

Scientific basis for the therapeutic use of *Cymbopogon citratus*, Stapf (Lemon grass)

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J. Adv. Pharm. Tech. Res.

ABSTRACT

Cymbopogon citratus, Stapf (Lemon grass) is a widely used herb in tropical countries, especially in Southeast Asia. The essential oil of the plant is used in aromatherapy. The compounds identified in *Cymbopogon citratus* are mainly terpenes, alcohols, ketones, aldehyde and esters. Some of the reported phytoconstituents are essential oils that contain Citral α , Citral β , Nerol Geraniol, Citronellal, Terpinolene, Geranyl acetate, Myrcene and Terpinol Methylheptenone. The plant also contains reported phytoconstituents such as flavonoids and phenolic compounds, which consist of luteolin, isoorientin 2'-O-rhamnoside, quercetin, kaempferol and apiginin. Studies indicate that *Cymbopogon citratus* possesses various pharmacological activities such as anti-amoebic, antibacterial, antidiarrheal, antiliferal, antifungal and anti-inflammatory properties. Various other effects like antimalarial, antimutagenicity, antimycobacterial, antioxidants, hypoglycemic and neurobehaviorial have also been studied. These results are very encouraging and indicate that this herb should be studied more extensively to confirm these results and reveal other potential therapeutic effects.

Key words: *Cymbopogon citratus*, essential oil, flavonoids, phytoconstituents

INTRODUCTION

Cymbopogon is a genus of about 55 species, which are indigenous in tropical and semi-tropical areas of Asia and are cultivated in South and Central America, Africa and other tropical countries. These are tufted perennial C₄ grasses with numerous stiff stems arising from a short, rhizomatous rootstock,^[1-2] as with citrus flavor, and can be dried and powdered or used fresh. The name *Cymbopogon* is derived from the Greek words "kymbe" (boat) and "pogon" (beard), referring to the flower spike arrangement.^[3]

Cymbopogon citratus, Stapf (Lemon grass) is commonly used

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Access this article online

Quick Response Code:



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DOI:

10.4103/2231-4040.79796

in teas, soups and curries. It is also suitable for poultry, fish and seafood.

ETHNOPHARMACOLOGY

Cymbopogon citratus is used in various countries for various purposes, which are summarized in Table 1.

TAXONOMICAL CLASSIFICATION

Kingdom: Plantae
Division: Magnoliophyta
Class: Liliopsida
Order: Poales
Family: Poaceae
Genus: *Cymbopogon* Spreng
Species: *citratus*

COMMON NAMES

Brazil: Capim-cidrao, Capim-santo
Egypt: Lemon grass
English: Lemongrass, Citronella, Squinant
Ethiopia: Tej-sar
Hindi: Sera, Verveine
Indonesian: Sereh
Italian: Cimbopogone

Malaysia: Sakumau
Mexico: Zacate limon
Swedish: Citrongrass
Thailand: Ta-khrai
Turkish: Limon out
USA: Citronella

PARTS USED

Leaves and whole plant.

SYNONYM(S)

Lemon grass stalk, *Andropogon citratus*.

BOTANICAL DESCRIPTION

Lemongrass is equally versatile in the garden. This tropical

Table 1: Ethnopharmacology of *Cymbopogon citratus*

Country	Uses	References
Argentina	Decoction of leaf is taken orally with "mate" tea for sore throat, empacho and as an emetic	[4]
Brazil	The tea made from its leaves is popularly used as antispasmodic, analgesic anti-inflammatory, antipyretic, diuretic and sedative	[5–6]
Cuba	Hot water extract of the dried leaves is taken orally as a hypotensive for catarrh and rheumatism	[7]
Egypt	Hot water extract of the dried leaves and stem is taken orally as a renal antispasmodic and diuretic	[8]
India	Fresh entire plant is said to repel snakes. Two to three drops of essential oil in hot water are taken orally for gastric troubles. For cholera, a few drops of oil with lemon juice are taken orally. Hot water extract of the dried leaves is used for bathing in cases of severe headache and fever. A tea prepared from lemon grass is used as a sedative for the central nervous system	[9–11]
Indonesia	Hot water extract of the entire plant is taken orally as an emmenagogue	[12]
Malaysia	Hot water extract of the entire plant is taken orally as an emmenagogue	[13]
Thailand	Fresh entire plant is inhaled as a fragrance and eaten as a condiment. ^[14] Hot water extract of the dried entire plant is taken orally as a stomachic. ^[15] Hot water extract of the dried root is taken orally for diabetes	[14–16]
USA	Hot water extract of the entire plant is used externally by Laotian Hmong in Minnesota for healing wounds and bone fractures	[17]

grass grows in dense clumps that can grow to 6 ft (1.8 m) in height and about 4 ft (1.2 m) in width, with a short rhizome.^[18] Table 2 shows the morphological description of *Cymbopogon citratus*.

