

Review Article

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A Review on Antifungal and Anti-Inflammatory Activity of Lemongrass Essential oil

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ABSTRACT

Lemongrass Essential Oil (LGEO) is a volatile oil obtained from Cymbopogon Citratus. Belonging to family Poaceae. Found in tropical countries, especially in South East Asia. Various constituents reported in Lemongrass essential oil are mainly citral, geraniol, limonene, borneol, nerol, geranyl acetate, myrecene and terpinolene etc. These have different pharmacological spectra against many disease that is antiamoebic, antibacterial, anti-diarrhoeal anti-fungal and anti-inflammatory etc. Antifungal activity of Lemongrass essential oil reported against various type of invaders (microorganism) yeast and filamentous fungi like Candida Albicans, C. Tropicalis and Aspergillus Niger. Action of Anti-candida observe in the vapour phase. These are active against post-harvest pathogens like Colletotrichum Coccodes, Botrytis Cinerea, Cladosporium Herbarum, Rhizopus Stolonifer and A. Niger. Lemongrass essential oil inhibits the skin inflammatory response.

Keywords: Lemongrass; Essential oil; Antifungal activity; Anti-inflammatory activity

Introduction

Essential oils are mainly utilized in the industries of cosmetics and food industries, and mostly of them are used for medicinal purpose as traditional medicine and modern medicines. Essential oil possess many pharmacological activity like antibacterial, antifungal, antiinflammatory, insecticidal and antimicrobial properties [1]. Essential oil show potent antimicrobial activity so it is used as skin infection in special, superficial mycoses [2]. *Cymbopogon* have approximately 55 species, these are herbaceous plant known as lemon grass, *Cymbopogon Citratus* family *Poaceae*, found in tropical and semitropical areas of Asian and American countries, and also cultivated in other tropical countries. *Cymbopogon Citratus* worthy for poultry farming [3].

C. Citratus Pharmacologically active as analgesic, anti-inflammatory, anti-pyretic, diuretic, sedative etc. [2]. Cymbopogon extract from fresh as well as dried leaves, are mostly used as cosmetic preparations, soaps, toiletries and detergents [2,4,5]. It also use as mosquito repellent [2,6,7,8]. Anti-fungal treatment is limited due to the costly medication and current less medicated spectrum, due to these reasons prolong therapy is required. So the alteration of treatment and novel drug medication is required, including natural product [2].

Approximately 65%-85% monoterpenes and citral is the major components of lemongrassessential oil, citral (3, 7-dimethyl-2, 6-octadienal) two isomeric a cyclic monoterpene aldehydes: Gerania (trans-citral, citral A) and neral (cis-citral, citra B) **Figure 1**. Lemongrass essential oil also consist of geraniol, geranylacetate and monoterpene olefins, that is myrecene [2].



Figure 1: Chemical structure of the citral.

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Literature Review

Essential oil extraction

Solvent extraction method: Essential oil obtained from dried as well as fresh leaves of Lemon grass. The percentage of essential oil from dried leaves are maximum rather than fresh leaves, fresh leaves are collected and dried at room temperature approximately 4 days. Then packed in a plastic container (sealed) at room temperature and protect from sun light. Then reduce the particle size and then soaked the plant material for 30 minutes with distilled water before extraction procedure. Then filter the plant material in to the flask and mix N-Hexane.

Assembly to stand for 36 hours. After 36 hours the extract transfer in to another beaker and follow the decanted process. Then ethanol added in to the extract till essential oil complete soluble in ethanol. Then the ethanolic extract transfer in to separating funnel and separate the mixture by liquid/liquid separation process. The lower layer have ethanol layer and upper layer have Hexane layer. They both are collected in to separate beaker. The ethanol beaker put on the water bath at 78°C till remove the ethanol and collect the only natural essential oil. The percentage yield of oil calculated by weighing the extract on an electronic weigh balance.

Weight of Essential oil=weight of extract Beaker-weight of empty beaker [9].

Steam distillation method

Take fresh lemongrass with distilled water and poured in to the RBF, start assembly refluxing at 100°C. Steam pass at low pressure and collect the vapor with volatile components. Then pass the components through refrigerated serpentine. Which are separated by using florentine flask, separate and collect the essential oil and hydrosol of lemongrass. Lemongrass essential oil dried with sodium sulphate and stored in a closed container under controlled temperature. After this procedure essential oil and hydrosol produce, which are used as anti-inflammatory and anti-microbial [10-12]. Calculate the percentage yield by weight of oil and weight of lemon grass quantity which taken.

