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A Review on Bioactive Compounds in Cymbopogon Citratus

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ABSTRACT

Lemongrass (*Cymbopogon citratus*) is a well-known medicinal herb characterized by its strong lemon-like fragrance and essential oil that is mainly composed of citral. The plant is rich in bioactive compounds such as flavonoids and phenolic substances, which contribute to its therapeutic value. Traditionally, lemongrass has been used in the treatment of fever, digestive disorders, infections, pain, and inflammatory conditions. Scientific studies have shown that it possesses antimicrobial, antioxidant, anti-inflammatory, and antimalarial activities. In addition to its medicinal uses, lemongrass essential oil is widely used as a natural insect repellent and is commonly obtained through steam distillation or solvent extraction techniques. Overall, lemongrass is an important herbal plant with wide-ranging medicinal and practical applications.

INTRODUCTION:

Cymbopogon citratus, commonly known as lemongrass, is a hardy and aromatic grass distinguished by its characteristic lemon fragrance. It grows well in tropical and subtropical regions and typically reaches a height of about 60–120 cm. The leaves of the plant are rich in bioactive constituents, which are mainly obtained from the foliage and are responsible for its pharmacological activities, including antibacterial and anti-inflammatory effects. In traditional medicine, lemongrass has been used to manage conditions such as coughs and malaria. Its essential oil is commercially important and finds wide applications in the food industry and pharmaceutical formulations. Moreover, lemongrass oil is widely recognized for its effectiveness as a natural repellent against mosquitoes and house flies. Several species of lemongrass, including *Cymbopogon ambiguus*, are distributed across different parts of the world.

TAXONOMICAL CLASSIFICATION:

1. Kingdom	Plantae
2. Division	Magnoliophyta
3. Class	Liliopsida
4. Order	Poales
5. Family	Poaceae
6. Genus	<i>Cymbopogon</i> Spreng
7. Species	<i>Citratus</i>

Table No. 1 Taxonomical Classification

COMMON NAMES:

Lemongrass, botanically identified as *Cymbopogon citratus*, is known by different common names across regions, including Capim-cidrao in Brazil and Citronella in the United States.

BOTANICAL DESCRIPTION:

The plant is mainly harvested for its leaves and sometimes the entire aerial portion. It is a tropical perennial grass that grows in compact clumps and can attain a height of nearly 6 feet with a spread of about 4 feet. The plant is characterized by the presence of a short rhizome that supports its dense growth habit.



Fig.2 green dry lemongrass

ETHNOPHARMACOLOGY:

The ethnopharmacological applications of this plant differ widely among countries. In Argentina, leaf decoctions are traditionally prepared to relieve sore throat and digestive discomfort such as empacho. In Brazil, the plant is commonly consumed as a tea for its pain-relieving and antispasmodic effects. Cuban traditional medicine uses hot water extracts to manage low blood pressure and rheumatic conditions. In Egypt, dried leaves and stems are employed as antispasmodic agents for kidney-related disorders. In India, the fresh plant is traditionally used as a snake repellent and to treat gastric ailments. Both Indonesia and Malaysia utilize hot extracts of the plant as emmenagogues. In Thailand, it has a wide range of applications, including use in the management of diabetes and as a culinary flavoring agent. In the United States, the Laotian Hmong community applies the plant externally to promote the healing of wounds and bone fractures.



Fig.1 Cymbopogon Citratus

PHYTOCHEMISTRY:

Medicinal plants such as lemongrass (*Cymbopogon citratus*) are rich in phytochemicals, which are naturally occurring compounds responsible for their therapeutic effects.

CHEMICAL COMPONENTS OF LEMONGRASS:

Lemongrass contains important constituents including flavonoids, phenolic substances, essential oils, and organic acids. The essential oil content of the plant ranges from approximately 0.2% to 0.5% and is mainly composed of citral. Citral occurs as two isomeric forms, geranial (about 40–62%) and neral (around 25–38%). These bioactive components play a major role in the medicinal and health-promoting properties of lemongrass. Recent studies have reported the isolation of triterpenoid compounds from the leaf wax of the plant, specifically cymbopogone and cymbopogonol. The flavonoid profile

includes luteolin along with its 6-C and 7-O glycoside derivatives, isoorientin 2'-O-rhamnoside, as well as quercetin, kaempferol, and apigenin. In addition, several phenolic constituents have been identified, including elemicin, catechol, chlorogenic acid, caffeic acid and hydroquinone.