PHYTOCHEMISTRY

The chemical composition of the essential oil of *Cymbopogon citratus* varies according to the geographical origin, the compounds as hydrocarbon terpenes, alcohols, ketones, esters and mainly aldehydes have constantly been registered.^[20,21] The essential oil (0.2–0.5%, West Indian lemon grass oil) consists of, mainly, citral.^[22] Citral is a mixture of two stereoisomeric monoterpenes aldehydes; the trans isomer geranial (40–62%) dominates over the cis isomer neral (25–38%),^[23,24] as shown in Table 3. Chemical structure of the major constituents of lemongrass essential oil [Figure 1].^[29]

Triterpenoids

Isolated and identified new triterpenoids from leaf wax are cymbopogone and cymbopogonol [Figure 2].^[30]

	R	R ¹
(1) Cymbopogone	$\beta\text{-CH}_3$, H	R ¹ = O
(2) Cymbopogonol	CH ₂	$\beta\text{-OH}$, H

Table 2: Morphological description of *Cymbopogon citrates*

Part	Description	References
Leaves	The strap-like leaves are 0.5–1 in (1.3–2.5 cm) wide, about 3 ft (0.9 m) long and have gracefully drooping tips. The evergreen leaves are bright bluish-green and release a citrus aroma when crushed Leaf arrangement: most emerge from the soil, usually without a stem Leaf type: simple Leaf margin: entire Leaf shape: linear Leaf venation: parallel Leaf type and persistence: fragrant Leaf blade length: 18–36 in Leaf color: green Fall characteristic: showy	
Flowers	The lemongrasses plants that you are likely to encounter are cultivars and do not typically produce flowers, or flowering panicles are rarely formed	
Inflorescence	Inflorescences are 30–60-cm-long and nodding, the partial inflorescences are paired racemes of spikelets subtended by spathes	[19]

Flavonoids and Phenolic Compounds

Lemongrass consists of luteolin and its 6-C and 7-O-glycosides,^[31] isoorientin 2'-O-rhamnoside^[32] and isolation of the flavonoids quercetin, kaempferol and apiginin^[33] from the aerial parts. The phenolic compounds elimicin, catecol, chlorogenic acid, caffeic acid and hydroquinone are also isolated from the plant.^[34]

PHARMACOLOGY

Although a lot of pharmacological investigations have been carried out based on the ingredients present, but a lot more can still be explored, exploited and utilized. A summary of the findings of these studies is presented below.

Anti-amebic Effect

The essential oil in broth culture was active on *Entamoeba histolytica*.^[35]

Antibacterial Activity

The chromatographic fraction of the essential oil in agar plate was active on *Bacillus subtilis*, *Escherichia coli*, *Staphylococcus aureus*^[36-37] and *Salmonella paratyphi* and *Shigella flexneri*.^[38] These activities are shown in two of the three main components of the oil identified through chromatographic and mass spectrometric methods. While the α -citral (geraniol) and β -citral (neral) components individually elicit an antibacterial action on gram-negative and gram-positive organisms, the third component, myrcene, did not show any observable antibacterial activity on its own.^[36] The extract was also active when the volatile oil extract was oxidized via the active oxygen method.^[39-42]

Antidiarrheal Activity

Cymbopogon citratus stalk decoction reduced the fecal output in a dose-dependent manner.^[43]

Antifilarial Activity

Fresh leaves were active on *Setaria digitata*.^[44]

Antifungal Activity

Lemon grass oil is active against such dermatophytes such as *Trichophyton mentagrophytes*, *T. rubrum*, *Epidermophyton floccosum* and *Microsporium gypseum*,^[45] and is among the most active agents against human dermatophytes. Other studies reported that lemon grass oil is active against keratinophilic fungi, 32 ringworm fungi^[46-47] and food storage fungi.^[48] Lemongrass oil is also effective as a herbicide and as an insecticide because of these naturally occurring antimicrobial effects.