Chemical Composition

Lemon grass essential oil has lemony fragrance, light yellow in color. Lemon grass produces terpenoidal hydrocarbons and essential oils. Approximately 23 chemical constituents present in lemongrass essential oil revealed after the analysis of GC-MS. That 23 compounds represent 90.6% of the total quantity of oil. The main components are geranial (42.2%), neral (31.5%), and b-myrcene (7.5%), Geranyl acetate (4.3%) and isopulegol (1.4%). Andother different compounds present in essential oil are show in **Table 1**.

Citral (3,7-dimethyl-2,6-octadienal) have both isomer cis and trans, cis-isomer geranial and the trans-isomer neral. Both are oxygenated monoterpenes, contain approximately 73.3% of total lemongrass essential oil. In LGEO the maximum quantity of oxygenated mono-terpenes, and minimum quantity of mono-terpenes hydrocarbons (9.54%), sesquiterpene hydrocarbons (0.79%), and oxygenated sesquiterpenes (0.33%) [13].

LGEO of African species constitute the maximum quantity of myrcene. The chemical component of lemongrass, extracted from different variety of lemongrass (*Cymbopogon flexuosus, Cymbopogon pendulus*) [14]. For cosmetics and medicinal preparation, many companies and distributers grow the clone of citral rich *Cymbopogon* variety.

Two species of aromatic plant on the basis of their chemical composition [15]. The East Indigenous with maximum quantity of myrcene (38%) and low citral (7%) and west Indian type with little bit quantity or no amount of myrcene (0%-12%) and high amount of citral up to (86%). LGEO have highly rich by citral content, citral use for the production of Ionone, vitamin-A, and β -caroteneas a raw material [9]. **Figure 2.** Difference in the range of chemical composition depends on the geographical and climatic location, as well as on the time of harvest, age and variety of the plant and also depend on the extraction method [16].



Figure 2: Different chemical compositions.

Pharmacology

LGEO possess may pharmacological activity like anti-bacterial, anti-fungal, stomachic toothache. Hence many studies have been published as anti-inflammatory activity and fungal infections. The organic or aqueous extract of lemongrass, either on human monocytes *in vitro* or on rodents *in vivo* [17,18].

In Asian and Affrican countries, essential oil of Lemongrass used as anti-septic, antitussive, anti-rheumatic and also used as backache, sprains, and heamoptysis. In some affrican countries, It also used as antidiabetic.

Clinical study on rats of citral, itis the main component of lemongrass.

Table 1. Chemical constituents of LGEO (Cymbopogon citratus) extracted by steam distillation.

Constituents ^a	RI ^b	Percentage
β-Myrcene	988	7.45
Limonene	1030	0.02
α-Ocimene	1043	0.45
β-Ocimene	1048	0.32
Terpinolene	1120	1.3
Citronellal	1167	0.29
Neral	1268	31.52
Geranial	1284	42.16
Caryophellene	1421	0.23
Rans-Bergamotene	1439	0.25
α-Humulene	1450	0.04
α-Farnesene	1459	0.05
β-Farnesene	1508	0.15
β-Bisabolene	1511	0.03
d-Cadinene	1527	0.04
Carvacrol	1298	0.23
Caryophellene oxide	1578	0.1
Isopulegol	1168	1.39
2-Undecanone	1294	0.05
Geranylformate	1303	0.07
Neryl acetate	1351	0.07
Geranyl acetate	1366	4.3
GeranylN-butyrate	1559	0.04
Total identified	-	90.55
Monoterpene hydrocarbons	-	9.54
Oxygenated monoterpenes	-	73.97
Sesquiterpene hydrocarbons	-	0.79
Oxygenated sesquiterpenes	-	0.33
Other oxygenated compounds	-	5.92
^a Compounds are listed in order of elution from an HP-5MS column not present.		
^b RI (retention index) calculated on the HP-5MS column relative to C_8 - C_{24} n-alkanes.		

Pharmacology

Essentialoil is used as cutaneous infection, spasmodic and toothache. Many study data explaining the anti-inflammatory activity of the organic or aqueous extract of LGEO have been published. *In vitro* studies on human monocytes or *In vivo* studies on animals [17,18].

