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The Science Behind Cymbopogon citratus: A Detailed Review

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ABSTRACT

Cymbopogon citratus, commonly designated as lemongrass, constitutes an herbaceous plant categorized within the Gramineae family. This designation of "lemon" arises from its distinctive lemon-like aroma, which is attributable to the presence of citral, a cyclic monoterpene. Indigenous tall-flowering aromatic species within the Poaceae family, commonly referred to as lemongrass, are cultivated across a variety of regions in both tropical and subtropical climates throughout Africa and Southeast Asia. In the Indian subcontinent, Cymbopogon citratus is represented by several varieties that are cultivated in warm, temperate, and humid environments at altitudes not exceeding 750 meters above sea level. Optimal growth conditions are characterized by annual temperatures ranging from 23°C to 30°C, alongside an annual precipitation of approximately 2500-3000 millimeters, which facilitates the ideal development of Cymbopogon citratus. As an herb, lemongrass is employed for its leaves and essential oil in the management of various medical conditions, including bowel spasms, chest pain, hypertension, epilepsy, dysentery, respiratory infections, rheumatism, influenza, common colds, and fatigue in traditional medicinal practices. The chemical composition of the essential oils serves as a distinctive biomarker for the plant, akin to unique fingerprints, as it mirrors the physiological state of the organism. The present review elucidates the comprehensive characteristics and applications of Cymbopogon citratus. The extracted oil is regarded as appropriate for incorporation into soaps, fragrances, and cleaning agents. Furthermore, it encompasses a multitude of therapeutic applications. Lemongrass is acknowledged to possess a wide spectrum of ethnopharmacological uses. In addition to being an abundant source of essential nutrients, such as lipids, proteins, dietary fibers, and minerals, lemongrass also harbors bioactive compounds that can be classified into terpenoids, tannins, saponins, flavonoids, and phenolic entities.

Keywords:- lemongrass, citral, spasms, hypertension, ethnopharmacological

1. INTRODUCTION

Cymbopogon citratus, widely recognized as lemongrass, constitutes an aromatic perennial sedge predominantly cultivated across numerous tropical and subtropical regions of Southeast Asia and Africa. This species is particularly prevalent in the Indian states of Karnataka, Tamil Nadu, and the Western Ghats, encompassing Maharashtra and Kerala, in addition to the foothills of Sikkim and Arunachal Pradesh within the Indian subcontinent. The discovery of this species in India occurred over a century ago, and it has since achieved widespread utilization throughout the region. Lemongrass is characterized as a robust and elevated sedge, producing a compact rhizome that is densely clustered in thick bundles. The aerial portion of the plant exhibits an upright and vigorous growth form, reaching heights of up to 1.8 meters. The leaf blades are elongated, displaying a grass-green coloration, and are flat with margins oriented both upwards and laterally; the ligule is relatively diminutive, while the sheaths are slender and rounded; the basal sheaths are broader and fit closely, whereas the sheaths associated with the non-flowering shoots are sturdy and distinctly separated. This species is esteemed as a significant flowering plant that thrives under short-day conditions typical of Southern India. The inflorescence manifests as a spike capable of extending to approximately one meter in length. The flowers are produced on decompound spathulate panicles that exhibit lengths ranging from 30 to over 60 centimeters.

The genus Cymbopogon, often known as lemongrass, includes over 50 native grass species from tropical Asia and Southern India. Ornamental Cymbopogon citratus (lemongrass) is the most recognized cultivated species, widely utilized in Vietnamese, Cambodian, and Thai culinary practices. The herb with a lemon scent enriches the taste profile of curries, soups, teas, and different drinks. Aside from its culinary uses, lemongrass oil is utilized in diverse areas such as Ayurvedic medicine, aromatherapy, cosmetics, and the perfume industry. A key feature of lemongrass is its high citrus content in the oil, giving it a strong lemon aroma.

The olfactory properties of the oil facilitate its incorporation into soaps, detergents, and other consumer products. Additionally, the unprocessed material utilized in the synthesis of ionone, which is subsequently used in the formulation of vitamin A, is derived from lemongrass[3]. This plant encompasses multiple bioactive compounds that confer medicinal properties. Substantial evidence exists regarding its ethnopharmacological applications. According to the World Health Organization (WHO), herbal medicine is recognized as a vital component of the healthcare sector by over 66% of the population in developing nations[4]. Asthma is characterized as a persistent inflammatory condition, marked by airway hyperresponsiveness to various stimuli, predominantly of allergic origin, accompanied by reversible airflow obstruction. The most significant clinical manifestations of asthma include wheezing, dyspnea, and coughing; these symptoms may exacerbate during nocturnal hours, leading to disruptions in the affected individual's sleep[5].

- **Scientific Classification of Cymbopogon citratus**

Cymbopogon species belongs to:

Kingdom	Plantae (plants)
Order	Poales (grasses, sedges, and allies)
Family	Poaceae (true grasses)
Subfamily	Panicoideae (a major lineage of grasses)
Tribe	Andropogoneae (tropical and subtropical grasses)
Subtribe	Andropogoninae (includes aromatic and medicinal grasses)

Fig. 1. Lemongrass plant (Inflorescence, leaf, root and stem)

- **Botanical description**

We are all familiar with lemongrass as a type of plant that comes from the grass family. It has a cluster growth form with short rhizomes, reaching a height of 6 ft (1.8 m) and 4ft (1.2 m) wide. The details related the family of its classification are explained in taxonomy of lemongrass while the anatomical parts of the plant are shown in Figure 1 below.

- **Inflorescence**

The entire inflorescence is 30-60 cm long. Other spikes in the inflorescence are developed but has beenplash.

- **Flowers**

Lemongrass constitutes a specific cultivar and generally does not yield floral structures or inflorescent panicles[6].

- **Leaves**

The bands that look like foliage are about 3 feet in width and droop at the tips. Dimensions of the leaves vary from 0.5 to 1 inch in length. The bluish-green foliage is evergreen and has a citrus fragrance when crushed[7].