Anti-inflammatory Activity

The hot water extract of the dried leaves administered intragastrically to rats was active when compared with carrageenin-induced pedal edema.^[7]

Table 3: Composition of essential oil in *Cymbopogon citratus*^[25-28]

Essential oil composition	Percentage of components
Citral α	40.8
Citral β	32
Nerol	4.18
Geraniol	3.04
Citronellal	2.10
Terpinolene	1.23
Geranyl acetate	0.83
Myrcene	0.72
Terpinol	0.45
Methylheptenone	0.2
Borneol	0.1–0.4
Linalyl acetate	0.1
α Pinene	0.07
β Pinene	0.04
Limonene	Traces
Linalool	Traces
β -caryophyllene	Traces

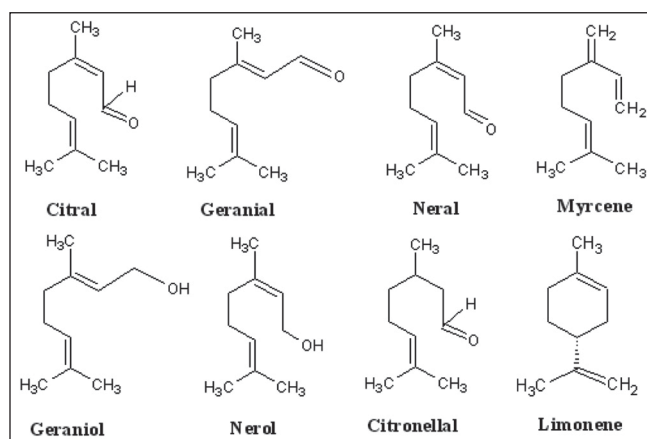


Figure 1: Chemical structure of the major constituents of lemongrass essential oil

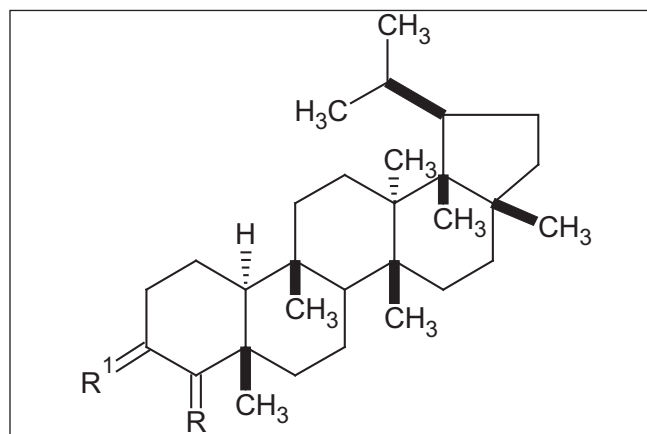


Figure 2: Chemical structure of cymbopogone and cymbopogonol

Antimalarial Activity

The essential oils of *Cymbopogon citratus* were found to produce 86.6% suppression in the growth of *Plasmodium*

berghei when compared with chloroquine (taking inhibition by chloroquine as 100%).^[49]

Antimutagenicity

The ethanolic extract of lemon grass extract exhibits an antimutagenic activity in various models^[50-52] and retards the growth of fibrosarcoma cells transplanted in mice in association with the prevention of lung metastasis.^[53] The plant extract is known to show inhibition on the formation of azoxymethane-induced DNA adducts and aberrant crypt foci in the rat colon.^[54] Inhibitory effects of the plant extract on the early phase of hepatocarcinogenesis after initiation with diethylnitrosamine were seen in 344 male Fischer rats.^[55]

Antimycobacterial Activity

The essential oil in agar plate was active on *Mycobacterium smegaris*.^[56]

Antinociceptive Effect

The essential oil of *Cymbopogon citratus* possesses a significant antinociceptive activity. Comparing the results obtained with three different experimental models of nociception (hot-plate, acetic acid-induced writhings and formalin test), we can speculate that the essential oil acts both at the peripheral and at the central levels.^[57]