In Affrican and Asian countries, LGEO is used as anti-septic, anti-tussive, anti-malarial, anti-inflammatory, anti-rheumatic, pain-killer, sprains and hemoptysis also. It used as alternative medicine of sedative. It is also used as in the treatment of diabetes in African countries [15]. Essential oil when citral combined with NSAIDs Naproxen through oral administration, combination of Naproxen citral show anti-inflammatory effect but with less side effect as compare to naproxen alone [17]. Various studies over the years provide more information

about the chemical and ontological spectrum of LGEO. There are very few studies on the antifungal and anti-inflammatory activity of LGEO [9].

Anti-Fungal Activity

Skin infection (fungal infection) is a normal disease in humans, and can also be caused by dermato-phytic fungi and yeast. Superficial candidiasis caused by *candida albicans*. This infection is common in mouth, skin, oesophagus, oral cavity, and vagina, mostly these infection can present in different immune suppressed patient [9]. And some time other member of candida species effect skin, nails or mucus membrane [20-23].

Vaginal yeast infection (*vulvovaginal candidiasis, candida albicans* affects 85%-95% of women and C. Glabrata affect (10%-20%) [22]. *C. Krusie* and *C. tropicalis* also affect the *Vulvovaginal candidiasis* [24,25].

Different research of LGEO describe the antimicrobial activity is completely depend on its composition [26]. As well as antifungal activity mostly depend on the presence of geranial and neral (Monoterpenic aldehydes). Many different grass essential oil those loaded of such oxygenated compound have already discover affective as antifungal activity [2,6,8].

The most active component of LGEO are monoterpenic aldehyde (Citral and Geranial) possess anti microbial activity against gramnegative and gram positive bacteria and fungi. Although it is very challenging to particulate the antifungal compounds from the complex mixture of essential oil. Some researchers indicate the potent inhibitory spectrum of LGEO against Candida species, they indicate the synergism with mono terpenes and other important compounds, that present in LGEO for example, terpinene, cymene and linalool [7,27,28].

The study explain the essential oil of lemon grass significantly decrease the growth of pathogenic yeast of *C. Albicans*, so he guide the potential value of the medication of skin disease (*Cutaneous Candidiasis*) from lemon grass essential oil [27]. Vapor of lemon grass essential oils show the potent inhibition on *C. Albicans*, by change the morphological and fungal cell structure and changes in cell surface morphology such alteration in morphological and fungal cell surface changes reduce the infections [2,7,29]. LGEO active against post harvest pathogens, so it use in the treatment for various plant disease against many pathogens and toxin.

C. Citratus possess potent antifungal activity by inhibit the growth of 47 fungal species, because it possess inhibit and decrease the growth of various fungal species so it have considered for the preservation of food crops [30]. Fungicide like agrosen GN, Dithane M-43, and Copper oxychloride inferior than LGEO [30,31].

Culture PDA medium with LGEO decrease the growth of different fungal species like *Cladosporium Herbarum* (up to 18%) at 100 PPM, *Botrytis Cinerea* (up to 33%) and *Rhizopus Stolonifer* (up to 16%) at 25 PPM where as the 500 PPM concentration of oil complete inhibition (100%) of fungal colonal species.

This concentration of *Cladosporium Herbarum* and *Rhizopus Stolonifer* after 10 days of inoculation whereas the 500 PPM, colony developed at 8 days after inoculation, and growth inhibit up to 60%, 10 days of inoculation [32].

Aspergillus Nigerspecies in liquid culture media at 1000 PPM 91% growth inhibit reported by LGEO. It also decrease the 90% and 100% growth of *Fusarium Verticilloides* in PDA medium at 500 PPM and 1000 PPM respectively [30].

When essential oil of lemongrass added with culture medium, that not active against *F. verticilloides* [30]. Oregano, thyme, lemon grass and cilantro vapours (500 rpm-1000 rpm) inhibit the proper growth of *Botrytis Cinerea* and *Alternaria Arborescens* through *in vitro* studies and as compare to thyme or oregano oils vapours, LGEO vapours more sensitive on *Geotrichum Candidum* [33].

So on the basis of above all data we can use the LGEO for ideal treatment of plants disease (fungal spreading) by the use of essential oil. Recently, the extract and essential oils of many aromatic plants possess antimicrobial activity to so they have use to control and decrease the growth of pathogens/toxins that produces micro-organism in foods [34].

