy-4-allylbenzene), carvacrol, linalool, and β -caryophyllene are the primary chemical components of Tulsi that are known from literature. These compounds are widely employed in food goods, fragrance, dental, and oral products. These differences between research demonstrate the significant impact of extraction procedures and solvents on the identified phytochemical profile.

4. Standardization Parameters-

4.1 Standardization of *Caralluma fimbriata*-

Concerns over the quality and inconsistency of commercially available herbal products make standardization of *C. fimbriata* preparations essential. By examining a commercially available standardized extract (Slimaluma®), based on literature review brought attention to this issue by discovering that the actual pregnane glycoside content (roughly 12% as determined by NMR) matched less than half of the 27.5% total pregnane glycosides reported on the supplier's technical data sheet. This disparity emphasizes how crucial independent analytical verification. By utilizing NMR spectroscopy to quantitatively determine the pregnane glycoside content as a trustworthy standardization technique. Using ¹H NMR spectroscopy and TSP as an internal standard, the



study calculated the pregnane content using the integral of the CH protons at position 21. Tannin content, flavonoid content, and total polyphenol content were measured using complementary colorimetric assays. Stem extracts from *C. fimbriata* have also been characterized using FTIR analysis. Using a Shimadzu IR Affinity 1 FTIR spectrometer, that found 12 unique peaks that corresponded to different functional groups. To acquire purer fractions for examination, column chromatography was utilized for purification, followed by FTIR characterization of the isolated chemical. In addition to excluding the presence of pathogenic microorganisms (*Escherichia coli*, *Salmonella* spp., *Pseudomonas aeruginosa*, *Staphylococcus aureus*), molds, fungi, and pesticides. On basis of various review Quality assessment of commercially available *C. fimbriata* extract also confirmed that heavy metals (Pb, Cd, As, and Hg) were within acceptable limits, illustrating the thoroughness of the necessary quality parameters.

4.2 Standardization of *Ocimum sanctum* L

Organoleptic properties, phytochemical screening, quantitative determination of active ingredients, and biological activity assays are among the many aspects that must be evaluated in order to standardize *O. sanctum* products.

The organoleptic characteristics of the aqueous extract of *O. sanctum* linn leaves were described in various review that noted its smooth texture, green color, aromatic odor, and mildly pungent

taste. For crude extracts, these features function as initial standardization criteria.

The methanolic *O. sanctum* extract was subjected to quantitative phytochemical analysis based on literature review Gallic acid was used as a standard in the Folin-Ciocalteu method to evaluate the total phenolic content (TPC), which resulted in 102.12 mg GAE/g extract. Using aluminum chloride, total flavonoid content (TFC) was calculated spectrophotometrically, yielding a value of 146.634 mg rutin equivalents/g extract. For methanolic extract, the extraction yield percentage was 29.45%.

By. used progressive extraction with more polar solvents (n-hexane, ethyl acetate, and n-butanol) to carry out a systematic fractionation analysis. TPC (212.26 ± 6.3 mg GAE/g extract) and TFC (54.51 ± 3.5 mg quercetin equivalents/g extract) had the highest concentration of the n-butanol fraction (OsB). Additionally, the ethyl acetate fraction displayed a notably elevated TPC (202.71 ± 5.5 mg GAE/g extract). Fractionation effectively concentrates active polyphenolic ingredients, as evidenced by these values being much higher than the crude methanolic extract (87.13 mg GAE/g for TPC, 221.97 mg QE/g for TFC). The best extraction solvent for concentrating antioxidant polyphenols from *O. sanctum* leaves was found to be n-butanol.