Leaf Form	Most of the leaves emerge directly from the substrate without a stem
Leaf margin	Entire
Leaf shape	Linear
Leaf venation	parallel,
Leaf type and persistence	Fragrant
Leaf blade length	18-36 inches
Leaf color	Green
Fall characteristic	conspicuously showy

2. HISTORY OF CYMBOPOGON CITRATUS

Cymbopogon citratus is a perennial botanical species that thrives in subtropical and tropical regions. It has two species: West Indian Cymbopogon citratus and East Indian Cymbopogon flexuosus. The former is cultivated extensively worldwide[8], with the first exports of citronella oil from the Philippines in the 17th century. Lemongrasses are used in herbal tea production, soft drinks, foodstuffs, and confectionery. The oil is applied in perfumery and cosmetic compositions, while citronella oil is used in industrial applications[9]. Lemongrass has insect-repelling and carminative properties, while West Indian lemongrass essential oils have potent antimicrobial activity[10]. East Indian lemongrass volatile oils have marked antifungal activity, although some genotoxic and pesticide features have been observed. Lemongrass is a safe botanical extract/essential oil for human use and versatile, producing excellent herbal tea and being used in cooking as an antibiotic and weed barrier. It grows quickly and is tolerant of drought[11].

3. TRADITIONAL USES OF CYMBOPOGON CITRATUS

Currently, numerous people use phytotherapeutic drugs as integral parts of traditional medicines to cure many health disorders[12-14]. It has been observed that the application of traditional medicines enhances the living standard and health situations among peasant farmers in developing countries[15,16]. Cymbopogon citratus, which is commonly referred as lemongrass, is one of the most widely applied medicinal plants by many people across the world[17-19]. The therapeutic uses of this species have considerable variation based on numerous factors, which include the nature of the disease for which they are used, the plant components used, and the cultural areas of the populations that use them. The whole traditional use of this plant is based on its rich content of bioactive compounds believed to have health benefits in C. citratus[20,21].

In the African setting, economic poverty forces communities to rely on traditional medicine. The uses of C. citratus and its extracts vary with region where they play a practical medicinal function in northern, western, southern, and eastern Africa[22-24]. The western region of Africa, the plant, with all of its parts, is used by people of Ethiopia as an antidote for gastrointestinal discomfort[25-26]. They are commonly administered with the ground fragments, mainly the roots, orally to patients suffering from digestive diseases[27]. In North Africa, this species is primarily utilized by Morocco, Algeria, and Tunisia's indigenous people in their folk medicine[28-31]. In fact, locally reported documents from some Moroccan tribes indicate that C. citratus has been employed to treat bacterial

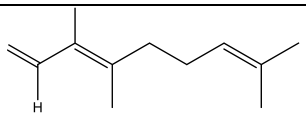
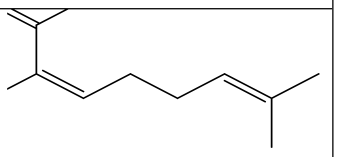
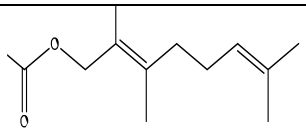
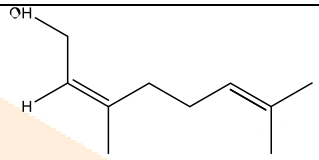
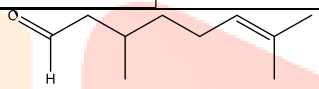
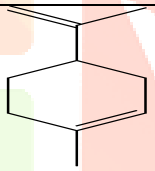
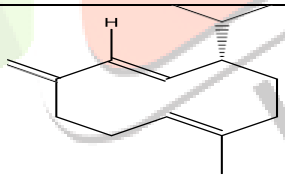
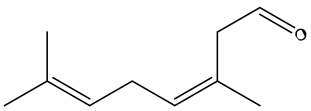
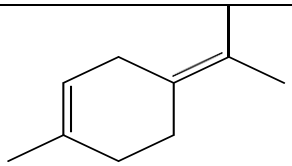
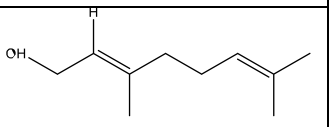
infection cases[32]. In Tunisia, infusions and extracts of Cymbopogon citratus are used by residents. citratus as an antidote against diuretic problems and gastrointestinal disorders[33]. In Egypt, Madi et al. have documented the application of essential oils isolated from Cymbopogon citratus as an agent possessing anticholinesterase activity. In Southern Africa, C. citratus has been extensively used by traditional communities for the treatment of gastrointestinal disorders, pyrexia, and cephalalgia. In Western Africa, specimens of C. citratus that originated in Nigeria have been known to act as antispasmodic[34], while Akono Ntonga et al.[35] recorded the use of essential oils, extracts, and infusions of Cymbopogon citratus in malaria and febrile condition treatment in Cameroon.

Several Asian studies have identified local populations' use of C. citratus for medicinal purposes[36,37]. For example, the Chinese people have used Cymbopogon citratus as an anxiolytic preparation dating back to ancient times[38-40]. Infusion prepared from dried leaves is the most commonly used form of this drug among the Chinese population[41]. The Indonesian population has also described hot-water extracts from the whole plant for aiding emmenagogue activity in orally administered drugs[42-44]. Another study reports the use of the aerial parts of Cymbopogon citratus in Pakistan, it addressed disinfectant requirements beside its use in the treatment of ailments such as stomachic disorders, diuretic needs, rheumatism, and malaria[45].

4. PHYTOCHEMISTRY OF CYMBOPOGON CITRATUS

Citral, geranial, and neral constitute approximately 75% of the aldehydes derived from the essential oil of lemongrass. These compounds are pivotal in contributing to the olfactory characteristics of the plant, thereby facilitating its application in aromatherapy interventions. A plethora of researchers have successfully isolated various chemical constituents from distinct anatomical parts of lemongrass. A specific subset of these compounds includes citral α, citral β, nerol, geraniol, citronellal, terpinolene, geranyl acetate, myrcene, and terpinol methylheptenone. Additionally, two triterpenoids, identified as cymbopogone and cymbopogonol, along with flavonoids such as luteolin and its 6-C-glucoside, have been extracted from the foliage of Cymbopogon citratus. The therapeutic attributes of this plant encompass a range of effects: it is recognized as carminative, fungicidal, analgesic, antiseptic, astringent, and bactericidal, while also exhibiting properties that may mitigate psychological conditions. Moreover, it holds potential for the management of dermatophytic infections, including conditions such as ringworm and athlete's foot, attributable to its inherent antibiotic and antiseptic properties. Empirical evidence supports its significant inhibitory activity against methicillin-resistant Staphylococcus aureus infections. Furthermore, it has been suggested for the treatment of colitis, dyspepsia, and gastroenteritis. It alleviates symptoms associated with headaches, myalgia, nervous fatigue, and stress-related disorders. Its infusions are frequently employed in the therapeutic management of infections such as sore throats, laryngitis, and bronchitis.