Anti-Inflammatory Activity

The extract of hot water of dried leaves of lemon grass essential oil induced intragastric manner in to rats, active when it compare with carrageenan-induced pedel edema[35]. LGEO prevent the level of many inflammatory and tissue remodelling, including VCAM-1, IP-10, I-TAC, MIG, collagen-I and III, EGFR, M-CSF and PAI. LGEO prove the potent and different effect on genome-wide gene expression analysis. Different type of genes and pathways contribute in inflammation, those promote the anti-inflammatory activity of lemon grass essential oil. It shows the potent action as treatment of skin inflammation [36].

Because citral is the main component of LGEO and it inhibit the Gramnegative and Grampositive bacteria, it does not cause resistance after prolonged used also [37,38]. It has high affective against *Staphylococcal* infection[38].

In the study of *Staphylococcal aureus* model air pouch [39], the essential oil showed a positive response in reducing inflammation. Like ginger oil, lemongrass, mint, pepper and raspberry have bactericidal properties against *S. aureus* [40]. Because antibiotics cause resistance, it should be known in this study that the essential oil reduces antibiotic resistance or other *S. Aureus* composition and subinhibitory concentrations, and it stops the biofilm binding of microorganisms [41]. Thus, it is true that essential oil enhances and enhances

the action of antibiotics for various molecular purposes and is more active against invaders where traditional therapies resist [42]. Many studies believe that the essential oil consists of various types of substances or components that penetrate the cell wall of bacteria that contain lipids and inhibit the penetration of the necessary material that helps the bacteria to grow [43]. During the time of inflammation, many mononuclear cells and polymorphonuclear leucocytes assimilate to the infected site and may start the inflammation [44].

During the study time [39] essential oil reported positive response to decrease the infected organism. In this study there are four groups, S, C, CT and S+CT group. Compare between S with S+CT, S=*Staphylococcal Aureus*S+CT=*S. Aureus*+Essential oils.

Cytokine play an important role on the infected site, TNF- α , IL-1 β , and IL-6 are used as dosage. After 4-8 hours, treated group (S+CT) show the reducing level of IL-6 and TNF- α . IL-1 β ratio reduced in group S and S+CT within 4 hours. So the difference is cleared between infected and treated group. So this study define the reduction level of all three cytokines after the treatment of essential oil. Thus, it has reported the antiinflammatory activity of essential oil, It mainly inhibit the TNF- α to reduced the inflammation.

Raw 264.7 cells stimulate the Lipopolysaccharide (LPS) production, so essential oil inhibition increase in TNF- α by increase the level of LPS [45]. Some study says, In a lungs injured mice, treated with citral by increase the level of LPS inhibit TNF- α , IL-1 and IL-6 levels *in vivo* and *in vitro* [46]. An alcoholic extract of lemon grass by the stimulation of LPS, decrease the level of TNF- α in bronchoalveolar macrophage, increase the inflammatory response and modulation of COX-2 and TNF- α [47].

Citral may interfere in gene expression with the stimulation of LPS, it inhibit the phosphorylation with Inhibitory Proteins (Ik β), and also block the translocation of P50 and P65 sub-units of NF-kB, and leading to the low expression of nitric oxide synthase inducing enzyme [48].

Conclusion

Cymbopogon citrates cultivated as, Asian, Affrican and other tropical areas of America. Essential oil is used as fragrance and flavouring agent in cosmetic and perfumery industry. In traditional medicine it is used as anti-fungal, anti-inflammatory, antiseptic, antispasmodic, antibacterial, analgesic, antitussive, anti-rheumatic, hypotensive, anticonvulsant etc. It used as post harvest pathogens for various disease in plants and possess the antimicrobial activity so it contribute as food preservation. It show potent anti-inflammatory activity against *Staphylococcal aureus*. It showvast chemical spectrum such as flavonoids, phenolic compounds, terpenoids, essential oil and hydrosol all above show the diverse biological action. Citral and Myrecene are the main components of lemon grass essential oil. Where the antibiotics cause resist, citral are used for enhance the activity and reduce resistance. Instead of traditional medicine, essential oils are preferred. The development of traditional medicine requires standardized API extracts (plant materials), isolation and characterization of compound analysis, and clinical trials. The isolated lead compound used for the synthesis of new compounds has advanced therapeutic activity.

All developed and developing countries global scenario have change, more interest with the traditional, and enhance the primary health care system.

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