5. Pharmacological Activities

5.1 Pharmacological Activities of *Caralluma fimbriata*



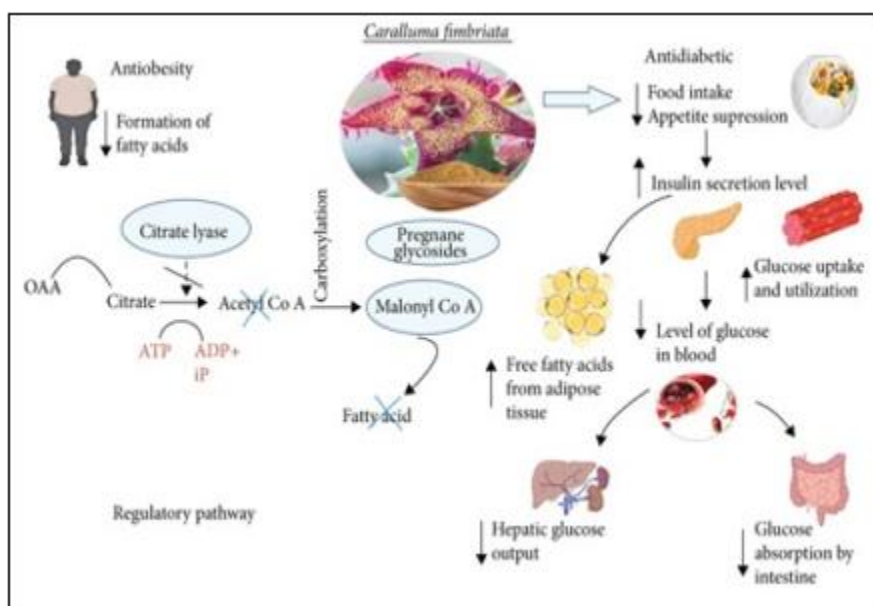


Fig: - Pharmacological properties of *Caralluma fimbriata*

5.1.1 Appetite Suppressant and Anti-obesity Activity-

The most well-known effect of *C. fimbriata* is its ability to decrease hunger. Pregnane glycosides, a group of naturally occurring substances believed to prevent the production of fat, are found in the plant. Central adiposity, a major component of metabolic syndrome linked to other risk factors like high blood pressure and cardiovascular disease, can be clinically meaningfully reduced by supplementing with *C. fimbriata*. One gram of *C. fimbriata* extract (12:1 concentrated aqueous/ethanolic extract equivalent to 12 g dried plant) caused 2.5% weight loss in 60 days, compared to 1.2% in the placebo group, according to a human intervention study with a statistically significant decrease in waist circumference.

5.1.2 Anti-diabetic and Insulin Resistance Activity

In vivo investigations have shown that *C. fimbriata* has anti-diabetic activity. An investigation into the impact of *C. fimbriata* (MCF) methanol extract on streptozotocin (STZ, 50 mg/kg b.w.)-induced

diabetic rats demonstrated that the methanolic extract considerably reduced the diabetic state, including oxidative stress in the kidney and liver. Furthermore, consumption of CFE may be advantageous for the suppression of high-fat diet-induced insulin resistance, according to a study examining the effects of hydroalcoholic extract of *C. fimbriata* (CFE) on oxidative stress and insulin resistance caused by a high-fat diet in Wistar rats.

5.1.3 Antioxidant Activity

C. fimbriata total phenolic and flavonoid content has been linked to its antioxidant properties. Methanol and water extracts from *C. fimbriata* had strong antioxidant and free radical scavenging properties, as well as good total phenolic and flavonoid levels, according to a study on the plant's antioxidant capacity. The amount of total phenolics in the extracts was shown to have a strong correlation with the antioxidant activity.

5.1.4 Antimicrobial Activity

By Using the disc diffusion method, according to study examined the antibacterial activity of *C. fimbriata* stem aqueous extracts against five

bacterial strains. Gram-negative germs displayed zones of 16 mm for *Proteus* sp., 15 mm for *Pseudomonas aeruginosa*, and 13 mm for *E. coli*, whereas gram-positive strains displayed zones of inhibition of 17 mm for *S. aureus* and 16 mm for *B. subtilis*. With zones of 24 mm for *S. aureus*, 21 mm for *B. subtilis*, 24 mm for *Proteus* sp., 20 mm for *Pseudomonas* sp., and 14 mm for *E. coli*, the chemical purified by column chromatography demonstrated improved antibacterial activity. The standard antibiotic gentamycin was used to compare these findings.

5.1.5 Anti-nociceptive and Analgesic Activity

Research employing petroleum ether, chloroform, and aqueous methanolic extracts of dried *C. fimbriata* leaves at doses of 100 and 200 mg/kg assessed for analgesic activity using the hot plate method and acetic acid-induced abdominal constrictions in mice revealed that *C. fimbriata* leaf extract demonstrated significant analgesic properties in all models examined.