Recent scholarly studies have confirmed that the antioxidant activity of plant-based foods is mainly contributed by polyphenols, flavonoids, lignins, alkaloids, terpenoids, carotenoids, vitamins, and other ingredients. These factors delay degradation and extend shelf life, thereby maintaining nutritional quality, since they inhibit lipid oxidation while reducing rancidity as well as eliminating deleterious oxidative by-products[50-53]. Similarly, phenolic compounds are integral to the functionality of antioxidant mechanisms as well as providing a defense against pest resistance and the propagation of various species. Moreover, phenolic compounds are pivotal in the neutralization of reactive oxygen species (ROS), which encompass hydrogen peroxide (H2O2), superoxide anion (O2-), and free radicals produced during metabolic activities within the organism, thereby facilitating the alleviation of oxidative stress[54]. Because of their high reactivity, ROS are known to cause damage to biochemical components such as cell membranes, cellular lipids, proteins, and DNA[55]. These reactive species represent critical factors in the pathogenesis of atherosclerosis, rheumatoid arthritis, muscular degeneration, cataracts, a range of neurological disorders, malignancies, and the senescence process. Consequently, the presence of antioxidants within the organism is imperative to establish a defensive mechanism against the deleterious consequences of oxidative processes initiated by these free radicals. The antioxidant effectiveness of lemongrass essential oil grown in the northern Indian plains is assessed using the DPPH assay, Nitric Oxide assay, reducing power assay, and β-carotene bleaching assay. The authors reported that the IC50 values for the DPPH and NO scavenging assays were established at 0.5 mg/ml and 2 mg/ml, respectively. The reducing capacity produced positive results, shown by a rise in absorbance related to the growing concentration of the oil. In the β-carotene bleaching test, an initial bleaching of 84.1% was noted during the first hour, falling to 46.8% by the end of the second hour. In every experimental procedure, BHT and Gallic acid were used as standard reference comparisons.

Citral	
Neral	
Geranyl acetate	
Nerol	
Citronellal	
Limonene	
Germacrene-D	
Isoneral	
Terpinolene	
Geraniol	

5. THERAPEUTIC PROPERTIES OF CYMBOPOGON CITRATUS

Traditionally, Cymbopogon citratus has been utilized for addressing various medical conditions. Its efficacy stems from the broad variety of secondary compounds that it produces. It was utilized in the treatment of fever, cough, elephantiasis, leprosy, malaria, and gastrointestinal illnesses among various other issues. The use of lemongrass within Ayurvedic practices is still relevant today due to its recognized therapeutic benefits.

At times, traditional medicine presents a fairly extensive array of unwanted side effects.

As a result, phytotherapy has emerged as the most favored alternative to synthetic pharmaceutical agents. In this context, this herbaceous species could hold considerable value in the pharmaceutical industry57-60.

Para ilmuwan Indonesia telah melakukan penelitian dan membuktikan kemampuan dari komponen utama minyak "Sereh Wangi", yang di Indonesia juga disebut serai, yaitu β-sitronelol dalam secara signifikan mengurangi total berat badan tikus yang diberi diet tinggi lemak.

The sympathetic nerve activities in the experimental subjects, triggered by β-citronellol vapor, enhanced metabolic activity in adipose tissue, promoting weight loss. These results are crucial as β-citronellol causes a decrease in body weight without negative impacts on the levels and performance of liver enzymes61. Losing weight is just one of the many benefits linked to citronella grass. Keeping up with oral hygiene is a crucial aspect of daily life for overall wellness. The accumulation of dental plaque leads to gingivitis and periodontitis, both identified as pathological conditions related to oral health. Several studies have indicated that these dental cavities elevate the risk of cardiovascular diseases and ischemic stroke. Lemongrass has demonstrated opposing effects on both planktonic and biofilm states of Candida dubliniensis, a prevalent oral infection. Citronella grass can additionally be used in the production of herbal medicinal products aimed at promoting oral health62-65.

Hyperlipidaemia, hypercholesterolaemia, and hyperglycemia are additional medical diseases that contribute to metabolic illnesses such as diabetes mellitus and obesity. Lemongrass has been shown to have hypoglycemic, hypolipidemic, and hypocholesteremic effects. Reports showing a decrease in very low-density lipoproteins and plasma cholesterol, which are closely linked to cardiovascular diseases, showed that plant extracts were helpful. Hypoglycemia state in rats was induced after 42-day treatment with the use of lemongrass extracts at a dose of 500 mg/kg/day, though the mechanism is not well understood[66-68]. Moreover, several studies have confirmed the anti-inflammatory, anticonvulsant, and anxiolytic effects of lemongrass extracts69,70. Lemon grass is also well-documented in published studies to possess antagonistic properties against pathogenic bacteria, protozoa, and fungi. Leishmaniasis is a significant illness that impacts the human population worldwide on an annual basis to a considerable degree. Research indicates that contact with citral, the primary component of lemon grass oil, induces programmed cell death in the Promastigotes of Leishmania infantum. Research additionally demonstrates that citronella oil prevents the development of Leishmaniasis anexic amastigotes81-83. It was believed that lemon grass could possess anti-protozoan medicinal properties. The capability of Cymbopogon species to impede the growth and Aflatoxin synthesis in Aspergillus sp. and Penicillium has been demonstrated to decrease the spoilage of melon seeds84. Moreover, there are indications of a combined inhibitory effect between the oil and silver nanoparticles.

It is recognized for its effectiveness in fighting infections such as Candida sp., Moraxella, Staphylococcus, Escherichia, and Enterococcus. Furthermore, citronella oil shows notable antifungal properties against Aspergillus niger and Candida sp. by revealing inhibitory zones at distances between 35 and 90 mm85.

Additionally, when given to mice with carrageenan-induced oedema, the oil has effects comparable to those of the synthetic oral medication diclofenac at a dose of 50 mg/kg. The fact that the oil is topically given to croton oil-induced oedematous mice further supports its in vivo anti-inflammatory properties[86].

Lemon grass can be used in the manufacturing of oral drugs derived from plants and in the fabrication of skin

creams that are applied topically.

The characteristics of lemon grass have It determined that limonene, nerol, geranial, geraniol, and myrcene were its main constituents. Thus, it is possible that they are responsible for its anti- inflammatory and microbicidal properties. A significant body of evidence supports the anti- inflammatory effects of monoterpene aldehydes. Research has demonstrated that the bioactive compounds citral, neral, and geranial diminish inflammation by inhibiting the production of IL- 1β, an inflammatory cytokine secreted by macrophages when exposed to pathogens87-90.