Essential oil composition	Percentage of composition
Citral	40.8% 32%
Nerol	0.2%
Geraniol	0.1-0.4%
Citronellal	0.1%
Terpinolene	0.07%
Geranyl acetate	0.04%
Methylheptenone	
Borneol	
Linalyl acetate Pinene	

Table No. 2 Composition of essential oil in *C. citratus*

PHYTOCHEMICAL CONSTITUENTS:

Cymbopogon citratus (lemongrass) contains a wide range of beneficial phytochemicals, particularly essential oils and flavonoids, which are responsible for its health-promoting properties. The plant has a relatively low moisture content (about 5.7%), which helps maintain freshness and supports its antimicrobial activity. It also provides a notable amount of crude fiber (approximately 9.28%), contributing to improved digestive function. The nutritional profile of lemongrass includes crude fat, ash, and protein, along with nearly 5% carbohydrate content. In addition, it supplies important minerals such as potassium, sodium, magnesium, and zinc. Although lemongrass contains phytates at around 11,860 mg per 100 g, the level remains within a safe range when balanced with its zinc content.

PHARMACOGNOSTIC EVALUATION:

The pharmacognostic evaluation of *Cymbopogon citratus* included a detailed study of its macroscopic, microscopic, and physicochemical characteristics. Organoleptic assessment of the leaves revealed a dark green upper surface and a lighter green lower surface, along with a characteristic lemon-like aroma and a bitter taste. Morphologically, the leaves are linear in shape, measuring approximately 1–2 meters in length and 5–10 mm in width.

Microscopic And Histological Techniques: Microscopic examination involved the preparation of transverse sections of the leaves after softening, followed by staining procedures to identify lignified tissues. Powder microscopy was performed by clearing powdered plant material on slides using chloral hydrate and glycerin. Physicochemical parameters such as alcohol- and water-soluble extractive values, total ash content, and loss on drying were determined. Quantitative analysis was carried out by developing calibration curves for major essential oil constituents, including citral and limonene.

METHODS OF EXTRACTION:

The isolation and identification of bioactive compounds from medicinal plants such as lemongrass (*Cymbopogon citratus*) play an important role in the development of therapeutically effective medicines. Among the various techniques available, distillation is widely regarded as an efficient method for essential oil extraction.

Steam Distillation: Steam distillation is especially favored because it can recover nearly 80–90% of essential oil components and is well suited for fresh plant material containing compounds with high boiling points. A range of extraction methods is employed, including hydrodistillation and steam distillation, as well as modern approaches such as microwave-assisted extraction and supercritical fluid extraction, which are designed to improve yield, minimize extraction time, and reduce processing costs. However, extraction techniques that involve high temperatures may cause the breakdown of volatile constituents, while solvent-based methods carry the risk of leaving residual solvents that may be undesirable or harmful.

Water (hydro) Distillation: Hydrodistillation is a traditional technique for obtaining aromatic oils from plant materials by boiling them in water. Despite its widespread use, the method has several limitations, including a lengthy extraction time and high energy consumption. It may also result in incomplete recovery of essential oils, and prolonged exposure to heat can alter the chemical composition of sensitive compounds. In some cases, direct heating can cause plant materials to scorch, leading to the development of undesirable odors in the final extract.

Maceration: Maceration is an extraction technique in which plant material is immersed in a cold solvent to minimize thermal degradation of sensitive compounds. Although this method helps preserve chemical stability, it is time-consuming and requires large volumes of solvent.

Solvent Extraction: Solvent extraction employs organic solvents such as petroleum ether or hexane to obtain essential oils while avoiding high temperatures, thereby maintaining the natural fragrance of the plant. However, this approach carries the risk of residual solvent contamination, which limits its suitability for topical or skin-care applications.

Soxhlet Extraction: Soxhlet extraction, widely used in nutraceutical research, offers efficient recovery of target compounds but demands considerable amounts of solvent and extended extraction periods ranging from several hours to weeks. The process relies on repeated solvent reflux cycles to continuously extract bioactive constituents from solid plant material.