5.2 Pharmacological Activities of *Ocimum sanctum*

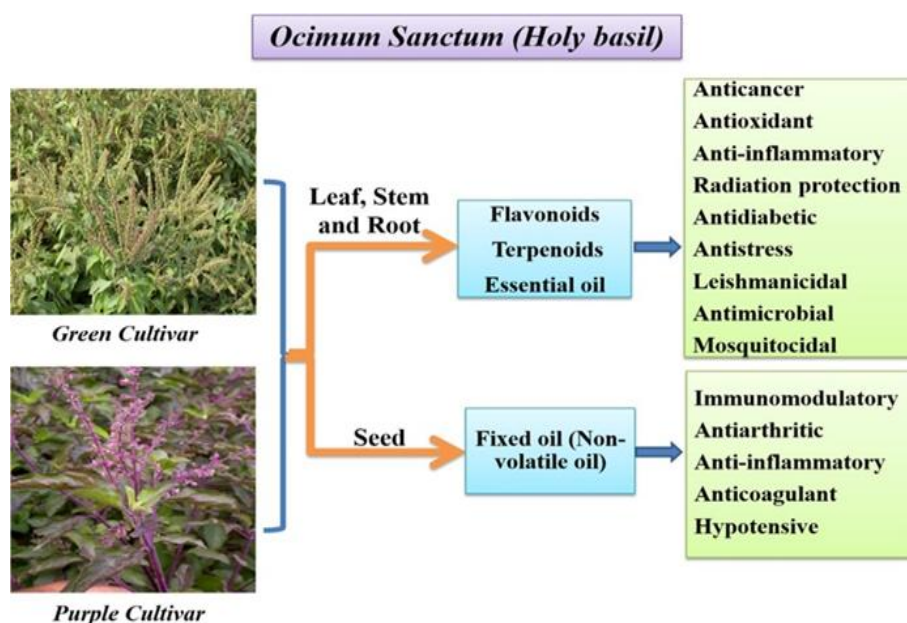


Fig :- Pharmacological properties of *Ocimum sanctum* L

5.2.1 Antioxidant Activity

Numerous in vitro assay techniques have been used to thoroughly investigate *O. sanctum* antioxidant capabilities. At a concentration of 500 µg/mL, research revealed that the methanolic extract of *O. sanctum* had a DPPH radical scavenging activity of 65.75%, while the control ascorbic acid had an activity of 88.52%. At doses of 10–500 µg/mL, the methanolic extract had superoxide radical scavenging activity values ranging from 12.04% to 60.16%. Five antioxidant

techniques were thoroughly assessed by using a variety of fractions. The n-butanol fraction outperformed the positive control ascorbic acid. The phosphomolybdate assay revealed a substantial and positive correlation between total polyphenolic content and antioxidant activity ($R^2 > 0.961$), indicating that polyphenols and flavonoids are the main contributors to antioxidant potential.

5.2.2 Antibacterial Activity

The based on review antibacterial activity of *O. sanctum* ethanolic extracts at three doses (0.2, 0.3, and 0.4 mg/ μ L) against commercial *S. aureus*, *Salmonella* spp., and poultry-isolated *E. coli*. The greatest zones of inhibition against *Salmonella* spp. (14–16 mm), *S. aureus* (14–15 mm), and *E. coli* (7–9 mm) were demonstrated by the 14-day extracts at 0.2 mg/ μ L. These zones were similar to amoxicillin, sulfamethoxazole, and ciprofloxacin intermediate sensitivity levels. No zone of inhibition against *E. coli* was seen at higher concentrations (0.3 and 0.4 mg/ μ L), which the authors explained by potential differences in leaf quality or extraction efficiency.

Eugenol and other phenolic chemicals found in the leaves of *O. sanctum*, such as cirsilineol, circimaritin, isothymusin, apigenin, and rosmarinic acid, are responsible for its antibacterial effect.

5.2.3 Anti-inflammatory Activity

Rats treated with 500 mg of *O. sanctum* methanolic extract showed anti-inflammatory properties. Tulsi's fixed oil and linolenic acid exhibit anti-inflammatory properties against PGE₂ and leukotriene-induced edema by blocking both the cyclooxygenase and lipoxygenase routes of arachidonic acid metabolism. In the carrageenan paw edema model, the aqueous extract (200–400 mg/kg) exhibited considerably higher action ($p < 0.05$) than the conventional medication

indomethacin. Tulsi's high eugenol content may make it a COX-2 inhibitor, according to recent research.