Additionally, it has been demonstrated that the bioactive compounds in lemon grass exhibit a considerable antagonistic effect against viruses. In mice, lemon grass has demonstrated antiviral effects against non-enveloped viruses. The mouse norovirus simulates the human norovirus, which is associated with global outbreaks of non-bacterial gastroenteritis. By enclosing the viral capsid, the research's lemon grass oil and citral's tangy aroma reduced the virus's ability to spread.

Preventing it from attaching to host cells. Foodstuffs and surfaces can be sterilised using lemon grass and citral to stop viral infections[91].

A comprehensive study on the bioactive constituents present in citronella grass regarding their anticancer properties has been conducted. The emulsion mixture of citral and lemongrass oil evinced considerable anticancer activity against cervical cell lines, such as HeLa and ME-180, through the regulation of cell proliferation, accompanied by apoptosis induction. Moreover, emulsion treatment altered the mitochondrial membrane potential and increased the levels of production of ROS in the cancerous cells. Additionally, two lipopolysaccharides from lemongrass with (1→4) connected b-D-Xylofuranose units have been shown to trigger apoptosis in the Siha and LNCap reproductive malignant cell lines via the intrinsic apoptotic mechanism[92-94]. Thus, the bioactive principles of lemongrass are likely to become the starting material in formulating effective anti-cancer drugs for the not-so-distant future.

Sl. No.	Properties of Cymbopogon citratus	MOA
1	Anti-hypertensive	Lemongrass extracts may act as natural calcium channel blockers, reducing calcium influx into vascular smooth muscles, leading to relaxation and reduced blood pressure.
2	Anti-bacterial	Essential oils such as β-citral and α-citral have been isolated, characterised and analysed from lemon grass leaf. These compounds are active Anti-bacterial compounds with predominant activities against gram positive and negative bacterial isolated[95].
3	Anti-inflammatory	Suppresses cytokines and prostaglandins that cause inflammation and pain[96].
4	Anti-fungal	Essential oils like citral and geraniol damage bacterial and fungal cell membranes, leading to cell death[97].
5	Anti-diabetic	Active compounds may help regulate blood glucose metabolism[98].
6	Anti-oxidant	Rich in flavonoids and phenolic compounds that prevent cell damage[99].
7	Anti-malaria	Secondary metabolites such as Citral (3, 7-dimethyl-2, 6-octadienal), myrcene and and citronella have been isolated from lemon grass and were characterized as antimalarial compounds[100].

8	Anti-HIV property	Some studies suggest that lemongrass contains compounds that may interfere with HIV reverse transcriptase, the enzyme responsible for converting viral RNA into DNA, which is essential for HIV replication.

6. CHEMICAL COMPOSITION OF CYMBOPOGON CITRATUS

Among many phytochemicals present, chemical composition of several species of essential oils of C. citratus have been extensively studied. The study that was carried out with C. citratus, has shown citrus-based compounds were the principal make up of essential oil profile. An experimental approach has gradually been developed for the investigation, and the sophistication with which researchers enhance their study can be done. The major and trace constituents identified are the essential oils obtained from Cymbopogon citratus. Chemical composition of lemongrass is summarized as follows in Table 1.

Table 1: Chemical composition of Cymbopogon citratus[101-103]

S.No	Components	Percent of oil
1	Terpene	20-70
2	Linalyl acetate	0.1
3	Terpinol	0.45
4	Tetaraniol	20-24
5	Myrecene	0.72
6	Geraniol	0.0-22.5
7	Citral	40.8
8	Nerol	4.18
9	Citronellal	2.10
10	Methylheptenone	0.2
11	Gel-terpine	7.5
12	Ci-Malic	0.0-3.5
13	Borneol	0.1-0.4
14	Jwarankusa	20-6
15	Geranyl acetate	0.83
16	Cihronellular	30-40
17	Pinene	3.5
18	Terpene-piperitone	20-6

Camphor, β-caryophyllene oxide, α-chamigrene, α-cubebene, cuprene, o-cymene, borneol, d- cadinene, calamene, camphene, camphor, β-bisabolene, α-bisabolene, and alleloaromadrenes are the trace components. Citronellol, 1.8-cineole, and 5.6-dimethyl-5-norbornene-2-ol. EU carvone, Eudemon, Fernone, geranyl, geranyl acetate, geranyl formate, geranyl propionate, germacrene, α- farnesene, β-farnesene, fenchone, and geranyl acetate are trace amounts of β-component, d- component, and elemi. Linalool, lavender, spirit cassock, iso-borneol, and α-humulene. Alpha- pineol, α-pineol, β-thuj-2-en-4-ol, verbenone, β-ylangene, cis and α-p-mentha-2, p-mentha-2, methyl thymol ether, α-murolene, myrtenal, phellandrene, myrtenal, and 8-dien-1-ol.

Geraniol and geranyl acetate are the main components of C. citratus leaves, and their levels vary significantly throughout the leaf's growth phases. The percentages of geraniol and geranyl acetate in the essential oil were around 59 and 33, respectively, ten days after the leaf formed. Piperidone, which makes up 54.36% of the essential oil, and phenoldrene, which makes up 30.86%, are its two main ingredients. The basic oil of C.

citratus contained the following substances: flavonoids, phenolic compounds, alcohol, quinones, tannins, and saponins. The main constituents of essential oils are ketones, aldehydes, alcohols, terpenes, citrates, and esters. The luteolin and their content are the orientin 2-O-rhamnoside, quercetin, kaempferol, and apigenin. This table 1 below presents the mineral and vitamin contents of lemongrass.

Table 2: Vitamin/Mineral Content of Cymbopogon citratus[104]

S.No.	Vitamin/mineral	Quantity (mg/100g)
1	Na	54.8
2	Mg	7.0
3	Zn	121
4	Fe	0.0024
5	Mn	0.952
6	Ca	39.5
7	P	89.3
8	K	59.5
9	Phytate	11860

Since infused lemongrass oil has a lot more calories, it is typically created by mixing lemongrass extract with cooking oil, such as canola oil. For example, a widely recognized brand of flavored oil spray contains 40 calories (1 teaspoon) and 4.5 grams of fat per serving, suitable for cooking or storage.

It should be noted, however, that flavored lemongrass oil has significantly higher calorie content. As a result, most flavored oils, like canola oil, mix cooking oils with extracts of lemongrass. Lemongrass stalks are smashed to extract their fragrant oils into the liquid when combined with teas, soups, and other liquid foods. The pieces are soaked in the liquid to release the active aromatic oils contained within. Prior to serving a cocktail, the stems ought to be divided. Prior to incorporating these bulb or lower stalk sections into a curry, salad, marinade, or stir-fry as per a recipe, they should be chopped or minced.