Supercritical fluid extraction (SFE): Employs carbon dioxide in its supercritical state as a solvent to isolate bioactive constituents from plant materials. Compared to conventional solvent-based methods, SFE offers faster extraction and higher efficiency. The unique properties of supercritical CO₂ allow the recovery of essential oils that closely retain the natural composition of the original plant. This technique is widely preferred because carbon dioxide is inexpensive, non-toxic, readily available, and environmentally friendly.

Simultaneous Distillation Extraction: The simultaneous distillation–extraction (SDE) method integrates distillation with solvent extraction to efficiently recover volatile compounds while limiting solvent consumption and reducing heat-related degradation. However, this technique may lead to the formation of artifacts in the extract and can result in the loss of compounds that are highly soluble in water.

Solvent-free microwave extraction (SFME): Solvent-free microwave extraction (SFME) is performed without the use of added solvents; instead, the plant material is slightly moistened before being exposed to microwave irradiation. The essential oils obtained through this method are collected and stored in dry conditions at 4 °C and protected from light. Operating parameters such as microwave power, temperature, and extraction duration are easily regulated through the instrument's control system.

BIOLOGICAL ACTIVITIES OF LEMONGRASS (CYMBOPOGON CITRATUS):

The essential oil of *Cymbopogon citratus* exhibits a wide range of biological activities:

Antimicrobial effects: antibacterial activity against *Bacillus subtilis* and *Staphylococcus aureus*, antifungal activity against dermatophytes, and antimycobacterial activity against *Mycobacterium smegmatis*.

Antiprotozoal and antiparasitic activities: anti-amoebic activity against *Entamoeba histolytica*, antimalarial effects against *Plasmodium berghei*, antifilarial action on *Setaria digitata*, antiprotozoan effects on *Crithidia deanei*, and ascaricidal activity. Gastrointestinal effects: antidiarrheal activity, reducing fecal output.

Anti-inflammatory and analgesic effects: reduces carrageenin-induced edema and exhibits antinociceptive properties.

Metabolic effects: hypocholesterolemic, hypoglycemic, and hypolipidemic activities.

Antioxidant and antimutagenic activity: scavenges free radicals and shows protective effects against mutagens.

Larvicidal activity: effective against insect larvae.

Neurobehavioral effects: increases sleeping time and shows anticonvulsant activity.

USES AND APPLICATIONS OF LEMONGRASS OIL:

Lemongrass oil is valued for its wide-ranging applications, owing to its therapeutic properties such as antifungal, antimicrobial, anti-inflammatory, and analgesic effects. Traditionally, it has been used to manage ailments including digestive disorders, muscle pain, and respiratory problems.

Cosmetics: In the cosmetic industry, lemongrass oil is incorporated into soaps, deodorants, and massage products, where it helps improve blood circulation and tone muscles.

Pharmaceutical and therapeutics: In pharmaceuticals, it is applied for treating infections, digestive issues, coughs, and fevers due to its medicinal properties.

Foods and Drinks: The food and beverage industry utilizes lemongrass oil as a natural flavoring agent and preservative, preventing microbial spoilage.

Industrial uses: Additionally, it finds applications in industrial products such as fragrances in deodorants, candles, and insect repellents.

Agriculture uses: In agriculture, lemongrass oil is employed for its germicidal and insecticidal properties, making it an effective natural option for pest control.

RESULT:

Lemongrass (*Cymbopogon citratus*) is a medicinal herb known for its high content of essential oils, particularly citral, which contribute to its antibacterial, antifungal, antioxidant, and anti-inflammatory activities. Traditionally, it has been used to manage fever, infections, digestive problems, stress, and to support wound healing. The plant is rich in bioactive compounds such as flavonoids and triterpenoids, making it valuable in Ayurvedic and herbal medicine. Additionally, lemongrass finds applications in cosmetics and pharmaceuticals, with its essential oils being extracted using a variety of techniques.

CONCLUSION:

Cymbopogon species is an aromatic grass containing a wide range of bioactive compounds with therapeutic potential, already utilized in cosmetics and perfumery. Its essential oil has the potential to enhance herbal medicine, particularly in the prevention of oral and respiratory infections. *Cymbopogon citratus* is rich in flavonoids and phenolic compounds, which contribute to strong antioxidant activity, as well as antifungal, antimicrobial, antinociceptive, and cardioprotective effects. Due to its commercial value and importance in traditional medicine, further phytochemical and pharmacological studies are essential to uncover new therapeutic applications and expand the clinical use of lemongrass.

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