5.2.4 Anti-diabetic and Other Metabolic Activities

O. sanctum is a useful diabetic medication since it has been demonstrated to lower blood glucose levels. Insulin secretion and glucose utilization are thought to be influenced by a number of phytochemicals, such as flavonoids and phenolic compounds. Because of its polyphenolic components, the plant also has anti-hyperlipidemic, hypotensive, anxiolytic, and cardioprotective qualities.

5.2.5 Anticancer and Immunomodulatory Activity

In animal experiments, oral treatment of a 50% alcoholic aqueous leaf extract of different *Ocimum* species (200 mg/kg) significantly reduced tumor volume, increased average body weight, and improved survival rate. according to recent research in vivo radioprotection tests showed that the antioxidant flavonoids orientin and vicenin from *O. sanctum* decreased lipid peroxidation in lymphocytes and improved the repair of radiation-induced damage. Additionally, the plant is said to have immunomodulatory qualities that improve neutrophil activity and antibody response.

6. Comparative Phytochemical Profile

Table 3: Comparative phytochemical profile of *Caralluma fimbriata* and *Ocimum sanctum*

Phytochemical Constituent	<i>Caralluma fimbriata</i>	<i>Ocimum sanctum</i> l
Alkaloids	Present	Present
Flavonoids	Present	Present
Tannins	Present	Present
Saponins	Present	Present
Glycosides	Present	Present
Phenolic compounds	Present	Present
Proteins & Amino acids	Present	Present
Sterols/Steroids	Present	Present
Carbohydrates	Present	Present
Pregnane glycosides	Present (major, ~12%)	Absent
Terpenoids	Present	Present
Rosmarinic acid	Absent	Present (major)
Eugenol	Absent	Present (major)
Fixed oils/fats	Present	Present
Gums & Mucilage	Present	Absent

7. DISCUSSION

The complex and varied phytochemical profiles of *C. fimbriata* and *O. sanctum* support the variety of pharmacological effects that have been documented. These plants are confirmed as significant sources of bioactive chemicals by the convergence of traditional use and contemporary scientific research. Pregnane glycosides seem to be the primary bioactive components of *C. fimbriata* that decrease appetite and have anti-obesity actions. A major issue that emphasizes the necessity for reliable standardization techniques is the disparity between the declared and real pregnane glycoside concentration in commercial products. Based on literature review FTIR characterisation and NMR-based quantification technique offer complementary analytical tools for standardization. By using differential extraction investigations for *O. sanctum* show that solvent polarity has a substantial impact on the phytochemical composition and antioxidant activity of extracts. Across several assay

techniques, the n-butanol fraction, which is rich in polyphenols and flavonoids (particularly the flavones apigenin, luteolin, and their glucuronides), demonstrated higher antioxidant activity. This study's discovery of quercetin for the first time in *O. sanctum* is an important phytochemical discovery. In light of the increasing prevalence of antibiotic resistance, the antibacterial research on both plants shows moderate to significant activity against common pathogenic bacteria, indicating potential as sources of novel antimicrobial agents.

CONCLUSION

Ocimum sanctum and *Caralluma fimbriata* both have well-defined, varied phytochemical profiles with established pharmacological importance. Pregnane glycosides, polyphenols, alkaloids, flavonoids, and tannins are abundant in *C. fimbriata*, which also has anti-obesity, anti-diabetic, antioxidant, antibacterial, nootropic, and analgesic properties. Eugenol, rosmarinic acid,



luteolin, apigenin, and many other polyphenols found in *O. sanctum* have been shown to have antibacterial, anti-inflammatory, anti-diabetic, immunomodulatory, and anticancer effects. A strong standardization framework is provided by the quantitative measurement of marker substances (pregnane glycosides for *C. fimbriata*; rosmarinic acid and eugenol for *O. sanctum*) utilizing NMR, HPTLC, HPLC, and LC-MS techniques in conjunction with biological activity testing. The phytochemical profile is greatly influenced by the extraction solvent selection, and for thorough characterization, progressive fractionation with more polar solvents is advised. Future research should concentrate on developing standardized reference materials for both plants, conducting independent clinical validation, and evaluating long-term safety.

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