7. CONCLUSION

Cymbopogon citratus is a multifunctional plant that holds significant medicinal, culinary, and industrial importance. Its abundant mix of bioactive substances, including essential oils and flavonoids, enhances its antimicrobial, antioxidant, anti-inflammatory, and therapeutic features. Lemongrass, as a renewable resource, presents encouraging uses in the fields of pharmaceuticals, cosmetics, and complementary medicine. Nonetheless, additional studies are needed to investigate its complete potential, enhance its cultivation methods, and standardize its commercial applications. As global fascination with natural treatments grows, lemongrass presents considerable potential for future developments and breakthroughs.

REFERENCE

1. Haque, A. N. M. A., Remadevi, R., C Naebe, M. (2018). Lemongrass (Cymbopogon): a review of its structure, properties, applications, and recent developments. Cellulose: 25(10), 5455- 5477.
2. Majewska, E., Kozlowska, M., Gruszczynska-Sekowska, E., Kowalska, D., C Tarnowska, K. (2019). Lemongrass (Cymbopogon citratus) essential oil: extraction, composition, bioactivity and uses for food preservation-a review. Polish Journal of Food and Nutrition Sciences: 69(4).
3. Spriha, Singh, R. and Kumar, A. (2021). Lemongrass a Wonder Herb of Poaceae Family: An Overview. Biological Forum – An International Journal, 13(2): 29.
4. Okémy, N. A, Moussoungou, A. S., Koloungous, B. C., C Abena, A (2015). Topical anti-inflammatory effect of aqueous extract ointment of Ageratum conyzoïdes L. in Wistar rat.

International Journal of Phytopharmacy: 5, 37-41.

5. Sisay, B., Debebe, E., C Meresa, A. (2020). Phytochemistry and method preparation of some medicinal plants used to treat asthma-review. J. Anal. Pharm. Res., 9(3), 107-115.
6. Ross, I. A. (2001). Chemical Constituents, Traditional, and Modern Medicinal Use. Humana Press.
7. Alzawqari, M. H., Al-Baddany, A. A., Al-Baadani, H. H., Alhidary, I. A., Khan, R. U., Aqil, G. M., C Abdurab, A. (2016). Effect of feeding dried sweet orange (Citrus sinensis) peel and lemon grass (Cymbopogon citratus) leaves on growth performance, carcass traits, serum metabolites and antioxidant status in broiler during the finisher phase. Environmental Science and Pollution Research, 23(17), 17077-17082.
8. B. Wannissorn, S. Jarikasem, T. Soontorntanasart. (1996). Antifungal activity of lemon grass oil and lemon grass oil cream. Phytotherapy Research. 10(7): 551-554.
9. T. Juntachote, E. Berghofer, F. Bauer, S. Siebenhandl. (2006). The application of response surface methodology to the production of phenolic extracts of lemon grass, galangal, holy basil and rosemary. International journal of food science C technology. 41(2): 121-133.
10. S.S. Shankar, A. Rai, A. Ahmad, M. Sastry. (2005). Controlling the optical properties of lemongrass extract synthesized gold nanotriangles and potential application in infrared-absorbing optical coatings. Chemistry of Materials. 17(3): 566-572.
11. J. Cheel, C. Theoduloz, J. Rodríguez, G. Schmeda- Hirschmann. (2005). Free radical scavengers and antioxidants from Lemongrass (Cymbopogon citratus (DC.) Stapf.). Journal of agricultural and food chemistry. 53(7): 2511-2517.
12. M.F. Manzoor, *et al.* Novel extraction techniques and pharmaceutical activities of luteolin and its derivatives. J. Food Biochem, vol. 43 (9) (2019), 10.1111/jfbc.12974
13. M. Harwood, B.DanielewskaNikiel, J.F. Borzelleca, G.W. Flamm, G.M. Williams, T.C. Lines. A critical review of the data related to the safety of quercetin and lack of evidence of in vivo toxicity, including lack of genotoxic/carcinogenic properties. Food Chem. Toxicol., vol. 45 (11) (2007), pp. 2179-2205, 10.1016/j.fct.2007.05.015
14. S.K. Nordeen, B.J. Bona, D.N. Jones, J.R. Lambert, T.A. Jackson. Endocrine disrupting activities of the flavonoid nutraceuticals luteolin and quercetin. Horm. Cancer, vol. 4 (5) (2013), pp. 293-300.
15. A.S. van Wyk, G. Prinsloo. Health, safety and quality concerns of plant-based traditional medicines and herbal remedies. South Afr. J. Bot., vol. 133 (2020), pp. 54-62, 10.1016/j.sajb.2020.06.031
16. M. Kumar, *et al.* Implementation of the Use of Ethnomedicinal Plants for Curing Diseases in the Indian Himalayas and Its Role in Sustainability of Livelihoods and Socioeconomic Development. Int. J. Environ. Res. Public Health, vol. 18 (4) (2021), 10.3390/ijerph18041509
17. S. Magotra, A.P. Singh, A.P. Singh. A review on pharmacological activities of Cymbopogon citratus. Int. J. Pharm. Drug Anal. (2021), pp. 151-157, 10.47957/ijpda.v9i2.475
18. E.M.H. Méabed, A.I.B. Abou-Sreea, M.H.H. Roby Chemical analysis and giardicidal effectiveness of the aqueous extract of Cymbopogon citratus Stapf Parasitol. Res., vol. 117 (6) (2018), pp. 1745-1755, 10.1007/s00436-018-5855-1
19. E.M.H. Méabed, A.I.B. Abou-Sreea, M.H.H. RobyChemical analysis and giardicidal effectiveness of the aqueous extract of Cymbopogon citratus Stapf. Parasitol. Res., vol. 117 (6) (2018), pp. 1745-1755, 10.1007/s00436-018-5855-1
20. D. Carbajal, A. Casaco, L. Arruzazabala, R. Gonzalez, Z. Tolon. Pharmacological study of Cymbopogon citratus leaves. J. Ethnopharmacol., vol. 25 (1) (1989), pp. 103-107, 10.1016/0378-8741(89)90049-4
21. M.F. Asaolu, O.A. Oyeyemi, J.O. Olanlokun. Chemical compositions, phytochemical constituents and in vitro biological activity of various extracts of Cymbopogon citratus. Pak.