Antiprotozoan Activity

A dose-dependent antiprotozoan effect of the essential oil of *Cymbopogon citratus* could be observed on two strains of *Crithida deanei*.^[58]

Ascaricidal Activity

The fresh leaf essential oil has an ascaricidal activity.^[59]

Free Radical Scavengers and Antioxidant Effects

Methanol, MeOH/water extracts, infusion and decoction of *Cymbopogon citratus* were shown to have free radical scavenging effects by measuring the bleaching of the 1, 1-diphenyl-2-picryl-hydrazyl (DPPH) radical, scavenging of the superoxide anion and inhibition of the enzyme xanthine oxidase and lipid peroxidation in human erythrocytes.^[60]

Hypocholesterolemic Effect

The elevated cholesterol concentration was significantly lowered in the animals given the plant extract. This reduction was found to be dose dependent. This result shows that the extract possesses a hypocholesterolemic potential.^[61]

Hypoglycemic and Hypolipidemic Effects

A fresh leaf aqueous extract of *Cymbopogon citratus* administered in normal rats lowered the fasting plasma glucose and total cholesterol, triglycerides, low-density lipoproteins and very low-density lipoprotein dose dependently while raising the plasma high-density

lipoprotein level in the same dose-related fashion, but with no effect on the plasma triglyceride levels.^[62]

Larvicidal Activity

The fresh leaf essential oil has a larvicidal activity.^[63]

Neurobehavioral Effect

The essential oil was evaluated for sedative/hypnotic activity through pentobarbital sleeping time, anxiolytic activity by elevated plus maze and light/dark box procedures and anticonvulsant activity through seizures induced by pentylenetetrazole and maximal electroshock. The essential oil was effective in increasing the sleeping time, the percentage of entries and time spent in the open arms of the elevated plus maze as well as the time spent in the light compartment of the light/dark box. In addition, the essential oil delayed clonic seizures induced by pentylenetetrazole and blocked the tonic extensions induced by maximal electroshock, indicating the elevation of the seizure threshold and/or blockage of the seizure spread.^[64]

MARKETED FORMULATION OF THE HERB

Lemongrass Essential Oil

As a vaporizer, the oil works as an effective panacea against bacteria, flu and colds. It has stimulating agent, tonics, aromas, diuretic and antispasmodic, and so on. People suffering from urine problems can apply lemon grass oils. In hot weather, this is the best oil to cool down the body temperature and to revive the mind and soul. In other health benefits, this is used to improve digestion, nausea and menstruation problems and ailments like headaches, muscle cramps, spasms and rheumatisms.

CONCLUDING REMARKS AND FUTURE POTENTIAL

Cymbopogon citratus is native to Sri Lanka and South India, and is now widely cultivated in the tropical areas of America and Asia. The plant is used as a fragrance and flavoring agent and in folk medicine as an antispasmodic, hypotensive, anticonvulsant, analgesic, antiemetic, antitussive, antirheumatic, antiseptic and treatment for nervous and gastrointestinal disorders and fevers. The plant is also used as an antibacterial, antidiarrheal and antioxidant, but the mode of action for the different bioactivities has not been studied in detail. *Cymbopogon citratus* contains various phytoconstituents such as flavonoids and phenolic compounds, terpenoids and essential oils, which may be responsible for the different biological activities. Hence, we can isolate some pure phytopharmaceuticals, which in turn can be used as lead molecules for synthesizing the novel agents having good therapeutic activity. With regard to the development of quality herbal medicine standardization of the extracts, phytopharmacology of different extracts, isolation and characterization of active

phytopharmaceuticals, elucidation of the mechanism of action of the isolated compounds and clinical trials of the compounds are much needed. In the changing global scenario, the interest toward plants with medicinal value is increasing substantially in the primary healthcare system both in the developed and in the developing countries. Therefore, the information will help scientists and researchers to screen the compounds responsible for different bioactivities and to elucidate the molecular mechanism of action.

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How to cite this article: Shah G, Shri R, Panchal V, Sharma N, Singh B, Mann AS. Scientific basis for the therapeutic use of *Cymbopogon citratus*, stapf (Lemon grass). *J Adv Pharm Tech Res* 2011;2:3-8.

Source of Support: Nil, **Conflict of Interest:** Nil.