J. Nutr., vol. 8 (12) (2009), pp. 1920-1922

22. C. Unuigbe, J. Enahoro, O. Erharuyi, H.A. Okeri. Phytochemical analysis and antioxidant evaluation of lemon grass (Cymbopogon citratus DC.) Stapf leaves. J. Appl. Sci. Environ. Manag., vol. 23 (2) (2019), 10.4314/jasem.v23i2.4

23. M.O. Soares, R.C. Alves, P.C. Pires, M.B.P.P. Oliveira, A.F. VinhaAngolan Cymbopogon citratus used for therapeutic benefits: Nutritional composition and influence of solvents in phytochemicals content and antioxidant activity of leaf extracts. Food Chem. Toxicol., vol. 60 (2013), pp. 413-418, 10.1016/j.fct.2013.07.064

24. C.P. Boeira, *et al*. Phytochemical characterization and antimicrobial activity of Cymbopogon citratus extract for application as natural antioxidant in fresh sausage. Food Chem., vol. 319 (2020), Article 126553, 10.1016/j.foodchem.2020.126553

25. A. Kumar, A. Gupta, A. Aggarwal, V. Bhargav. Efficacy of bioinoculants on biomass, nutritional status and yield of lemon grass, Cymbopogon citratus (DC.) Stapf. J. Spices Aromat. Crops, vol. 29 (1) (2020), pp. 59-66

26. H.M. Hassan, M.A. Aboel-Ainin, S.K. Ali, A.G.G. Darwish. Antioxidant and Antimicrobial activities of MEOH Extract of Lemongrass (Cymbopogon citratus). J. Agric. Chem. Biotechnol., vol. 12 (2) (2021), pp. 25-28, 10.21608/jacb.2021.149473

27. A.C. Mendes Hacke, E. Miyoshi, J.A. Marques, R.P. Pereira.Anxiolytic properties of Cymbopogon citratus (DC.) stapf extract, essential oil and its constituents in zebrafish (Danio rerio). J. Ethnopharmacol., vol. 260 (2020), Article 113036, 10.1016/j.jep.2020.113036

28. W. Gemechu, A. Meresa, F. Teka, T. Berhau, A. Tadele. An ethno botanical review on medicinal plants used for the management ectoparasitic skin diseases of ruminants. J. Med. Plants, vol. 7 (4) (2019), pp. 212-224

29. M. Kumar, *et al*. Implementation of the Use of Ethnomedicinal Plants for Curing Diseases in the Indian Himalayas and Its Role in Sustainability of Livelihoods and Socioeconomic Development. Int. J. Environ. Res. Public Health, vol. 18 (4) (2021), 10.3390/ijerph18041509

30. S.U. Qadir, V. Raja. Herbal medicine: Old practice and modern perspectives R.A. Bhat, K.R. Hakeem, M.A. Dervash (Eds.), Phytomedicine, Academic Press (2021), pp. 149-180, 10.1016/B978-0-12-824109-7.00001-7

31. T. Kassahun, *et al*. Ethnobotany, traditional use, phytochemistry and pharmacology of Cymbopogon citratus: Review article Int. J. Herb. Med., vol. 8 (4) (2020), pp. 80-87

32. W.C.B. Muala, Z.S.C. Desobgo, N.E. Jong. Optimization of extraction conditions of phenolic compounds from Cymbopogon citratus and evaluation of phenolics and aroma profiles of extract. Heliyon, vol. 7 (4) (2021), 10.1016/j.heliyon.2021.e06744

33. Y. Lahlou, B. El-Amraoui, B. Toufiq. The antibacterial activity screening of the extracts of some Moroccan medicinal plants. Int. J. New Technol. Res., vol. 5 (10) (2019), pp. 31-38

34. A.K. Aremu, O.K. Fadele. Study of some properties of doum palm fruit (Hyphaene thebaica Mart.) in relation to moisture content. Afr. J. Agric. Res., vol. 6 (15) (2011)

35. D.W. Gakuya, *et al*. Traditional medicine in Kenya: Past and current status, challenges, and the way forward. Sci. Afr., vol. 8 (2020), Article e00360, 10.1016/j.sciaf.2020.e00360

36. A. Mariod, H.E. Tahir, M.A. Agab. History of Traditional Medicine Practices in Sudan: REVIEW. Int. J. Tradit. Complement. Med. Res., vol. 4 (1) (2023), 10.53811/ijtcmr.1200069

37. Y.F. Madi, M.A. Choucry, M.R. Meselhy, E.-S.A. El-Kashoury. Essential oil of Cymbopogon citratus cultivated in Egypt: seasonal variation in chemical composition and anticholinesterase activity. Nat. Prod. Res., vol. 35 (21) (2021), pp. 4063-4067, 10.1080/14786419.2020.1713125

38. M.O. Soares, R.C. Alves, P.C. Pires, M.B.P.P. Oliveira, A.F. Vinha. Angolan Cymbopogon citratus used for therapeutic benefits: Nutritional composition and influence of solvents in phytochemicals content and antioxidant activity of leaf extracts. Food Chem. Toxicol., vol. 60 (2013), pp. 413-418, 10.1016/j.fct.2013.07.064

39. O.A. Lawal, A.L. Ogundajo, N.O. Avoseh, I.A. Ogunwande. Chapter 18 - Cymbopogon citratus. V. Kuete (Ed.), Medicinal Spices and Vegetables from Africa, Academic Press (2017), pp. 397-423, 10.1016/B978-0-12-809286-6.00018-2

40. P. Akono Ntonga, N. Baldovini, E. Mouray, L. Mambu, P. Belong, P. Grellier. Activity of Ocimum basilicum, Ocimum canum, and Cymbopogon citratus essential oils against Plasmodium falciparum and mature-stage larvae of Anopheles funestus s.s. Parasite, vol. 21 (2014), p. 33, 10.1051/parasite/2014033

41. D.-C. Zhou, *et al*. Comprehensive evaluation on anti-inflammatory and anti-angiogenic activities in vitro of fourteen flavonoids from Daphne Genkwa based on the combination of efficacy coefficient method and principal component analysis. J. Ethnopharmacol., vol. 268 (2021), Article 113683, 10.1016/j.jep.2020.113683

42. Y.L.E. Loko, *et al*. Bioactivity of essential oils of Cymbopogon citratus (DC) Stapf and Cymbopogon nardus (L.) W. Watson from Benin against Dinoderus porcellus Lesne (Coleoptera: Bostrichidae) infesting yam chips. Int J. Trop. Insect Sci., vol. 41 (1) (2021), pp. 511-524, 10.1007/s42690-020-00235-3

43. N. Zhang, L. Yao. Anxiolytic effect of essential oils and their constituents: a review. J. Agric. Food Chem., vol. 67 (50) (2019), pp. 13790-13808, 10.1021/acs.jafc.9b00433

44. J. Gaba, G. Bhardwaj, A. Sharma. G.A. Nayik, A. Gull (Eds.), Antioxidants in Vegetables and Nuts - Properties and Health Benefits, Springer, Singapore (2020), pp. 75-103, 10.1007/978-981-15-7470-2_4

45. G. Volpato, D. Godínez, A. Beyra, A. Barreto. Uses of medicinal plants by Haitian immigrants and their descendants in the Province of Camagüey, Cuba. J. Ethnobiol. Ethnomed., vol. 5 (1) (2009), p. 16, 10.1186/1746-4269-5-16

46. Y.L.E. Loko, *et al*. Bioactivity of essential oils of Cymbopogon citratus (DC) Stapf and Cymbopogon nardus (L.) W. Watson from Benin against Dinoderus porcellus Lesne (Coleoptera: Bostrichidae) infesting yam chips. Int J. Trop. Insect Sci., vol. 41 (1) (2021), pp. 511-524, 10.1007/s42690-020-00235-3

47. Y.F. Madi, M.R. Meselhy, E.-S.A. El-Kashoury, M.A. Choucry. Morphological and Anatomical Characterization of Cymbopogon citratus (DC.) Stapf Cultivated in Egypt. Bull. Fac. Pharm. Cairo Univ., vol. 60 (1) (2022), 10.54634/2090-9101.1032

48. D. Boukhalfa, N.E.Y. Yaha, B. Nabti, D. Boukhalfa, N.E.Y. Yaha, B. Nabti. Phytochemical analysis and biological activity of the essential oil of lemongrass (Cymbopogon schoenanthus (L.) Spreng) from the Algerian Sahara. GSC Biol. Pharm. Sci., vol. 22 (3) (2023), 10.30574/gscbps.2023.22.3.0103

49. O. Avoseh, O. Oyedeji, P. Rungqu, B. Nkeh-Chungag, A. Oyedeji. Cymbopogon species;

ethnopharmacology, phytochemistry and the pharmacological importance. Molecules, vol.20 (5) (2015), 10.3390/molecules20057438

50. E.M.H. Méabed, A.I.B. Abou-Sreea, M.H.H. Roby. Chemical analysis and giardicidal effectiveness of the aqueous extract of Cymbopogon citratus Stapf. Parasitol. Res., vol. 117 (6) (2018), pp. 1745-1755, 10.1007/s00436-018-5855-1
51. M. Aourach, G.F. Barbero, A.V. González de Peredo, A. Diakite, M. El Boukari, H. Essalmani. Composition and antifungal effects of aqueous extracts of Cymbopogon citratus, Laurus nobilis and Santolina chamaecyparissus on the growth of Fusarium oxysporum f. sp. Lentis. Arch. Phytopathol. Plant Prot., vol. 54 (19-20) (2021), pp. 2141-2159, 10.1080/03235408.2021.1922169
52. A. Boudechicha, *et al*. Microfluidizing technique application for Algerian Cymbopogon citratus (DC.) Stapf effects enhanced volatile content, antimicrobial, and anti- mycotoxigenic properties. Molecules, vol. 28 (14) (2023), 10.3390/molecules28145367
53. Y. Lahlou, B. El-Amraoui, B. Toufiq. The antibacterial activity screening of the extracts of some Moroccan medicinal plants. Int. J. New Technol. Res., vol. 5 (10) (2019), pp. 31-38
54. A. Khadri, *et al*. Antioxidant, antiacetylcholinesterase and antimicrobial activities of Cymbopogon schoenanthus L. Spreng (lemon grass) from Tunisia. LWT - Food Sci. Technol., vol. 43 (2) (2010), pp. 331-336, 10.1016/j.lwt.2009.08.004
55. I. Trabelsi, S. Mouna, I. Amri, N.B. Brahim. Chemical composition and allelopathic activity of lemongrass (Cymbopogon citratus) essential oils growing in Tunisia. Tunis. J. Plant Prot., vol. 14 (2) (2019), pp. 39-48
56. W.M. Torres-Avilez, F. dos Santos Silva, U.P. Albuquerque. Cymbopogon citratus (DC.) Stapf. U.P. Albuquerque, U. Patil, Á. Máthé (Eds.), Medicinal and Aromatic Plants of South America: Brazil, Springer Netherlands, Dordrecht (2018), pp. 183-196, 10.1007/978-94-024- 1552-0_16
57. Vazquez-Briones, Hernandez IR, Guerrero-Beltran JA. J Food Res. 2015; 4(3):36-45.
58. 26. Shah G, Shri R, Panchal V, Sharma N, Singh B, Mann AS. Scientific basis for the therapeutic use ofCymbopogon Citratus (Lemon grass) J Adv. Pharm. Technol. Res. 2011; 2(1):3-8.
59. A. Khadri, *et al*. Antioxidant, antiacetylcholinesterase and antimicrobial activities of Cymbopogon schoenanthus L. Spreng (lemon grass) from Tunisia. LWT - Food Sci. Technol., vol. 43 (2) (2010), pp. 331-336, 10.1016/j.lwt.2009.08.004
60. A. Boudechicha, *et al*. Microfluidizing technique application for Algerian Cymbopogon citratus (DC.) Stapf effects enhanced volatile content, antimicrobial, and anti- mycotoxigenic properties. Molecules, vol. 28 (14) (2023), 10.3390/molecules28145367
61. 27. Becker EM, Nissen LR, Skibsted LH. European Food Res. and Tech. 2004; 219:561-571
62. Joseph Mercola. Benefit of lemongrass oil. Edmon Agron Lemongrass as mosquito repellent word, 2005
63. Fukumoto LR, Mazza G. Assessing antioxidant and prooxidant activities of phenolic compounds.Journalof Agricultural and Food Chemistry. 2000; 48(8):3597-3604.
64. Valko M, Leibfritz D, Moncol J, Cronin MTD, Mazur M, Telser M. Free radicals and antioxidants in normal physiological functions and human disease. International Journal of Biochemistry and Cell Biology. 2007; 39(1):44-84.
65. Sies H. Oxidative stress: oxidants and antioxidants. Experimental Physiology, 1997; 82(2):291-

295.

66. Prakash D, Gupta KR. The antioxidant phytochemicals of nutraceutical importance. The Open Nutraceuticals Journal. 2009; 2:20-35.

67. Heo SJ, Lee KW, Song CB, Jeon YJ. Antioxidant activity of enzymatic extracts from brown seaweeds. Algae. 2003; 18:71-81.

68. Devasagayam TPA, Tilak JC, Boloor KK, Sane Ketaki S, Ghaskadbi Saroj S, Lele RD. Free Radicals and Antioxidants in Human Health: Current Status and Future Prospects. Journal of Association of Physicians of India. 2004; 52:794-804.

69. Lawrence R, Lawrence K, Srivastava R, Gupta D. Antioxidant activity of lemon grass essential oil (Cympopogon citratus) grown in North Indian plains. The Scientific Temper. 2015; 4:23-29.

70. Sforcin JM, Amaral JT, Fernandes A, Sousa JPB, Bastos JK. Lemongrass effects on IL-1ß and IL-6 production by macrophages. Natural Product Research, 23, 2009, 1511-1519.

71. Tarek N, Hassan HM, AbdelGhani SM, Radwan IA, Hammouda O, El-Gendy AO. Comparative chemical and antimicrobial study of nine essential oils obtained from medicinal plants growing in Egypt. Beni-Suef University,
Journal of Basic and Applied Sciences, 3, 2014, 149-156.

72. Azeredo CMO, Soares MJ. Combination of the essential oil constituents citral, eugenol and thymol enhance their inhibitory effect on Crithidiafasciculata and Trypanosoma cruzi growth. Revista Brasileira de Farmacognosia, 23, 2013, 762-768.

73. Bassolé IHN, Lamien-Meda A, Bayala B, Obame LC, Ilboudo AJ, Franz C Novak J, Nebié RC, Dicko MH. Chemical composition and antimicrobial activity of Cymbopogoncitratus and Cymbopogongiganteus essential oils alone and in combination, Phytomedicine, 18, 2011, 1070-1074.

74. Karbach J, Ebenezer S, Warnke PH, Behrens E, Al-Nawas B. Antimicrobial effect of Australian antibacterial essential oils as alternative to common antiseptic solutions against clinically relevant oral pathogens, Clinical Laboratory, 61, 2014, 61-68.
75. Trindade LA, de Araújo Oliveira J, de Castro RD, de Oliveira. Lima E. Inhibition of adherence of C. albicans to dental implants and cover screws by Cymbopogonnardus essential oil and citronellal, Clinical Oral Investigations, 19, 2015, 1-9.
76. Wannissorn B, Jarikasem S, Siriwangchai T, Thubthimthed S. Antibacterial properties of essential oils from Thai medicinal plants. Fitoterapia, 76, 2005, 233-236.
77. Pereira RS, Sumita TC, Furlan MR, Jorge AOC, Ueno M. Antibacterial activity of essential oils on microorganisms isolated from urinary tract infection. Revista de Saude Publica, 38, 2004, 326-328.
78. Tadtong S, Watthanachaiyingcharoen R, Kamkaen N. Antimicrobial constituents and synergism effect of the essential oils from Cymbopogoncitratus and Alpiniagalangal. Natural Product Communications, 9, 2014, 277-280.
79. Friedman M, Henika PR, Levin CE, Mandrell RE. Antibacterial activities of plant essential oils and their components against Escherichia coli O157: H7 and Salmonella enterica in apple juice. Journal of Agricultural and Food Chemistry, 52, 2004, 6042-6048.
80. Cardoso J, Soares MJ. In vitro effects of citral on Trypanosoma cruzimetacyclogenesis. Memórias do Instituto Oswaldo Cruz, 105, 2010, 1026-32.
81. Desjeux P. Leishmaniasis: current situation and new perspectives, Comparative

Immunology, Microbiology and Infectious Diseases, 27, 2004, 305-318.
82. Machado M, Pires P, Dinis AM, Santos-Rosa M, Alves V, Salgueiro L, Cavaleiro C, Sousa MC. Monoterpenic aldehydes as potential anti-Leishmania agents: Activity of Cymbopogoncitratus and citral on L. infantum, L. tropica and L. major. Experimental Parasitology, 130, 2012, 223-231.
83. Santin MR, dos Santos AO, Nakamura CV, Dias Filho BP, Ferreira ICP, Ueda-Nakamura T. In vitro activity of the essential oil of Cymbopogoncitratus and its major component (citral) on Leishmania amazonensis. Parasitology Research, 105, 2009, 1489-1496.
84. Bankole SA, Joda AO. Effect of lemon grass (Cymbopogoncitratus Stapf) powder and essential oil on mould deterioration and aflatoxin contamination of melon seeds (Colocynthiscitrullus L.). African Journal of Biotechnology, 3, 2004, 52-59.
85. Ahmad A, Viljoen A. The in vitro antimicrobial activity of Cymbopogon essential oil (lemon grass) and its interaction with silver ions. Phytomedicine, 22, 2015, 657-665.
86. Boukhatem MN, Ferhat MA, Kameli A, Saidi F, Kebir HT. Lemon grass (Cymbopogoncitratus) essential oil as a potent anti-inflammatory and antifungal drugs. Libyan Journal of Medicine, 9, 2014, 25431.
87. Miguel MG. Antioxidant and anti-inflammatory activities of essential oils: a short review. Molecules, 15, 2010, 9252-9287.
88. Tiwari M, Dwivedi UN, Kakkar P. Suppression of oxidative stress and pro-inflammatory mediators by Cymbopogoncitratus DC. Stapf extract in lipopolysaccharide stimulated murine alveolar macrophages. Food and Chemical Toxicology, 48, 2010, 2913-2919.
89. Pérez GS, Zavala SM, Arias GL, Ramos LM. Anti-inflammatory activity of some essential oils. Journal of Essential Oil Research, 23, 2011, 38-44.
90. Bachiega TF, Sforcin JM. Lemongrass and citral effect on cytokines production by murine macrophages. Journal of Ethnopharmacology, 137, 2011, 909-913.
91. Gilling DH, Kitajima M, Torrey JR, Bright KR. Mechanisms of antiviral action of plant antimicrobials against murine norovirus. Applied and Environmental Microbiology, 80, 2014, 4898-4910.
92. Gautam N, Mantha AK, Mittal S. Essential oils and their constituents as anticancer agents: a mechanistic view. BioMed Research International, 2014, 2014, 1-23.
93. Ghosh K. Anticancer effect of lemongrass oil and citral on cervical cancer cell lines. Pharmacognosy Communications, 3, 2013, 41-48.
94. Thangam R, Sathuvan M, Poongodi A, Suresh V, Pazhanichamy K, Sivasubramanian S Kanipandian N, Ganesan N, Rengasamy R, Thirumurugan R, Kannan S. Activation of intrinsic apoptotic signaling pathway in cancer cells by Cymbopogoncitratus polysaccharide fractions. Carbohydrate Polymers, 107, 2014, 138-150.